The good, the bad, and the ugly

Resource nationalism, geopolitics, and processing strategic minerals in Indonesia, South Africa, and Malaysia

Clingendael Report

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May 2024

Cover photo Nickel processing in IMIP, Indonesia (left), Platinum ore in Rustenburg, South Africa (top right), 2019 protest against Lynas permit extension in Malaysia (bottom right). © Shutterstock

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Executive Summary

Strategic minerals are essential to the modern-day technologies that enable the digital and climate transitions, as well as to the development of advanced military systems. However, their production and processing is concentrated in a handful of countries. There are growing concerns across Europe that this creates unwanted economic dependencies and can become a source of geopolitical leverage. In response, the European Union and its member states are developing policies to reduce their exposure to possible economic coercion while securing the supply of minerals to pursue their decarbonisation and digital strategies. In order to do so, a better understanding of the resource policies of key suppliers of strategic minerals is needed.

Much of the focus so far has been on those countries where strategic minerals are extracted. This study focuses on the role played by states that hold key positions in the processing of strategic minerals. This research looks at three minerals in three mineral-processing countries:

- Nickel in Indonesia
- Platinum Group Metals (PGMs) in South Africa
- Rare Earth Elements (REEs) in Malaysia

The questions this research addresses are: how do the policies of resource-processing countries impact European and Dutch efforts to achieve security of supply? Do these countries pursue resource nationalism, and if so, what does it mean for European efforts to reduce unwanted economic dependencies? What policies are the US and China pursuing regarding these strategic minerals?

Case-studies

Nickel is a key input to produce batteries for electric vehicles. In a clear expression of resource nationalism, Indonesia, the world's largest nickel producer and processor, implemented an export ban on nickel ore, which attracted a large amount of Chinese investment into Indonesia's nickel sector. Aside from concerns over environmental damage and labour conditions, the deep involvement of Chinese companies now makes the US government hesitant to pursue a strategic materials deal with Indonesia. For similar reasons, European investment in Indonesian nickel processing would deepen Europe's dependence on Chinese entities, instead of contribute to de-risking. European governments would avoid

this if they invested in the entire upstream chain of Indonesian nickel production. But this is unlikely, amongst other things because it would run counter to Europe's current critique of the Indonesian government's nickel ore export ban. An alternative would be to reduce Europe's dependence on foreign nickel imports altogether by investing in substitution, innovation and circularity.

Platinum Group Metals (PGMs) are used in catalytic converters (reducing pollutants) and in polymer electrolyte membrane (PEM) hydrogen technologies. South Africa is the world's largest PGM producer and processor. Risks surrounding PGM production in South Africa are caused by electricity shortages as well as labour strikes triggered by concerns over working conditions in the mining sector. These risks stem from domestic economic issues, rather than geopolitical ones.

South Africa aims to further develop its PGM industry and become a key supplier for the global hydrogen economy. For now, there is no plan to introduce a PGM export ban. American and Chinese parties do not play any major role in South Africa's PGM processing industry. European governments could work with South Africa to help address problems in its electricity grid and improve labour conditions, as part of broader EU-South Africa development cooperation. The United States is investing in PGM recycling and PGM-free hydrogen technologies to reduce its dependence on foreign imports. This could become an area of transatlantic cooperation.

Rare Earth Elements (REEs) are used in a number of critical technologies, including permanent magnets for wind turbines and advanced weapons systems. REE processing in Malaysia increased in response to concerns over Chinese REE supplies to Japan in the early 2010s. The Australian company Lynas processes REE in Malaysia. Its plant now accounts for 12% of total global REE processing. The Lynas REE mine in Australia and its REE processing facility in Malaysia together form the only non-Chinese REE supply chain. But REE processing is controversial due to the radioactive by-products associated with the method of processing, and the Malaysian government is putting pressure on Lynas to reduce the environmental risks. China remains by far the world's largest REE miner and processor, although the US and Australia are currently planning to open REE processing facilities of their own. When they do, Malaysia's position in the global REE supply chain will become less important. European governments should help stimulate research and collaboration into non-radioactive REE

processing techniques while simultaneously investing in innovation and recycling to reduce demand for foreign REE supplies.

Geopolitics and the importance of understanding market compositions

The market composition of the minerals processing sector in each of the countries stands out as a key feature to understand the degree to which resource politics are an issues of concern. In the case of nickel, Chinese dominance of the Indonesian nickel sector has been an inadvertent result of Indonesia's export ban. This is now an important, geopolitical determinant stifling cooperation opportunities with the US in the field of nickel processing.

In the case of PGMs, we found no evidence of explicit resource nationalism, which is in part related to the composition of the South African PGM market. This market is characterised by a few publicly traded private companies with headquarters located in South Africa and the United Kingdom. Nevertheless, resource nationalism may be an issue of concern for other minerals produced in South Africa.

Malaysia's position in the global REE supply chain is driven by geopolitics. Its geopolitical relevance with regards to global REE production is based on the presence of one company, Australia's Lynas. Australian and US steps to develop domestic REE processing facilities aimed at reducing their foreign dependence – or a technological breakthrough reducing the radioactive content of REE processing – could change Malaysia's role altogether.

All three cases demonstrate the relevance of domestic economic, social and environmental practices in shaping their approach to strategic minerals processing. This includes the ecological damage associated with nickel processing and REE production, labour conditions in the mining sector and the broader development challenges of primary resource exporters. The Netherlands and the EU would do well to keep this in mind.

All three cases demonstrate the importance of investing in demand-reduction for critical minerals through substitution, innovation and circularity, as well as exploring diversification of supplies. The potential benefits of close cooperation with the United States on these issues emerges from all three cases.

Recommendations

Nickel:

- ➔ **Reduce nickel demand** through investment in substitution, innovation and circularity of nickel usage, including in a transatlantic context.
- ➔ **Invest in alternative nickel ecosystems** in Indonesia to stimulate diversification from China. However, this is very costly and would run contrary to current European complaints – also at the WTO – concerning Indonesia's export ban.
- ➔ **Collaborate with the Indonesian government and/or Chinese nickel producers in Indonesia** to promote more sustainable processing techniques.

PGMs:

- ➔ **Reduce reliance** on platinum imports by investing in domestic recycling and research into PGM-free technologies. Transatlantic cooperation could yield promising results.
- ➔ Ensure a stable PGM supply from South Africa by **promoting stability of the electricity grid** and helping address **issues surrounding labour conditions**.

REEs:

- ➔ Ensure the availability of a non-Chinese REE supply by **facilitating cooperation between Dutch companies and Australian company Lynas**, involving Australia, Malaysia and the US.
- ➔ Cooperate with Malaysia, Australia and the United States to increase research innovation into **'non-radioactive' REE processing techniques**.
- ➔ Invest in **recycling and innovation** in the use of REEs to increase the potential of EU-based REE production.

Introduction

Governments are spending increasing amounts of time developing policies to secure the supply of strategic minerals necessary to pursue the green and digital transitions.[1] The production of strategic minerals is characterised by a high degree of geographic concentration and limited opportunities for substitution.[2] European economies are dependent on only a few suppliers, which increasingly see their resource wealth as a tool of economic and geopolitical influence. As economies seek to get access to green and digital technologies, the supply chains that make these technologies possible are at risk of becoming subject to geopolitical pressures, rightfully worrying governments and businesses alike.

The United States, the EU and individual member states are mapping their dependence on strategic minerals, and are drafting policies to reduce their exposure and achieve security of supply. For instance, the EU has recently adopted a Critical Raw Materials Act which contains ambitious targets on diversification, substitution and domestic production and recycling. Similarly, the Netherlands has agreed a 'National Raw Materials Strategy'. As the Dutch strategy mentions: "Control of critical raw materials is of not only economic but increasingly also geopolitical importance…Countries are increasingly prepared to use their economic influence as a geopolitical weapon…The energy transition increases the chance of shortages, and geopolitical developments may put international supply under further pressure."[3] For Europe, implementing policies to reduce dependencies is the next step. But in order to do so, a better understanding of the resource policies of key suppliers of strategic minerals is needed.

When it comes to the security of supply of strategic minerals, it has become commonplace to focus on the role played by China. The country is the largest

1 The authors are grateful to Anniek Sienot for her support in this research.

2 Throughout this report the authors have made an effort to use the same terms to describe certain metals and minerals as they appear in official policy documents. Nevertheless, because definitions and assessments may differ between governments, the terms "strategic metals" and "critical metals", or "strategic minerals" and "critical minerals" are at times used interchangeably.

3 Rijksoverheid, *National raw materials strategy: material resources for the major transitions* (The Hague: Rijksoverheid, December 2022), 3 & 4.

producer of a variety of minerals and intermediate products crucial to the green and digital transitions. This raises concerns in Western capitals as Beijing could use its dominant position in a number of commodity markets as a source of economic coercion. Indeed, no analysis of the field would be complete without taking China's actions and policies into account. Similarly, the United States, as the largest consumer of many strategic metals – but also because of its domestic resource-wealth – plays a crucial role. Its great power competition with China adds an extra dimension, as it raises the spectre that geopolitical competition between Washington and Beijing could lead to a disruption of critical technology supply chains. But the geopolitics of strategic minerals goes well beyond China, and the US response to it.

This study focuses on the role played by three states that hold key positions in the refining and processing of three strategic minerals. The fact that these countries have developed a key position in refining or processing is now increasingly of geopolitical importance. Similar to the extraction of critical materials, refining and processing is often geographically concentrated with limited opportunities for substitution.

In order to develop security of supply, it is important to better understand how these countries are (or are not) using their position in the supply chain to pursue geopolitical or resource nationalist ambitions. This then helps to inform policy choices for the EU and its member states.

The three countries in this research – Indonesia, South Africa, and Malaysia – have become essential nodes in the supply chains of nickel, Platinum Group Metals (PGMs), and Rare Earth Elements (REEs). The EU has designated platinum group metals and light rare earth elements as "critical raw materials", while nickel is considered a "strategic raw material" essential for the European economy and for the energy transition. While Indonesia and South Africa are also major extractors of nickel or PGMs and have expanded in the realm of refining, Malaysia has little extraction yet is one of the few non-Chinese sources of refining for REEs.

What type of policies are resource-processing countries pursuing, and how do they impact Europe's and the Netherlands' ability to achieve security of supply? Is resource nationalism increasingly pursued by these countries, and if so, what does it mean for European efforts to reduce unwanted dependencies? This research explores the policies of these countries in relation to their

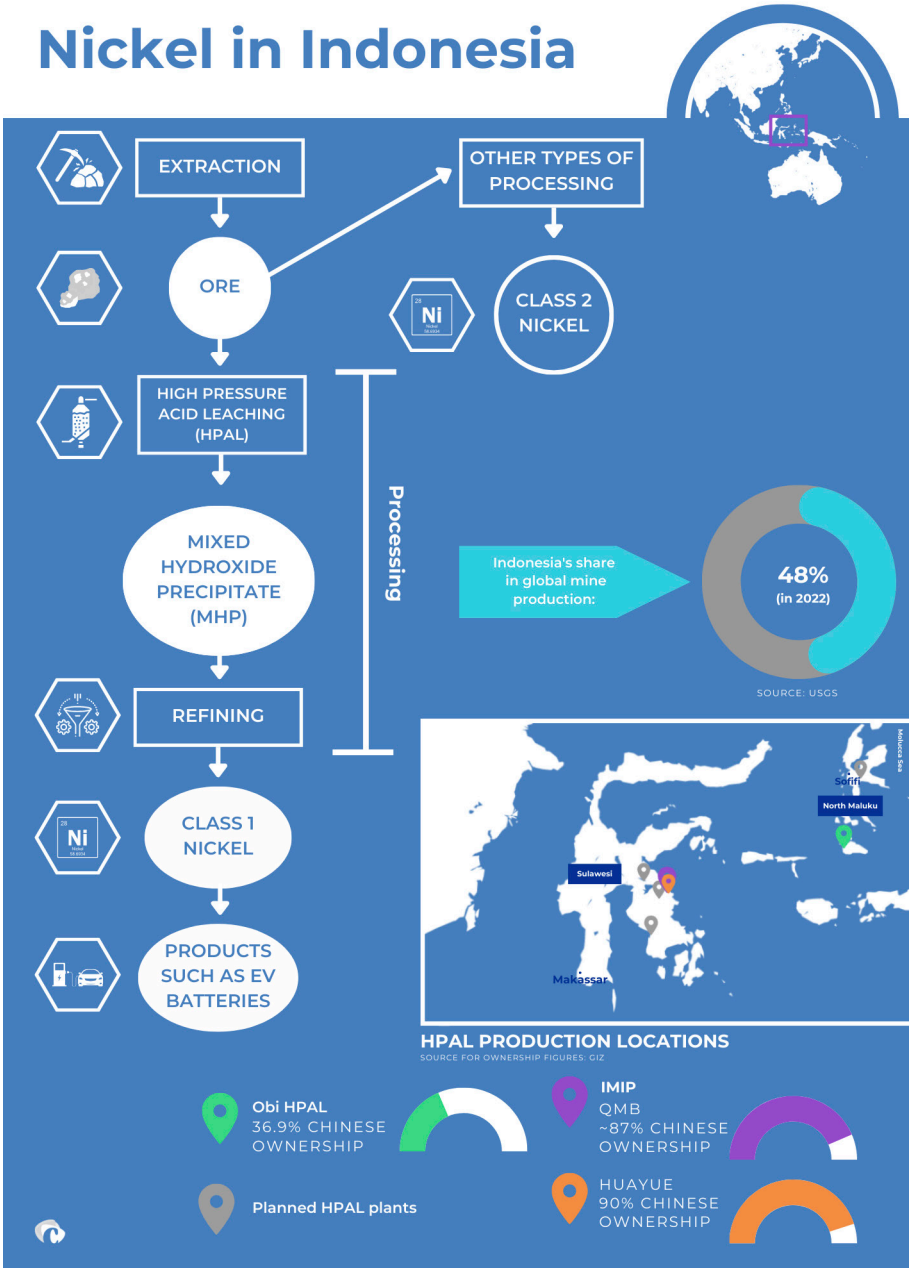
resource wealth and relevant domestic political and social-economic dynamics, including labour rights and sustainability, the domestic market composition and ownership structure of the mining sector, and the role played by China and the United States. Each case study will explore the (geo)political and economic challenges and opportunities connected with the policies of these resource-refining countries.

The national raw materials strategy of the Netherlands highlights five policy priorities to increase the security of supply of strategic minerals:

- Circularity and innovation
- Sustainable European mining and refining
- Diversification of sources
- Greater sustainability of international supply chains
- Knowledge-building and monitoring

Each case study will follow the same outline and close with a brief assessment of the degree to which these five policy approaches apply or are relevant to the minerals and countries concerned. From the case studies, it becomes clear that there is no one-size-fits-all. There are major differences in the way each minerals-processing country deals with the central position it has in the global supply chain. While some countries are subject to geopolitical pressures, resource nationalism is not apparent everywhere, and domestic factors play a role. Instead, a deeper understanding of the country, its policies, and particularly the domestic dynamics shaping market conditions and the ownership structure of the minerals sector is necessary to make a clear assessment of how resource policies in these countries may develop, and what this means for the EU and the Netherlands. Each case study shows an element of 'good', 'bad' and 'ugly'. All three cases demonstrate the need to make trade-offs. How the EU and the Netherlands deal with these trade-offs will determine how access to strategic minerals will impact Europe's geopolitical predicament.

Figure 1 Nickel refining in Indonesia



Indonesia and Nickel

Class-1 Nickel: an essential ingredient in batteries

Nickel has a variety of metallurgical uses, depending on its degree of refinement. The majority of the nickel ore mined around the world is used to produce stainless steel and other alloys. For this, so-called 'class-2' nickel suffices. Class-2 nickel has a purity of less than 99.8% and is mainly produced in the form of nickel pig iron (NPI) and ferronickel (FeNi). For usage in electric vehicle (EV) batteries however, a higher degree of purity is required. Class-1 nickel is refined to a purity of at least 99.8%. **Its use in EV batteries, and given the role these batteries play in the green energy transition, has led nickel to be classified a critical or strategic material by the US, China and the EU.**

Nickel alloys play an important role in aerospace, including in components for jet engines.[4] But class-2 nickel is often used to produce these alloys, which is easier to source globally.[5] Advanced military technology however, increasingly relies on the use of lithium-ion batteries. For these reasons we will focus on class-1 nickel in this case study.

Lithium-ion batteries are used in almost all plug-in electric vehicles. In recent years, there has been a gradual increase in the nickel-content (class-1) of the most popular batteries. Lithium nickel manganese cobalt oxide (NMC) batteries had a market share of 60% in 2022 and contain a relatively large amount of nickel. Commercially successful NMC batteries include NMC811 (80% nickel, 10% manganese, 10% cobalt) and NMC622 (60% nickel, 20% manganese, 20% cobalt).[6] Among NMC producers, since 2019 the trend has been to phase out those with high cobalt and low nickel content (such as the NMC333 battery) and instead make use of high nickel-low cobalt (such as NMC811) chemistries.[7]

4 Mark Lessard, "New high temperature alloy for aerospace applications," ThermoFisher Scientific, published May 2, 2019.

5 Emmanuel Hache, Charlène Barnet and Gondia-Sokhna Seck, *Nickel in the energy transition: why is it called the devil's metal?* (Paris: IFP Energie Nouvelles, March 29, 2021), pp. 1-12.

6 Energy Technology Policy Division, *Global EV Outlook 2023: Catching up with climate ambitions* (Paris: IEA, 2023), pp. 55-62.

7 Ibid, pp. 39.

There are also alternative batteries that do not contain nickel, such as lithium iron phosphate (LFP) batteries. They have a market share of almost 30%.

Due to rising demand from the clean energy sector, the demand for nickel is increasing. The International Energy Agency (IEA) has calculated that based on current technologies, global production of nickel needs to increase 19-fold from 2020 to 2040 if the world is to meet the objective of the 2015 Paris Agreement on Climate Change. Clean energy applications are already the main driver behind rising demand for nickel and this is expected to continue.[8]

There are two types of nickel ores: laterite and sulphide ores.[9] These ores typically have a nickel content of less than 2.5-3 percent. Processing class-1 nickel from laterite ores is technologically more challenging, more expensive and more environmentally damaging than the process for sulphide ores. Indonesia mines laterite ores. To do so, it relies on a process called High Pressure Acid Leaching (HPAL) to produce an intermediate product called Mixed Hydroxide Precipitate (MHP), which is then refined into class-1 nickel. Another route from laterite ores to class-1 nickel currently under development involves creating nickel matte from nickel pig iron. This process, however, is more energy intensive than HPAL and four times more environmentally polluting than sulphide ore refinement.[10]

Nickel processing in Indonesia

Indonesia is the largest producer of nickel worldwide. According to the US Geological Survey, Indonesia accounted for 48 percent of estimated global production in 2022.[11] Next to the production of class-2 nickel, Indonesia recently shifted to producing class-1 nickel through the construction of HPAL plants. It currently has three plants in operation. All three plants are joint ventures with

8 "Total nickel demand by sector and scenario, 2020-2040," IEA, modified May 3, 2021.

9 National Minerals Information Center, "Nickel Statistics and Information," U.S. Geological Survey, accessed September 6, 2023.

10 IEA, *Critical Minerals Market Review 2023* (Paris: IEA, July 2023), pp. 34. "The case for low-grade sulfide nickel deposits," AheadOfTheHerd, published October 4, 2022.

11 Michele E. McRae, *Nickel* (Washington: U.S. Geological Survey Mineral Commodities Summaries, January 2023), 1-2.

Chinese companies and together they produce around 160,000 tonnes[12] of MHP (for battery use).[13] In comparison, in 2021 Indonesia produced 2,364,600 tonnes of class-2 nickel products such as nickel pig iron, ferronickel and nickel matte.[14] It means that roughly 6 per cent of Indonesia's nickel processing volume is destined for battery production. Aside from Indonesia, Russia, New Caledonia, and Canada are major producers of ore for class-1 nickel production.[15]

Indonesia's Three HPAL Plants

Joint ventures are common in this industry for financial and economic reasons, which triggers a degree of vertical integration in the sector. Mining companies that extract the ore seek to expand into processing/refining as this adds value, while battery producers aim to secure inputs for their products.[16]

Indonesia Morowali Industrial Park: 2 plants

Located on the east coast of Central Sulawesi, the Indonesia Morowali Industrial Park (IMIP) is a joint venture between Chinese and Indonesian companies. The Park hosts nickel mines, smelters, and two HPAL plants.

The first HPAL plant is **QMB New Energy Materials HPAL**. This is a joint venture between five companies and is majority Chinese-owned:

- GEM New Materials, which owns 36% of the plant. GEM New Materials is fully owned by GEM Co. Ltd., (格林美) a Chinese company listed on the Shanghai Stock Exchange. Since 2022, it has a secondary listing on the Swiss Stock Exchange.[17]

12 This report uses the British term 'tonne' to refer to a metric ton of 1,000 kg.

13 Joseph Rachman, "Indonesia fast-tracks its electric vehicle ambitions," *The Diplomat*, October 26, 2023.

14 Muhammad Habib Abiyan Dzakwan, "Indonesia's surging nickel industry must embrace greater social and environmental safeguards," *Fulcrum*, June 20, 2023.

15 Raghav Jain, "Class 1 Ni shortfall complicates nickel supply chain," *Argus*, April 29, 2022.

16 Ker Liang Chan, "The promise and pitfalls of Indonesia's Nickel boom," *S&P Global*, March 13, 2023.

17 Jannick Saegert, Vovia Witni and Marie Nerreter, *Nickel for the Energy Transition: A Developmental Perspective* (Bonn: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, November 2022), 1-68.
Kenji Kawase and Echo Wong, "Chinese companies are cancelling plans for Swiss listings," *Nikkei Asia*, July 28, 2023.
"Group profile," GEM, accessed October 30, 2023.

- Guangdong Brum Recycling, which owns 25%. Guangdong Brum Recycling is majority-owned by CATL (Chinese Amperex Technologies, 宁德时代) the Chinese battery manufacturer specialised in lithium-ion batteries and the world's largest lithium-ion battery manufacturer. CATL is listed on the Shenzhen Stock Exchange.[18]
- New Horizon Holdings Hongkong, which owns 20%, is fully owned by Tsingshan Holding Group (青山控股), a private company focused on stainless steel and nickel. Tsingshan Holding group is number 257 on the 2023 Fortune Global 500 list.[19]
- The Indonesia Morowali Industrial Park itself owns 10% of the HPAL plant.
    - IMIP is 49.7% owned by Shanghai Decent Investment which is fully owned by Tsingshan Holding Group. IMIP is 25% owned by PT Sulawesi Mining Investment,[20] which is majority-owned by Tsingshan Holding Group and Indonesian conglomerate Bintang Delapan Group. The other 25.3% of IMIP is owned by Bintang Delapan Group.[21]
- Hanwa Inc. owns the remaining 8% of IMIP. Hanwa Inc. is a Japanese global trading company, focusing on steelmaking. Hanwa is listed on the Tokyo Stock Exchange.[22]

18 Jannick Saegert, Vovia Witni and Marie Nerreter, *Nickel for the Energy Transition: A Developmental Perspective* (Bonn: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, November 2022), 1-68.
"Global market distribution of lithium-ion battery makers between January and August 2023," Statista, published October 2023.
"Contemporary Amperex Technology Co Ltd," *Reuters*, accessed October 30, 2023.

19 Jannick Saegert, Vovia Witni and Marie Nerreter, *Nickel for the Energy Transition: A Developmental Perspective* (Bonn: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, November 2022), 1-68.
"Global 500 2023: Wenzhou," Fortune, accessed October 2023.

20 On the usage of "PT" in front of company names:
"Perseroan Terbatas (PT) is the type of legal entity that a foreign company, foreign government, or foreign individual must use to run a revenue-generating business in Indonesia. Also known as a foreign investment limited liability company, a PT is a business entity that allows foreign investors to conduct commercial activities in Indonesia." Julia Kagan, "Perseroam Terbatas (PT): Overview and Types," Investopedia, modified March 28, 2022.

21 Pius Ginting and Ellen Moore, "Indonesia Morowali Industrial Park (IMIP)," The People's Map of Global China, modified November 22, 2021.

22 Jannick Saegert, Vovia Witni and Marie Nerreter, *Nickel for the Energy Transition: A Developmental Perspective* (Bonn: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, November 2022), 1-68.
"Company Profile," Hanwa, accessed October 30, 2023.

The second HPAL plant in the IMIP Industrial Park is **Huayue Nickel and Cobalt HPAL** and is also a majority Chinese-owned joint venture:

- Zhejiang Huayou Cobalt owns 57% of the HPAL plant. Zhejiang Huayou Cobalt is fully owned by China Huayou Cobalt. (华友钴业) Huayou Cobalt is a Chinese company specialized in lithium-ion battery materials and cobalt materials. It is listed on the Shanghai Stock Exchange and since 2023 has a secondary listing on the Swiss Stock Exchange.[23]
- W-Source Holding owns 30% and is fully owned by CMOC (洛阳钼业, previously: China Molybdenum). CMOC is a Chinese metal and phosphate mining company, listed on both the Hong Kong Stock Exchange and the Shanghai Stock Exchange.[24]
- Tsing Creation International owns 10% and is fully owned by Tsingshan Holding Group.[25]
- Huaqing Hualong Consulting Co. Ltd. (華青華龍咨詢有限公司), a Hong Kong company incorporated in 2019, owns 2%.[26]
- Long Sincere Holding owns 1%.[27]

In August 2023, the Australian company Nickel Industries announced that they had acquired a 10% stake in Huayue Nickel and Cobalt HPAL from Shanghai Decent, a subsidiary of Tsingshan Holding Group.[28]

23 Pius Ginting and Ellen Moore, "Indonesia Morowali Industrial Park (IMIP)," The People's Map of Global China, modified November 22, 2021.
"About us," Huayou Cobalt, accessed October 30, 2023.
Anne Koslowski, "Huayou Cobalt is listed on the SIX Swiss Exchange," Switzerland Global Enterprise, published July 12, 2023.
"Zhejiang Huayou Cobalt Co Ltd: Profile," *Financial Times*, accessed October 30, 2023.

24 Pius Ginting and Ellen Moore, "Indonesia Morowali Industrial Park (IMIP)," The People's Map of Global China, modified November 22, 2021.
"CMOC Group Limited," Wikipedia, last edited December 21, 2023.

25 Pius Ginting and Ellen Moore, "Indonesia Morowali Industrial Park (IMIP)," The People's Map of Global China, modified November 22, 2021.

26 Karl Decena, "China Molybdenum joining Huayue's nickel-cobalt JV in Indonesia," *S&P Global*, November 11, 2019.
"Huaqing Hualong Consulting Company Limited," Hong Kong Company List, published September 23, 2019.

27 Karl Decena, "China Molybdenum joining Huayue's nickel-cobalt JV in Indonesia," *S&P Global*, November 11, 2019.

28 "Completion of HNC HPAL and Oracle Nickel acquisitions," Nickel Industries, published August 4, 2023.

Obi HPAL

Located in the Kawasi village on Obi Island (the largest of the Obi Island archipelago) in North Maluku is the Obi HPAL nickel-cobalt project. This HPAL plant is owned by PT Halmahera Persada Lygend, a joint venture between Indonesian conglomerate Harita Group which owns 63.1%, and the Chinese nickel company Ningbo Lygend (宁波力勤) which owns 36.9% of the plant. Ningbo Lygend is listed on the Hong Kong Stock Exchange.[29] In September 2020 an offtake agreement was signed between the Obi plant and Chinese company GEM (see QMB New Energy Materials HPAL above). This agreement lasts eight years and entails that GEM will receive between 74,400t and 178,560t of MHP per year from the plant.[30]

There is little information available on offtake agreements of the HPAL facilities at IMIP and no information to suggest that joint-ventures or offtake agreements are mandatory in the nickel-processing sector in Indonesia. However, it is mandatory for foreign EV producers to team up with Indonesia Battery Corporation (IBC), which was founded in 2021 and consists of several state-owned companies active in the mining and energy industries.[31] Although IBC's exact role has remained unclear, its cooperation with foreign EV companies is likely meant to boost technology transfer and job creation.[32]

29 "Obi HPAL Nickel-Cobalt Project," NS Energy, accessed October 30, 2023. Wilda Asmarini, "Harita Group operates Indonesia's first battery raw material factory," *CNBC Indonesia*, June 24, 2021.

30 "Obi HPAL Nickel-Cobalt Project," NS Energy, accessed October 30, 2023.

31 Isabelle Huber, "Indonesia's Battery Industrial Strategy," *CSIS*, February 4, 2022.

32 ibid.

Planned HPAL projects

Besides the 3 existing plants, there are a number of HPAL plants that have been announced or are under construction.

Table 1 Planned HPAL plants in Indonesia

Who is involved	Date of publication	Location of HPAL plant	Extra information
Vale (BR), Huayou (CN), Ford (US)[33]	*April 2022*	*Pomalaa, Southeast Sulawesi*	*Capacity of 120,000t of MHP yearly*
Vale (BR), Huayou (CN)[34]	*September 2022*	*Sorowako, South Sulawesi*	*Capacity of 60,000t MHP yearly*
Merdeka Battery (ID), Ningbo Brunp Contemporary Amperex (CN, CATL subsidiary)[35]	*March 2023*	*Konawe Industrial Park, Southeast Sulawesi*	*Two HPAL plants: capacity 120,000t each* *Tsingshan Holding Group will be involved with Konawe Industrial Park*
Nickel Industries (AU company), Shanghai Decent (CN company, Tsingshan subsidiary)[36]	*October 2023*	*IMIP*	*Project name: Excelsior Nickel Cobalt HPAL Capacity 72,000t yearly*
Eramet (FR) and BASF (GER)[37]		*Weda Bay Industrial Park Halmahera Island, North Maluku*	*Final investment decision yet to be made*

33 "PT Vale Indonesia and Huayou sign Nickel Agreement with Ford Motor Co. supporting growth of the global sustainable EV industry," Vale, March 30, 2023.
"PT Vale and Huayou sign agreement for new HPAL plant in Indonesia," *Mining Technology*, September 14, 2022.

34 "Nickel miner Vale Indonesia signs HPAL deal with China's Huayou," *Reuters*, September 13, 2022.

35 Joseph Ho, "Merdeka makes 2Q progress at Indonesian Ni assets," *Argus*, August 3, 2023.
"Corporate update – PT Merdeka Battery Materials," Merdeka Copper Gold, published March 17, 2023.
"Indonesia nickel company Merdeka Battery Materials plans $580 million IPO," *CNA*, March 28, 2023.
"Indonesia's Merdeka Battery plans to build two nickel HPAL plants," *Reuters*, March 30, 2023.

36 Joseph Ho, "Nickel Industries takes FID on Indonesian HPAL plant," *Argus*, October 11, 2023.
"Positive final investment decision for ENC HPAL project, supported by Indonesian Bank loans," Nickel Industries, published October 11, 2023.

37 "Indonesia says BASF, Eramet near $2.6 bln deal to process nickel for EV batteries," *Reuters*, January 19, 2023.
"BASF and Eramet partner to assess the development of a nickel-cobalt refining complex to supply growing electric vehicle market," BASF, published December 15, 2023.

Though the Eramet-BASF project is the only initiative not to involve a Chinese partner, the Weda Bay Industrial Park, where the HPAL project will be located, is 57% owned by Tsingshan. The other 43% is owned by Eramet. Konawe Industrial Park, where the two HPAL projects planned by Merdeka Battery and Ningbo Brump are to be located, is being developed by Merdeka Battery and Tsingshan in a joint-venture.[38] From the above ownership information, it becomes clear that **Chinese entities dominate Indonesia's HPAL processing sector**.

Nickel Policy

Indonesia

Indonesia is the world's largest producer of nickel. **The Indonesian government aims to use its nickel deposits and the growing importance of class-1 nickel in the energy transition as a way to move up the value chain and strengthen the country's economic development and geopolitical relevance.** Indonesia's strategic ambition is to be a country where nickel is not just mined, but also where it is processed, and eventually where batteries for electric vehicles, and ultimately electric vehicles, are produced.[39]

Indonesia's export ban on nickel ore

A key policy tool meant to further this strategic aim is the nickel export ban. In 2014, Indonesia adopted a raw mineral export ban, yet it was watered down in 2017. The current nickel export ban came into effect on January 1st, 2020 and stipulates that all exports of nickel ore are outlawed.[40]

The 2014 export ban on raw minerals was aimed at attracting investments in Indonesia's processing sector. **The export ban triggered a large amount of Chinese investment**, including the establishment of IMIP. In 2016, Indonesian president Joko Widodo declared IMIP a national strategic project, even though it is not state-led (it is co-owned by Tsingshan Group and Bintang Delapan). Its designation was a strategic move that cemented China's growing role in

38 "PT Merdeka Copper Gold Tbk Investor Presentation," Merdeka Copper Gold, published September 2022.

39 Joseph Rachman, "Indonesia fast-tracks its electric vehicle ambitions," *The Diplomat*, October 26, 2023.

40 "Prohibition of the export of nickel ore," *IEA*, modified December 12, 2023.

Indonesia's nickel processing sector. It also meant that IMIP became the core around which Indonesia's MHP production developed.[41]

Due to the ban, Indonesian mining companies were no longer able to sell their ore abroad and had to sell domestically. The 2014 export ban and the large amount of Chinese investments that followed positioned Chinese-invested industrial parks like IMIP as the largest buyers of Indonesia's nickel products.[42] The industrial parks "created an oligopsony – a market situation in which each one of a few buyers exerts a disproportionate influence on the market due to the distortion generated by the export ban",[43] which in turn led to Chinese buyers having a monopoly over domestic nickel demand and being able to buy at "prices below the market average."[44] This has made Tsingshan's production very competitive. To make up for the loss of profit, Indonesian companies were seen to cut back on environmental and safety practices.[45]

In short, Chinese investment in downstream nickel processing and refining – through the industrial parks – has ensured that Chinese companies have been able to play a strategic role in, if not dominate, class-1 nickel production in Indonesia.

Indonesia's resource nationalism has enabled it to move its industry up the value chain and move away from a nickel industry focused primarily on extraction.[46] But it has turned Indonesia into an integral part of the Chinese battery supply chain.

The Indonesian government has said it was keen to explore **a trade deal with the US** to supply its industries with critical minerals. A trade deal would enable Indonesian exporters to benefit from tax credits under the US Inflation Reduction Act. However, according to the Peterson Institute for International Economics, such a deal would only be feasible if Indonesia abandoned its export ban on

41 Tham Siew Yean and Siwage Dharma Negara, *Chinese Investments in Industrial Parks: Indonesia and Malaysia Compared* (Singapore: ISEAS Yusof Ishak Institute, September 2020), 1-39.

42 Angela Tritto, *How Indonesia used Chinese industrial investments to turn nickel into the new gold* (Washington: Carnegie Endowment for International Peace, April 2023), 1-23.

43 ibid.

44 ibid.

45 ibid.

46 James Guild, "Indonesia wants more than a nickel for natural resources," *East Asia Forum*, January 26, 2023.

nickel ore.[47] There is no consensus in the US on the benefits of a deal with Indonesia. Labour conditions, environmental standards, and the role of Chinese companies in the Indonesian nickel industry are cited as the main concerns. After all, one of the main rationales for the Inflation Reduction Act is to reduce US dependency on Chinese-sourced materials. The US National Security Council has been particularly critical of a deal with Indonesia due to Chinese involvement in the Indonesian nickel sector. Indonesian class-1 nickel would not substitute for existing dependencies on China.[48]

In response to hesitancy on the US side, in an interview with the New York Times, Coordinating Minister for Maritime Affairs and Investment Luhut Binsar Pandjaitan said Indonesia is looking to develop its nickel and EV battery sector regardless of US' willingness to make a deal. Although a trade deal on critical minerals and US' investment in Indonesia – particularly by Tesla – is Indonesia's preferred option, the country will look for more investment elsewhere, including China, if the US or its companies are not interested.[49] It is a clear expression of Indonesia's resource nationalism and growing self-confidence on the international stage.

The EU has requested consultations with Indonesia at the World Trade Organization (WTO) on its nickel export ban.[50] The EU sees the ban as a protectionist policy that contravenes international trade rules. In November 2022 the panel report was completed but Indonesia appealed "into the void".[51] The European Commission announced in July 2023 that it had launched "a consultation on the possible use of the Enforcement Regulation in its dispute settlement case on Indonesian nickel export restrictions", which could raise trade tensions between Brussels and Jakarta and lead to the imposition of countervailing duties on other Indonesian exports.[52] Obviously, this would not be

47 Cullen S. Hendrix, "Indonesia wants to sell nickel to the US, but first it should scrap its export bans," *PIIE*, April 26, 2023.

48 Peter S. Goodman, "How geopolitics is complicating the move to clean energy," *New York Times*, August 18, 2023.

49 ibid.

50 "DS592: Indonesia – Measures relating to raw materials," *World Trade Organization*, modified February 7, 2023.

51 ibid.

52 Directorate-General for Trade, "EU launches consultation on use of Enforcement Regulation on Indonesian nickel export restrictions," *European Commission*, July 7, 2023.

a healthy starting point from which to discuss European access to Indonesian MHP exports.

Domestic criticism: labour conditions and environmental issues

Indonesia's approach also faces domestic opposition. The three main issues include 1) concerns about labour conditions, 2) environmental damage, and 3) anti-Chinese sentiment. Protests, including violence, occur with some regularity around Indonesian nickel facilities.

In January 2023, an Indonesian and Chinese worker were killed at PT Gunbuster Nickel Industry (a smelter in Morowali) as a result of demonstrations and riots between Indonesian and Chinese workers.[53] The demonstrations were triggered due to the collapse of negotiations between the nickel company and a trade union about the work and safety conditions at the plant.[54] It led to ethnic tensions between Indonesian workers and Chinese workers.[55]

According to ISEAS, two of the underlying factors that explain why a labour dispute led to violence are "ethnic and cultural differences" and "poor governance in labour relations".[56] Anti-Chinese sentiment in Indonesia has existed at least since colonial rule when the Dutch East India Company and later the Dutch colonial government used 'divide and rule'-tactics and classified people into different ethnic groups (creating the 'inlander' or native Indonesian, while categorising Chinese as 'foreign orientals'). In the capital, for instance, ethnic groups were segregated into different neighbourhoods.[57] Aside from this century-old system of ethnic division, anti-communist sentiment is also widespread in contemporary Indonesian society.[58] There is a degree of societal scepticism towards mainland Chinese. The more immediate concern, however,

53 Muhammad Zulfikar Rakhmat and Yeta Purnama, "Chinese and Indonesian workers clash at Indonesian nickel plant," *The Diplomat*, January 17, 2023.

54 "Dandim Morowali says PT GNI's death clash was ridden by other interests," *CNN Indonesia*, January 16, 2023.

55 Muhammad Zulfikar Rakhmat and Yeta Purnama, "Chinese and Indonesian workers clash at Indonesian nickel plant," *The Diplomat*, January 17, 2023.

56 Leo Suryadinata and Siwage Dharma Negara, *Lessons to learn from the North Morowali Smelter Riot* (Singapore: ISEAS Yusof Ishak Institute, February 17, 2023), 1-11.

57 Marsely L. Kehoe, "Dutch Batavia: Exposing the hierarchy of the Dutch colonial city," *Journal of Historians of Netherlandish Art* 7, no. 1 (Winter 2015), 1-35.

58 Phelim Kine, "Indonesia's dangerous 'anti-communist' paranoia," *Human Rights Watch*, September 18, 2017.

is the unequal treatment of Indonesian and Chinese workers. This has included differences in pay or Chinese workers' passports being withheld by recruiters.[59] The ISEAS study recommends as the most important steps to prevent violent conflict an improvement in worker safety, and higher wages.[60]

On 23 December 2023, an explosion occurred in one of the furnaces in a nickel smelter at IMIP. It resulted in the deaths of at least 18 workers. It sparked protests involving hundreds of workers, who complained about labour conditions. Among the casualties were also 8 Chinese workers. One of the demands of the Indonesian protestors was that Chinese workers should learn the Indonesian language as communication difficulties were seen to have contributed to the accident.[61]

Opposition against nickel processing also focuses on the associated environmental damage. Environmental damage created by the nickel industry includes deforestation (in areas that have been described as "the world's most biodiverse forests"[62]), as well as "waste, pollution and high carbon emissions".[63] In March 2023, local farmers in Wawonii Island organised sit-ins to protest against land being cleared by nickel miners. The farmers and rights groups were concerned about their land rights and the environmental damage.[64]

Environmental concerns have led to changes in Indonesian policy, and have directly impacted the HPAL ecosystem. One example is the successful campaign by NGOs to convince the Indonesian government to block permits for the disposal of nickel tailings in the deep-sea marine environment. Several companies backed out of their deep-sea tailings disposal plans.[65] The deep-sea tailings disposal

59 Liza Lin, Yifan Wang and Jon Emont, "Chinese workers say they are lured abroad and exploited for Belt and Road jobs," *Wall Street Journal*, October 27, 2021.

60 Leo Suryadinata and Siwage Dharma Negara, *Lessons to learn from the North Morowali Smelter Riot* (Singapore: ISEAS Yusof Ishak Institute, February 17, 2023), 1-11.

61 "Indonesian workers protest after deadly blast at China-funded nickel plant", VOA News, 27 December 2023.

62 Mercedes Ruehl and Harry Dempsey, "Nickel miners linked to devastation of Indonesian forests," *Financial Times*, October 8, 2023.

63 ibid.

64 "Indonesian farmers fight for their land in nickel mining boom," *France24*, March 13, 2023.

65 Angela Tritto, *How Indonesia used Chinese industrial investments to turn nickel into the new gold* (Washington: Carnegie Endowment for International Peace, April 2023), 1-23.

plans at IMIP were also cancelled.[66] NGOs have also asked Tesla not to invest in the Indonesian nickel industry because of environmental concerns, though the results of this effort remain unclear.[67]

China

Nickel as a critical material and domestic production

In 2021, China produced 109,000 metric tons of nickel, representing almost 4% of the total global nickel production that year.[68] But it also consumes around 59% of the world's nickel.[69] China is heavily dependent on imports to satisfy domestic demand.

China's national mineral resources plan (2016-2020) includes nickel as one of 24 'strategic minerals'. The metal is also mentioned in the State Council's New Energy Vehicle Industry Development Plan (2021-2035) as a material that Chinese car companies should have better access to. Chinese policy, including support from state-owned funders and banks, is aimed at creating a beneficial environment for Chinese companies to source their nickel supplies from abroad.

Belt and Road Initiative and Indonesian nickel

The Belt and Road Initiative is Chinese president Xi Jinping's flagship foreign policy initiative. It was first announced in 2013 in Kazakhstan and Indonesia, and encompasses a wide range of Chinese investments in foreign projects from infrastructure, ports and manufacturing to health and digital initiatives.

As a clear sign of its strategic importance, China has designated the Indonesia Morowali Industrial Park (IMIP) a Belt and Road project. In October 2013, both President Xi and Indonesian president Susilo Bambang Yudhoyono attended the signing ceremony founding IMIP. The full name of the industrial park is the "China-Indonesia Economic and Trade Cooperation Zone Indonesia Morowali

66 Jannick Saegert, Vovia Witni and Marie Nerreter, *Nickel for the Energy Transition: A Developmental Perspective* (Bonn: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, November 2022), 1-68.

67 "NGOs ask Musk to not invest in Indonesia's nickel industry over environmental worries," *Reuters*, July 25, 2022.

68 Michele E. McRae, *Nickel* (Washington: U.S. Geological Survey Mineral Commodities Summaries, January 2023), 1-2.

69 Nornickel, *Annual Report 2022* (Moscow: Nornickel, 2022), 53-59.

Industrial Park", clearly demonstrating the degree to which the Chinese government feels connected to Indonesian nickel production. The Park is also based on the model of similar industrial zones in China.[70]

Although the Chinese companies operating Indonesia's HPAL projects are not state-owned, Chinese state-owned and state-funded banks provided the financing. IMIP's financiers include:

- Export-Import Bank of China [Exim Bank]
- China Development Bank
- Bank of China
- Industrial and Commercial Bank of China (ICBC) and
- HSBC China.[71]

HSBC is the only commercial non-state-owned bank involved.

Another example of Chinese state involvement are the contractors involved in the Obi HPAL project. Four subsidiaries of state-owned conglomerate China Metallurgical Group Corporation and one subsidiary of the state-owned China National Chemcial Engineering Corp are involved in the construction of the plant, its telecommunication systems, plant control systems and managerial supervision.[72] Both of these companies are overseen by the State-owned Assets Supervision and Administration Commission (SASAC) of the State Council. It is safe to say that China's role in Indonesia's class-1 nickel production is significant.

United States

Critical minerals & US policy

In 2022, the US government updated its critical-mineral commodities list. It includes metals "deemed key to national security and the economy". The list consists of 50 critical-mineral commodities, considerably more than the 35 that were included in the first version of the list published in 2018. The 2022 list included nickel for the first time.

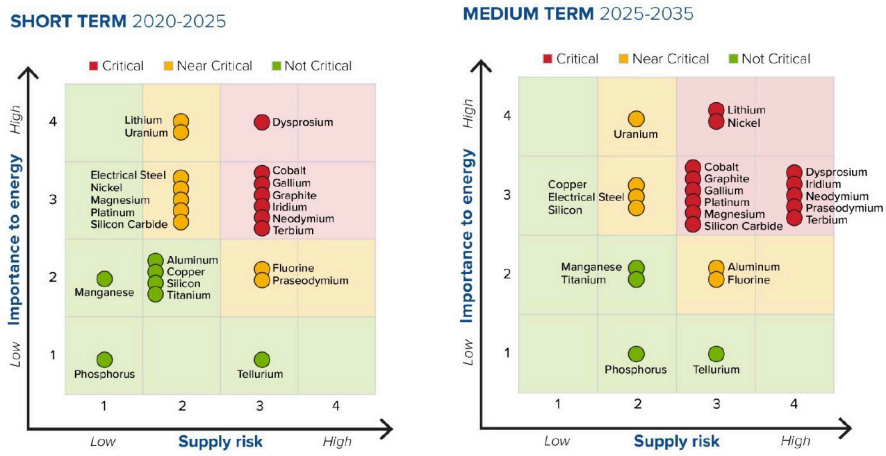
70 "Tsingshan's Indonesia Morowali Industrial Park: Build, and they will come," HSBC China, 2019.

71 Pius Ginting and Ellen Moore, "Indonesia Morowali Industrial Park (IMIP)," The People's Map of Global China, modified November 22, 2021.

72 "Obi HPAL Nickel-Cobalt Project," NS Energy, accessed October 30, 2023.

In the 2023 Department of Energy (DOE) Critical Materials Assessment, nickel is projected to be 'near critical' in the short-term (2020-2025), and critical in the medium term (2025-2035).

Figure 2 Critical Minerals Assessment Short and Medium Term (US DOE)



The designation of nickel as 'critical' is of importance to US policy development on nickel. According to the Mining Journal: "The list is designed to act as a trigger for government initiatives to improve domestic production, and diversity of supply, of key minerals. In practice this could unlock government support for junior minors and refining businesses in the US."[73]

The drivers behind US' critical materials policy are defined in the Department of Energy's Vision and Strategy for Critical Minerals and Materials. The vision aims to:

- secure domestic critical mineral and materials supply chains
- support the clean energy transition
- promote just solutions to meet current and future needs

73 Steven Swindells, "US government mandate to support nickel and zinc production," *Mining Journal*. February 23, 2022.

The strategy to realize this vision consists of five parts: 1) diversify and expand supply, 2) develop alternatives, 3) materials and manufacturing efficiency, 4) circular economy, 5) enabling activities.[74]

Not explicitly mentioned in the DOE Vision, but a key driver behind its critical materials policy, is the US' ambition to become less dependent on China. This is explicit in White House publications on critical materials, such as the fact sheet 'Securing a Made in America Supply Chain for Critical Minerals'. It states that the administration and US companies will "announce major investments to expand domestic critical minerals supply chains, break dependence on China and boost sustainable practices."[75]

Funding for domestic nickel production

The Battery Manufacturing Awards, part of the Bipartisan Infrastructure Law (BIL), provides funding for battery-grade – or class-1 – nickel production in the US. The law, which came into force on 15 November 2021, aims to produce "enough battery-grade nickel to supply approximately 400,000 EVs annually."[76] Furthermore, the White House plans to use authorities granted under the Defense Production Act to increase investments in the domestic production of nickel.[77] It illustrates the degree to which national security plays a role in shaping US nickel policy.

When it comes to nickel reserves, the US only holds 0.4% (370,000 tonnes) of the world's total known nickel ore deposits. The US accounts for 0.5% (18,000 tonnes) of yearly global production. The only nickel mine located in the US (the Eagle Mine in Michigan) will be closed in 2025. Nickel ore mined at the Eagle Mine is exported to Canadian smelters for refining.[78] US consumption, on

74 Diana J. Bauer, Ruby T. Nguyen and Braeton J. Smith, *Critical Materials Assessment* (Washington: U.S. Department of Energy, July 2023), 1-267.

75 "FACT SHEET: Securing a Made in America Supply Chian for Critical Minerals," The White House, published February 22, 2022.

76 "FACT SHEET: Biden-Harris Administration driving U.S. battery manufacturing and good-paying jobs," The White House, October 19, 2022.

77 Biden's Economic Plan in Action states he wants to invoke "the Defense Production Act to authorize investments to secure American production of critical materials for electric vehicle and stationary storage batteries – lithium, nickel, cobalt, graphite, and manganese – from sustainable mining and processing, as well as unconventional sources such as mine waste and geothermal brine"

78 Michele E. McRae, *Nickel* (Washington: U.S. Geological Survey Mineral Commodities Summaries, January 2023), 1.

the other hand, is 80,000 tonnes yearly. This means that the US has to import nickel to meet demand, and that in the hypothetical scenario where it mines all of its reserves, those would last less than 5 years.[79] Instead, in the US recycling and circularity offer a more promising perspective.

On 22 February 2022, the US announced a number of projects to promote domestic nickel production as part of the 'Securing a Made in America Supply Chain for Critical Minerals'. They include:

- A pilot project by Redwood Materials, in partnership with Ford and Volvo. The initiative will collect and recycle end-of-life lithium-ion batteries at its Nevada based facilities to extract lithium, cobalt, nickel, and graphite.
- USD $3 billion in funding to invest in refining battery materials such as lithium, cobalt, nickel, and graphite, and battery recycling facilities, "creating good-paying clean energy manufacturing jobs."
- Tesla intends to source high-grade nickel for EV batteries from Talon Metals' Tamarack nickel project under development in Minnesota. Talon Metals and the United Steelworkers (USW) have established a workforce development partnership for the project to train workers on next-generation technologies in the local community.[80]

Nickel and the US Department of Defense

On 31 March 2022, domestic nickel projects received funding under the Defense Production Act Title III funding. As Fabian Villalobos of the RAND Corporation notes, "it was nickel's utility for energy storage and not its utility for aerospace or defense" that motivated this decision.[81] The determination underlines the importance to national security of "the clean energy economy, such as the production of large-capacity batteries".[82] Under the authority of the Defence Production Act, on 12 September 2023, the Department of Defense (DoD) announced its involvement in a USD $20.6 million agreement with Talon for the domestic production of nickel.[83]

79 Shubham Dwivedi and Gregory D. Wischer, "Securing the critical minerals that America and its allies lack," *Australian Strategic Policy Institute*, April 12, 2023.

80 "FACT SHEET: Securing a Made in America Supply Chian for Critical Minerals," The White House, published February 22, 2022.

81 Fabian Villalobos and Morgan Bazilian, "Militaries, Metals, and Mining," *The RAND Blog*, April 18, 2023.

82 "Memorandum on Presidential Determination Pursuant to Section 303 of the Defense Production Act of 1950, as amended," The White House, published March 31, 2022.

83 "Department of Defense enters an agreement to strengthen the U.S. supply chain for nickel production," U.S. Department of Defense, published September 12, 2023.

US involvement in Indonesia

Although the Indonesian government has shown an interest in a trade deal with the US on critical materials, the US government has appeared somewhat reluctant. A key concern is the role of "Chinese investment in Indonesia's nickel industry".[84]

In September 2023, the Indonesian government asked the US to start negotiations for a trade deal on critical minerals.[85] Late October, nine US senators from both parties sent a letter to the US Trade Representative and the Treasury, Energy and Commerce Secretaries highlighting their concerns about a potential deal with Indonesia, which were focused around Chinese involvement in Indonesia's industry and specifically Chinese ownership of the three functioning HPAL plants.[86] Nevertheless, on November 13, Indonesian President Widodo visited US President Biden. The joint statement released after the meeting includes their commitment to "develop a critical minerals action plan (...) to increase high standard investment in the critical minerals sectors in both countries. They commit to pursue these efforts with a view toward establishing the foundation to launch future negotiations on a critical minerals agreement."[87] This language illustrates the difficulties that have to be surmounted. "A view toward establishing the foundation" suggests that negotiations in the short-term are not likely.

Even though a fully-fledged agreement may not be reached anytime soon, US companies could choose to invest anyway. As can be read in the section on nickel activities in Indonesia, Ford announced it had reached an agreement with PT Vale Indonesia Tbk and Zhejian Huayou Cobalt Co. for investments in the Pomalaa Block HPAL Project. The importance of this project was underscored by the presence of Indonesian President Widodo at the agreement ceremony.

84 Peter S. Goodman, "How geopolitics is complicating the move to clean energy," *New York Times*, August 18, 2023.

85 "Indonesia proposes critical minerals trade deal with US," *Reuters*, September 7, 2023.

86 "Concerns Regarding a Potential Critical Minerals Trade Agreement," United States Senate, published October 24, 2023.

87 "Joint Statement from the Leaders of the United States and the Republic of Indonesia: Elevating relations to a comprehensive strategic partnership," The White House, published November 13, 2023.

Implications for Europe and the Netherlands

Indonesia has developed its nickel processing industry through a policy of resource nationalism. The country aimed to develop its domestic economic potential by restricting the export of nickel ore, attracting foreign investments into domestic downstream nickel processing. This policy has been a mixed blessing for the country. Though it has contributed to Indonesia's position as the world's most important source of processed nickel, the policy has led to a large inflow of Chinese investments and Chinese companies now dominate the sector. This is seen as a geopolitical obstacle for attracting US investment. It has also complicated Indonesia's efforts to become eligible for beneficial tax credits under the US Inflation Reduction Act.

Indonesia's class-1 nickel mining sector is characterised by a high degree of Chinese funding and ownership. In fact, Chinese companies have a controlling stake in two out of three major Indonesian HPAL facilities, and a large minority in the third one. Besides, two nickel-focused industrial parks are Chinese-funded and majority-owned. One of which is even presented as **a jewel in China's Belt & Road crown**. Because of the high-level of Chinese involvement, European investments in existing class-1 nickel activities in Indonesia would amount to a degree of "pseudo-derisking" from China. It would not substantially reduce European dependencies on China or Chinese actors.

Although investment in Indonesia's nickel sector may not lead to reduced dependence on China in the short term, this does not appear to dissuade European companies from investing in Indonesia's nickel industry in order ensure their access to nickel. According to the Indonesian government, in April 2023 Volkswagen agreed to work with German BASF, French Eramet and Indonesian Merdeka Copper Gold to create an EV battery ecosystem in the country. The government also announced that the German automobile manufacturer will also join the nickel partnership initiated by Ford, Vale and Zhejiang Huayou Cobalt.[88] Volkswagen however, has yet to make a definitive statement on these investments.

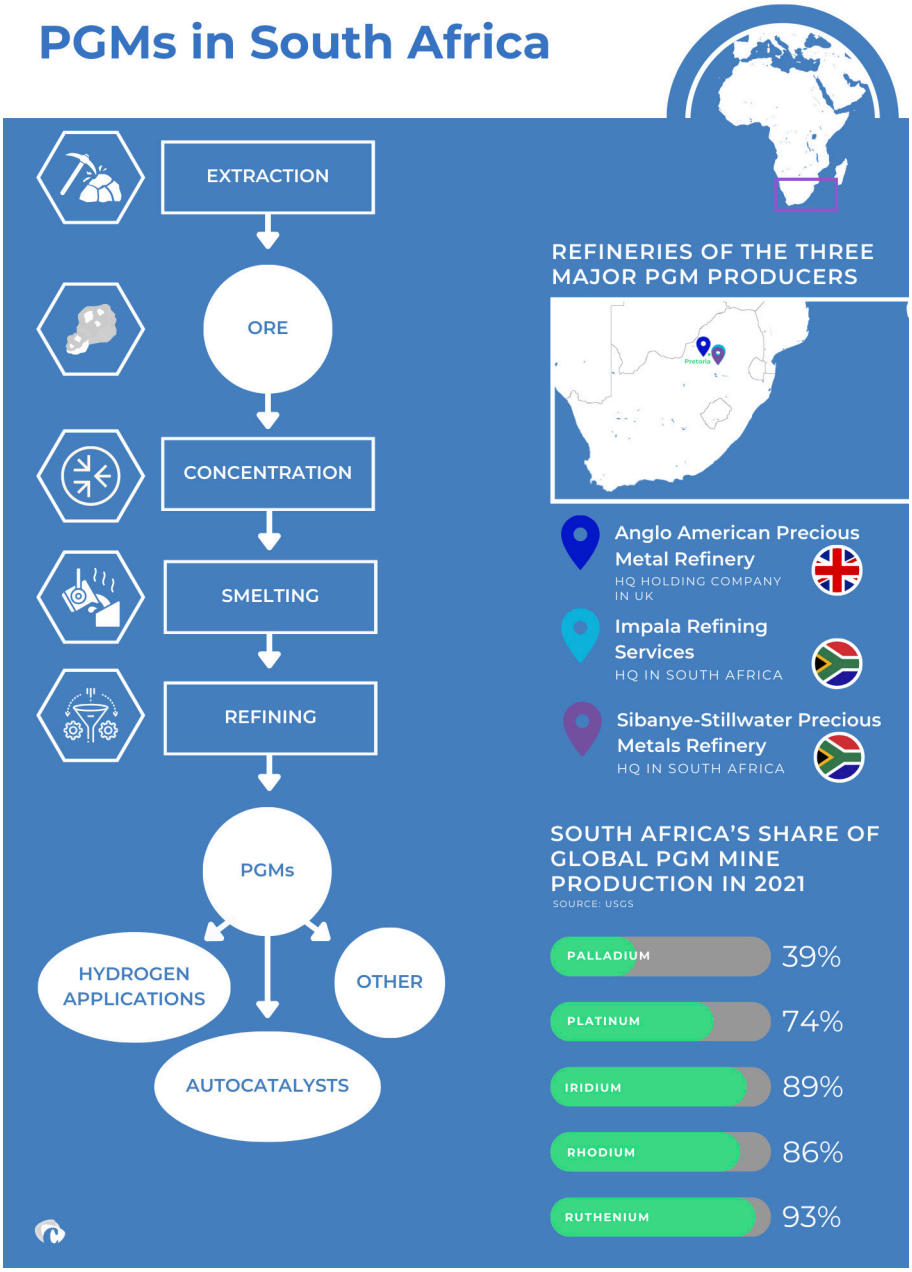
88 Joseph Ho, "BASF, Eramet, VW set up Indonesia car battery ecosystem," *Argus*, April 17, 2023; Alex Donaldson, "Volkswagen joins EV battery partnership in Indonesia," *Mining Technology*, April 17, 2023; Chandra Asmara and Norman Harsono, "Indonesia Woos VW to offset China's dominance in nickel riches," *Bloomberg*, April 18, 2023.

If the objective of European policy is to reduce Europe's dependence on Chinese-sourced class-1 nickel, then Indonesian MHP hardly qualifies as a source of diversification. That is, unless European governments and companies invest in setting up an alternative nickel ecosystem in Indonesia, which includes upstream extraction as well as processing of class-1 nickel. In other words, Europe could consider establishing a non-Chinese class-1 nickel supply chain in Indonesia. However, the costs involved would be substantial and Chinese companies already have a competitive advantage in terms of price, technology and local expertise working in Indonesia's nickel sector. Another obvious impediment for this is the ongoing WTO dispute between the EU and Indonesia. Thus, for the time being, Chinese involvement in any European nickel processing project in Indonesia should be expected. Even the Franco-German HPAL initiative mentioned above is located in an industrial park that is owned by Chinese entities.

Equally, there are major concerns regarding the ecological impact of HPAL nickel processing. From a sustainability point of view, reliance on Indonesian MHP to source class-1 nickel is problematic. The EU and the Netherlands could work with the Indonesian government to promote more sustainable refining and processing techniques. But given the nature of HPAL, this is unlikely to yield quick results. Neither is this problem specific to Indonesia, as it impacts all nickel processing. Alternatively, the Netherlands could reach out to Chinese nickel producers to discuss how extraction and processing techniques can become less environmentally damaging.

Ultimately, the Netherlands and the EU should aim to reduce their demand for foreign nickel imports by investing more in substitution, innovation and circularity. For instance, the EU and the Netherlands should invest in research efforts to reduce the nickel content in high-end batteries, or to stimulate the development of high performance nickel-free batteries. Besides, circularity of class-1 nickel in the Dutch and EU-wide economy remains underexplored. The EU's new 'battery alliance' rightly calls for greater action on recycling. This may also be an opportunity for further transatlantic cooperation.

Figure 3 PGM refining in South Africa



South Africa and Platinum Group Metals

What are Platinum Group Metals?

Platinum Group Metals (PGMs) consist of platinum, palladium, rhodium, ruthenium, iridium, and osmium. These metals are often found and produced together.[89] PGMs have a variety of uses, including in heavy industry, jewellery and the automotive sector. A well-known application of platinum, palladium and rhodium is in catalytic converters that reduce pollutants in combustion engines. Their main use is in automobiles, airplanes but also in generators and in the mining sector.

PGMs also have promising new applications in the field of green technologies and the hydrogen economy. The metals – primarily platinum and iridium – are crucial for polymer electrolyte membrane (PEM) technologies that can produce green hydrogen. PEM technologies include PEM electrolysis, which produces hydrogen from electricity, and PEM fuel cells, which converts hydrogen into electricity.

Platinum's main relevance to the defence industry is in the field of catalytic converters and the potential use of PEM technologies as the energy source for a variety of defence equipment, including drones or vehicles.[90]

Platinum prices reached a record high in 2008 and remained high during the early 2010s fluctuating between USD$ 1400 and USD$ 1000 per troy ounce (see figure 4). In 2023, platinum prices were down 11% compared to the previous year.[91] Palladium prices have been climbing since 2017 and reached an all-

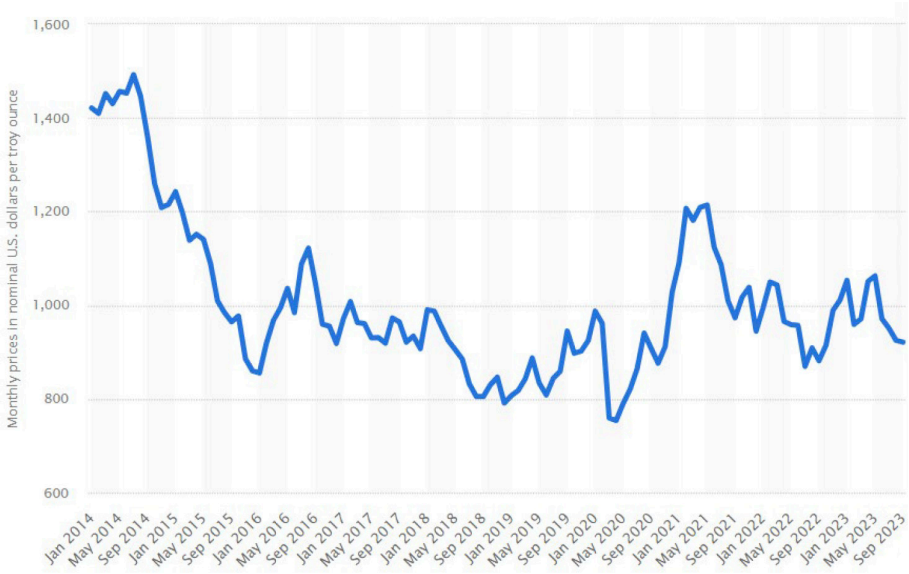
89 Hubert Schmidbaur and John L. Cihonski, "Noble Metals (Chemistry)," in *Encyclopedia of Physical Science and Technology (Third Edition)*, ed. Robert A. Meyers (Academic Press, 2003), 463.

90 Benedetta Girardi, Irina Patrahau, Giovanni Cisco and Michel Rademaker, *Strategic raw materials for defence: Mapping European industry needs* (The Hague: The Hague Centre for Strategic Studies, January 2023), 9.

91 Nelson Banya, "Jinchuan's S. African PGM project to cut 75% of workforce amid price rout," *Reuters*, November 27, 2023.

time high in March 2022, just above USD$ 3400 per troy ounce.[92] In 2023, the palladium price had fallen by 40%.[93]

Figure 4 Platinum prices (monthly) in nominal USD per troy ounce[94]



PGM activities in South Africa

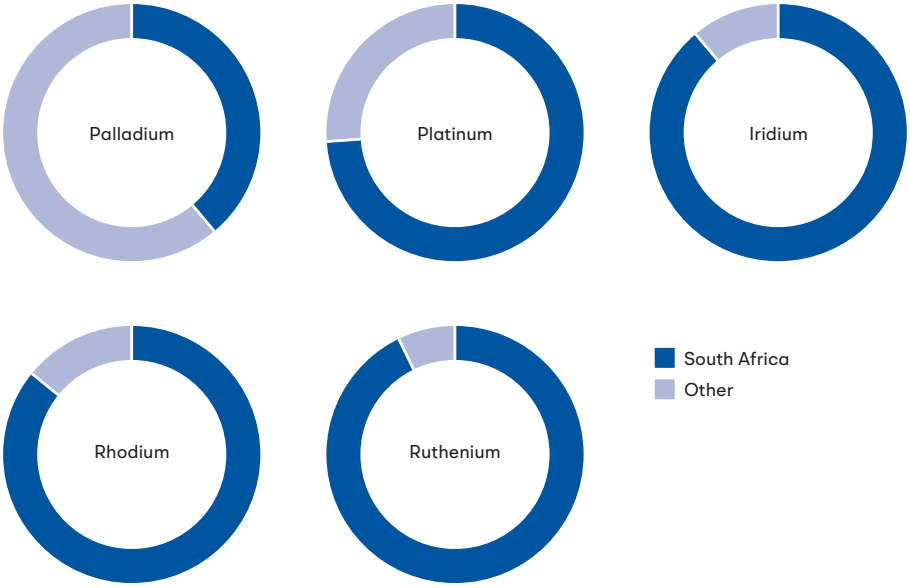
South Africa is the largest producer of PGMs. South Africa produces more platinum group metals than the rest of the world combined. The only exception is palladium, where it 'only' produces 40% of the global total (see figure 5).

92 Corey McDowell, "Record Palladium Price and Historical Highs," *Chards*, February 2, 2023.

93 Nelson Banya, "Jinchuan's S. African PGM project to cut 75% of workforce amid price rout," *Reuters*, November 27, 2023.

94 Aaron O'Neill, "Monthly prices for platinum worldwide from January 2014 to September 2023," *Statista*, October 4, 2023.

Figure 5 Production of PGMs (2021)[95]



Aside from extraction, **South Africa is the world's largest producer of refined platinum**. South Africa's share of total global refined platinum production in 2022 was 71%.[96]

In the northeast of South Africa, the Bushveld Igneous Complex contains more than 70% of the world's known platinum reserves, as well as more than half of the world's other PGMs.[97] The Complex is estimated to contain at least

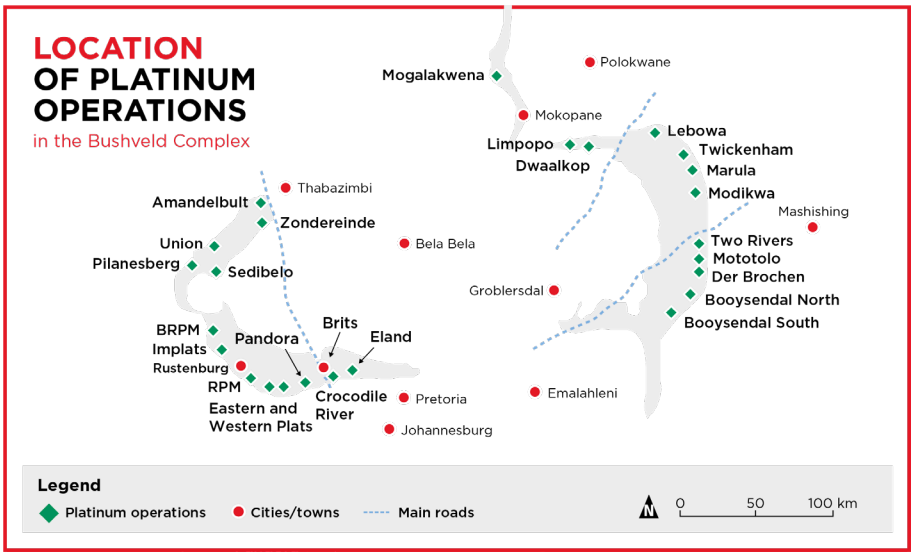
95 National Minerals Information Center, "Platinum-Group Metals Statistics and Information: Mineral Yearbook, 2021 tables-only release," U.S. Geological Survey, accessed September 6, 2023.

96 "Platinum Quarterly Q3 2023: Table 1," World Platinum Investment Council, accessed September 6, 2023.
"Supply of platinum worldwide in 2020 and 2022 with a forecast for 2023, by country," Statista, published November 2023.

97 "The Bushveld Complex," SFA Oxford, accessed September 6, 2023.
"Platinum," Minerals Council South Africa, accessed September 6, 2023.

34,000 tonnes of PGMs, of which more than half is platinum.[98] Annually, around 140 tonnes of platinum is produced from the Bushveld Complex.[99]

Figure 6 Location of Platinum Operations[100]



Three companies dominate the South African PGM industry. And together they dominate global PGM production, accounting for more than 70% of the world's PGMs.[101] They are Anglo-American Platinum Limited (Amplats), Impala Platinum Holdings Limited (Implats) and Sibanye-Stillwater.

- Amplats
  Amplats is traded on the Johannesburg stock exchange. It is a subsidiary of Anglo American plc, a British multinational traded on the London Stock Exchange. When the Anglo American Corporation was founded in 1917, it received funding from US bank JP Morgan as well as other US and UK

98 R. Grant Cawthorn, "The Platinum Group Element Deposits of the Bushveld Complex in South Africa," *Platinum Metals Rev.* 54, 4 (2010): 205-215.

99 R. Grant Cawthorn, "The Platinum Group Element Deposits of the Bushveld Complex in South Africa," *Platinum Metals Rev.* 54, 4 (2010): 205-215.

100 Minerals Council National Platinum Strategy (2023), p. 6.

101 "Profiling the world's top five platinum-mining companies," NS Energy, October 26, 2020.

funders, explaining the name. Currently, the largest American shareholder is The Vanguard Group holding 3.2%.[102]
Amplats has operations in mining, processing and transporting mineral resources. Their refining facilities are located at Rustenburg.[103] Amplats describes itself as the world's largest primary PGM producer.[104]

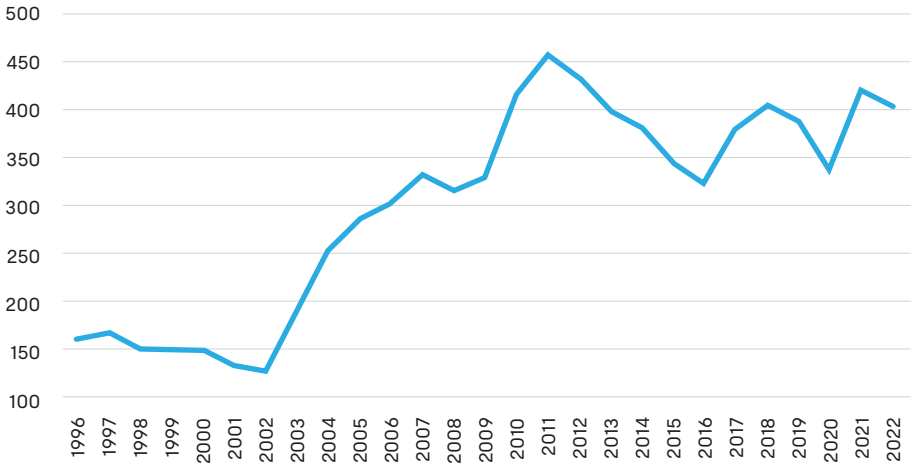
- Implats
  Implats is a holding company that owns several mines, and refining plants, including the largest platinum mine in South Africa.[105] Implats is traded on the Johannesburg and London stock exchanges.
- Sibanye-Stillwater
  Sibanye-Stillwater is a public company traded on the Johannesburg and New York Stock Exchanges. Sibanye-Stillwater's PGM operations include mines and processing facilities.

Labour strikes & Electricity shortages

South Africa is the second-largest economy on the African continent after Nigeria. But the OECD describes South Africa's economy as 'fragile'. Economic growth has been limited since 2009 and GDP per capita has declined: 2019 levels are lower than in 2008.[106] The unemployment rate is around 35% with youth unemployment exceeding 50%.[107] The difficult economic situation is exacerbated by structural electricity shortages, which has affected the mining industry. Power outages have contributed to a 4.8% drop in exports in Q4 2022. In that same quarter, GDP declined 1.3%.[108]

102 "Anglo American Plc," Market Screener, accessed September 6, 2023.
103 July Ndlovu, "Overview of PGM processing," Anglo American Platinum, published 2014.
104 "About us: What we do," Anglo American, accessed September 6, 2023.
105 "Operations," Implats, accessed September 6, 2023.
106 "South Africa Economic Snapshot," OECD, accessed October 4, 2023.
107 ibid.
108 According to the OECD, other contributing factors besides power outages are "challenges in railway freight transport". OECD, *Economic Outlook: South Africa*, (Paris: OECD, 2023).

Figure 7 GDP of South Africa in current USD (billion)[109]



Strikes are a common feature in South Africa's platinum industry. In recent years, 2012 stands out as a year with particularly large protests, mainly because they were not limited to one or two companies but took place across the mining industry. The 2012 strikes were motivated by poor working conditions and wage demands.

The three companies described above have been mired in controversy, particularly related to the widespread strikes in 2012. That year, Amplats fired 12,000 striking mine workers, even though many were later reinstated.[110] Similarly, that year Implats fired 17,200 striking workers.[111]

In 2019, Sibanye-Stillwater acquired Lonmin plc, a British PGM production company. Lonmin gained international attention in 2012 when a group of its workers were striking at its platinum mine in Marikana. On 16 August 2012, South African police opened fire on a group of workers, killing 34 and injuring 78.

109 The World Bank, "GDP (current US$) South Africa."

110 Simon Neville, "Anglo American sacks 12,000 striking South African miners," *The Guardian*, October 6, 2012.
"South Africa strikes: Sacked platinum miners reinstated," *BBC*, October 27, 2012.

111 "Mining company fires 13,000 after strike," *France24*, February 2, 2012.

A few days earlier, Lonmin security staff had fired rubber bullets at striking workers, hospitalising two.[112]

More recently, Reuters reports that platinum mine workers at Sibanye-Stillwater planned to strike in April 2022 in solidarity with strikers at a Sibanye-Stillwater gold mine.[113] In June 2022, 4000 mine workers organized a strike at Impala Platinum mines in Rustenburg to address labour concerns and pay disparities.[114]

PGM Policy

South Africa

The government in Pretoria wants to leverage its unique position in the PGM industry and platinum supply chain to develop its economy and create employment opportunities. But it needs the development of a global hydrogen economy that relies on PEM technologies in order to achieve its ambitions, and this is all but clear.

Hydrogen Society Roadmap

In 2021, the South African Department of Science and Innovation published the Hydrogen Society Roadmap for South Africa. This roadmap presents how South Africa wants to capitalise on its PGM reserves and associated industry. The roadmap emphasises that PGMs are an opportunity for the South African economy: "South Africa has identified PGM beneficiation as a key economic opportunity and a driving force for advancing hydrogen and fuel-cell RDI [Research, Development & Innovation]. The country has a window of opportunity to develop PGM-based components for hydrogen production to meet the demands of other countries that have developed policies to integrate hydrogen in their economies."[115]

112 Nick Davies, "Marikana massacre: the untold story of the strike leader who died for workers' rights," *The Guardian*, May 19, 2015.

113 Nelson Banya, "South African union plan strike at Sibanye's platinum operations," *Reuters*, April 12, 2022.

114 "Thousands of workers on strike at South Africa's Impala platinum mines," *Peoples Dispatch*, June 24, 2022.

115 Department of Science and Innovation, *Hydrogen society: Roadmap for South Africa 2021* (Pretoria: Department of Science and Innovation, October 6, 2021), 17.

The government sees future rising demand for PGMs because of the hydrogen economy as a route to economic development. The roadmap states: "Given the country's large share of PGM resources and their significant contribution to the economy [ZAR187.6 billion/EUR11 billion in 2019] and the dire unemployment situation, it is essential to capitalise on the increased demand for hydrogen applications that require PGM metals. The PGM industry currently employs about 160.000 people, with two to three indirect jobs in other industries for each direct job, resulting in close to 400.000 jobs. The potential for hydrogen to support the growth of the RE [renewable energy] industry in South Africa as an energy-storage solution could also contribute to job creation."[116]

But while PEM technologies yield promise for the South African economy, there is also peril. The future decline in demand for engines with combustion engines will depress the demand for catalytic converters. According to the roadmap, 40% of PGMs are used in catalytic converters for internal combustion engines. PEM technologies are expected to make up for the decrease.[117] Yet, this is not certain.

The roadmap also includes the plan for a 'Platinum Valley'. This is an industrial area where different parts of the hydrogen economy are meant to be integrated, including PGM mining and processing.[118] In the section on research, development and innovation, the roadmap states: "it is important that researchers keep in mind the need to leverage the country's PGM resource endowment"[119] calling on hydrogen researchers to look for technologies that rely on PGMs in order to benefit South Africa. In other words, PGMs are seen to be a strategic resource for the development of the economy.

Currently there are no specific export controls or restrictions imposed on PGM exports from South Africa. But the OECD has issued a word of warning. It has said that "there are a number of legislative provisions that might be viewed as

116 Department of Science and Innovation, *Hydrogen society: Roadmap for South Africa 2021* (Pretoria: Department of Science and Innovation, October 6, 2021), 20.

117 Department of Science and Innovation, *Hydrogen society: Roadmap for South Africa 2021* (Pretoria: Department of Science and Innovation, October 6, 2021), 1-105.

118 "Science and Innovation on South Africa's Platinum Valley project," South African Government, published October 19, 2020. & Tani Salma and Nikos Tsafos, "South Africa's Hydrogen Strategy," CSIS, published April 4, 2022.

119 Department of Science and Innovation, *Hydrogen society: Roadmap for South Africa 2021* (Pretoria: Department of Science and Innovation, October 6, 2021), 80.

[indirect] restrictions on exports".[120] These provisions include royalties on PGM production and refining, as well as the need for export permits.[121] Nevertheless, South Africa is much less restrictive in terms of its export policies for PGMs when compared to other countries in southern Africa, like Namibia[122] and Zimbabwe[123], or even further afield in Tanzania[124] and Ghana,[125] which have already implemented export bans or restrictions on specific natural resources. For instance, since late 2022, Namibia and Zimbabwe have banned the export of raw lithium and other critical minerals, such as cobalt, manganese, and graphite.[126] Ghana followed suit with its own Green Minerals Policy, restricting exports of lithium, bauxite, and iron.[127] Most recently, Tanzania announced it would implement export restrictions on unprocessed lithium, starting from May 2024.[128]

The composition of the PGM sector – made up of a few publicly-traded, predominantly South-African or British multinational companies – and the troubling domestic economic situation suggest that the degree to which South Africa can use its position in the platinum supply chain as a tool of geopolitical leverage, is limited.

120 Jane Korinek and Jeonghoi Kim, "Export Restrictions on Strategic Raw Materials and Their Impact on Trade and Global Supply," *OECD Trade Policy Papers*, no. 95 (March 2010): 12.

121 Jane Korinek and Jeonghoi Kim, "Export Restrictions on Strategic Raw Materials and Their Impact on Trade and Global Supply," *OECD Trade Policy Papers*, no. 95 (March 2010): 12.

122 "Namibia bans export of unprocessed critical minerals," *Reuters*, June 8, 2023.

123 "Zimbabwe bans raw lithium exports to curb artisanal mining," *Reuters*, December 21, 2022.

124 "Tanzania to Ban Raw Lithium Exports from 2024," Energy Capital Power, November 8, 2023.

125 "Banning the export of unprocessed critical minerals: Is Ghana next on this trajectory?" Commodity Monitor, accessed November 16, 2023.

126 Nyasha Nyaungwa, "Namibia orders police to stop Chinese firm's lithium exports," *Reuters*, October 24, 2023.
Isabeau van Halm, "Zimbabwe joins the wave of resource nationalism," *Mining Technology*, January 19. 2023.

127 "Ghana Greenlights Minerals Policy to Enhance Beneficiation," Energy Capital Power, August 8, 2023.
Kiran Pandey, "Green minerals race: Ghana approves policy to reap maximum benefits from mining projects," Down to earth, August 9, 2023.

128 David Whitehouse, "Exclusive: Tanzania to ban unrefined lithium exports from May 2024," *The Africa Report*, November 2, 2023.
See also OECD, "Raw Materials Critical for the Green Transition: Production, International Trade and Export Restrictions", OECD Trade Policy Paper, April 2020, no. 269.

China

Platinum and critical mineral policy

Platinum group metals are not included in the list of 24 strategic minerals in China's National Mineral Resources Plan (2016-2020). However, platinum is named in the State Council's New Energy Vehicle Industry Development Plan (2021-2035). This Plan states that in order to "promote the development of the entire value chain of power batteries" companies must be encouraged "to improve their ability to secure key resources such as lithium, nickel, cobalt, and platinum".[129] Platinum is only mentioned once, but it is mentioned specifically in the context of security of supply. This underlines the Chinese government's awareness of its dependence on other countries for PGM supplies.

As a positive sign, at the end of December 2022, the Chinese ministry of Commerce and the ministry of Science and Technology published a notice to revise the list of technologies that are prohibited or restricted from export. The Chinese government stated that catalyst production technology – which relies on platinum components – will be removed from the list.[130]

Domestic production

China only produces around 1 tonne of palladium annually, or 0.5% of global production. It produces around 2.5 tonnes of platinum out of a global annual production of about 180 tonnes, or 1.4%.[131] But China's domestic demand for palladium has hovered between 65 to 99 tonnes, and its platinum demand between 61 and 78 tonnes each year.[132]

To meet demand, China relies on foreign imports and domestic PGM recycling operations. Johnson Matthey, a UK multinational, operates a platinum recycling and recovery plant in China, and in 2022 the German companies BASF and

129 "Notice of the General Office of the State Council on printing and distributing the development plan for the new energy vehicle industry (2021-2035)," China General Office of the State Council, published October 10, 2020.

130 KPMG, "China plans to revise the list of technologies prohibited and restricted from export to PRC," February 2023, 1-7.

131 National Minerals Information Center, "Platinum-Group Metals Statistics and Information: Mineral Yearbook, 2021 tables-only release," U.S. Geological Survey, accessed September 6, 2023.

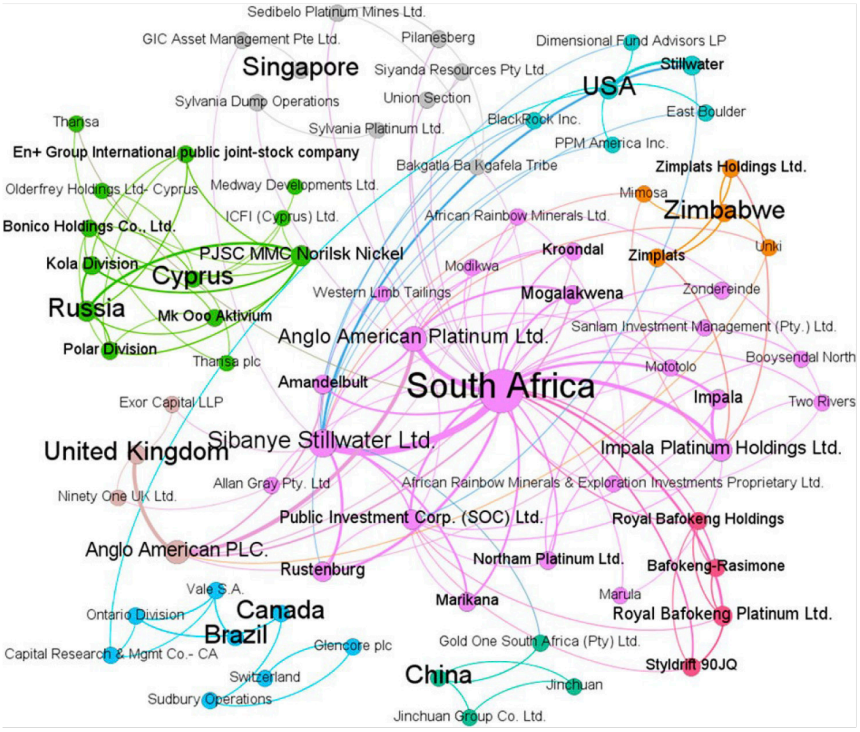
132 Johnson Matthey, *PGM Market Report* (London: Johnson Matthey, May 2023), 40 & 46.

Heraeus announced a joint venture to recover and recycle PGMs from used catalytic converters in China.[133]

China's involvement in South Africa

Involvement of Chinese companies and actors in the South African PGM industry is very limited (see figure 8). The figure below shows the global platinum supply network as mapped by Li et al (2023). The only case involving significant Chinese involvement is that of Wesizwe Platinum, which is partially owned by the Jinchuan (金川) mining company.

Figure 8 Global Platinum Supply Network (source: Li et al.)[134]



133 "BASF and Heraeus to form a joint venture offering world-class precious metal recycling solutions in China," BASF Catalysts, published February 11, 2022.

134 Pengyuan Li, Qunyi Liu, Ping Zhou and Ying Li, "Mapping global platinum supply chain and assessing potential supply risks," *Frontiers in Energy Research* 11 (2023): 1-17.

Wesizwe Platinum is a relatively new platinum mining company which will extract PGMs from the Bakubung mine. Wesizwe aims for annual production of about 12 tonnes of PGMs, of which around 7,5 tonnes platinum, from the Bakubung mine.[135] In comparison, Anglo American produces approximately 58 tonnes and Implats produces about 37 tonnes of platinum per year.[136] Wesizwe faces significant challenges in realising its production goals, as the opening of the mine has been delayed due to strikes.

Chinese parties Jinchuan Group and the China-Africa Development Fund (CADFund) own 45% of Wesizwe Platinum. Jinchuan Group is a state-owned enterprise active in cobalt and nickel manufacturing, and is majority owned by Gansu Province.[137] CADFund was established in 2006 by the China Development Bank.[138] It is owned by the Chinese Ministry of Finance and state-owned Central Huijin Investment Corporation.[139] The other 55% of Wesizwe Platinum is owned by South African companies including Amplats, and by institutional and other shareholders.[140] Jinchuan Group and CADFund bought a 45% stake in Wesizwe for more than USD$ 200 million in 2011.[141] Wesizwe Platinum received a USD$ 650 million loan from the China Development Bank to develop the Bakubung mine. According to a 2019 article published by Mining Indaba, the China Development Bank loan was received "at a much smaller interest rate than the standard rate, 3.8% vs 8%, characteristic of financing offered by Chinese institutes to projects considered highly strategic in value".[142]

135 "Bakubung platinum mine," Wesizwe, accessed September 6, 2023.

136 "Profiling the world's top five platinum-mining companies," NS Energy, October 26, 2020.

137 "Major shareholder," Jinchuan Group International Resources Co. Ltd, accessed September 19, 2023.

138 "Introduction," China-Africa Development Fund, accessed September 19, 2023.

139 *More detailed information in the Nickel case: The China Development Bank was also established as a policy bank under the State Council but was 'commercialised' in 2008 – although its only shareholders are the Ministry of Finance and Central Huijin Investment Corporation "both departments within the Chinese government". The China Development Bank's mission also includes the Belt and Road Initiative.*

140 "Wesizwe Platinum – a Unique Chinese/South African Mining Partnership," Wesizwe, published October 31, 2013.

141 Martin Creamer, "$650m Chinese loan for Wesizwe's Bakubung platinum mine project," *Mining Weekly*, January 21, 2013.

142 "Chinese investment in African mining: what you need to know," Mining Indaba, published October 16, 2019.

Similar to the larger platinum companies, Wesizwe has had its share of labour conflicts. The Bakubung Platinum Mine has been closed for five weeks in July and August 2023 as a result of a strike.[143] Wesizwe has not disclosed the reason for the current strike. Previously there have been delays in construction because of technical problems and community protests.[144] On 27 November 2023, Wesizwe Platinum announced that up to 571 jobs at the Bakubung mine may be cut (around 75% of the workforce) and that the company had started "mandatory consultations". The reasons for this major restructuring are twofold: firstly, the price for PGMs have declined: platinum fell by 11% and palladium by 40% in 2023 and secondly, the labour strikes resulted in a delay to start production.[145] According to Reuters, the three major South African PGM miners Anglo-American, Impala, and Sibanye Stillwater are all planning to cut costs or jobs due to the decline in prices.[146]

United States

Critical minerals, IRA and the Defense Production Act

The 2022 version of the US critical mineral commodities list includes five PGMs: iridium, palladium, platinum, rhodium and ruthenium. In the 2023 Department of Energy Critical Materials Assessment, platinum is projected to be 'near-critical.'[147] in the short-term (2020-2025), and 'critical' in the medium term (2025-2035). In the same assessment, iridium is considered 'critical' in the short term and will remain so in the medium term.

143 Marleny Arnoldi, "Wesizwe's Bakubung mine remains closed as unprotected strike continues," *Mining Weekly*, August 4, 2023.

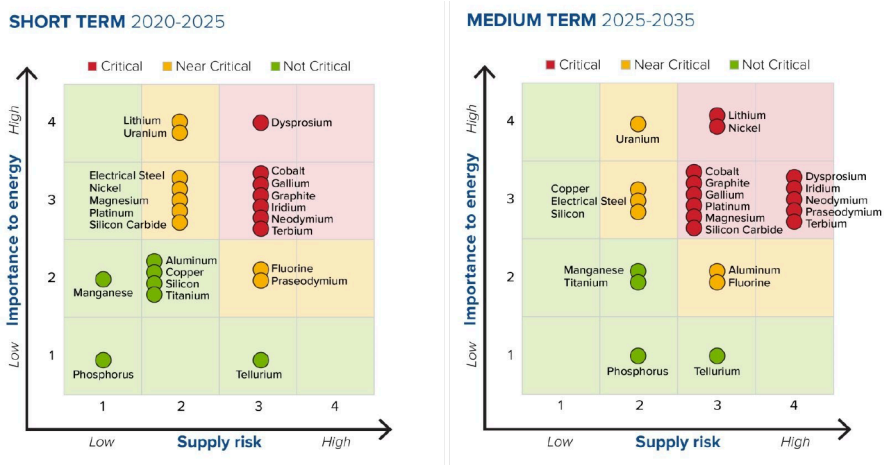
144 Marleny Arnoldi, "Wesizwe temporarily shuts Bakubung mine amid unprotected strike," *Mining Weekly*, July 24, 2023.
David McKay, "Wesizwe warns of "huge losses" after protests force suspension of Bakubung Platinum project," *Miningmx*, February 8, 2022.

145 Nelson Banya, "Jinchuan's S. African PGM project to cut 75% of workforce amid price rout," *Reuters*, November 27, 2023.

146 Nelson Banya, "Jinchuan's S. African PGM project to cut 75% of workforce amid price rout," *Reuters*, November 27, 2023.

147 'Near-critical' refers to materials that – although currently not classified as critical – could change to 'critical' material when there is a small change in underlying factors, such as market dynamics.

Figure 9 Critical Minerals Assessment Short and Medium Term (US DOE)



The Inflation Reduction Act (IRA) includes financial incentives for hydrogen and fuel cell projects, which will probably lead to a rising demand for PGMs and PEM technologies.[148] Nevertheless, current hydrogen-related demand for platinum is relatively small.[149]

Although the Biden-Harris administration does not devote as much attention to PGMs as it does to other critical materials like rare-earths or lithium, in June 2022 President Biden authorised the Department of Energy to use the Defense Production Act to speed up domestic manufacturing of five clean energy technologies, including: "Equipment for making and using clean electricity-generated fuels, including electrolyzers, fuel cells, and related platinum group metals".[150]

The most concrete initiative in US' hydrogen policy is the announcement on 13 October 2023 to invest USD$ 7 billion in the establishment of clean

148 "Financial incentives for hydrogen and fuel cell projects," U.S. Office of Energy Efficiency & Renewable Energy, accessed October 18, 2023.

149 "Platinum – the critical mineral for energy transition and energy independence," World Platinum Investment Council, published December 21, 2022.

150 "FACT SHEET: President Biden takes bold executive action to spur domestic clean energy manufacturing," The White House, published June 6, 2022.

hydrogen hubs. A hydrogen hub is a network of "clean hydrogen producers, consumers, and connective infrastructure that will help accelerate the large-scale production and use of clean hydrogen".[151] This investment is funded by the Bipartisan Infrastructure Law (BIL). The projects include the Appalachian Hydrogen Hub, California Hydrogen Hub, Gulf Coast Hydrogen Hub, Hartland Hydrogen Hub, Mid-Atlantic Hydrogen Hub, Midwest Hydrogen Hub and Pacific Northwest Hydrogen Hub.[152] The project descriptions of these hydrogen hubs do not mention PGMs.

Instead, it seems the Department of Energy is investing in substitution of PGMs. It is funding and enabling research into PGM-free catalysts for fuel cells and electrolysers.[153] It is also seeking to improve domestic platinum recycling from used fuel cells.[154] The US National Clean Hydrogen Strategy and Roadmap includes ambitious targets on recovery and recycling of PGMs. For instance, it formulates a 2024-2028 target of "≥95% of platinum group metals (PGMs) recovery from fuel cell membrane electrode assemblies (MEA) pathways" and a 2029-2036 target of "99% of PGMs from MEA pathways". The Roadmap also wants to reduce fuel-cell PGMs with 50% (from the 2020 baseline) in the next decade.[155] One of the actions mentioned that will support clean hydrogen use and broader market adoption is to "demonstrate ultra-low-NOx turbine operation and low-PGM fuel cell operation on 100% hydrogen for power generation by 2030."[156]

151 "Regional clean hydrogen hubs selections for award negotiations," U.S. Office of Clean Energy Demonstrations, accessed October 18, 2023.

152 "Biden-Harris Administration announces $7 billion for America's first clean hydrogen hubs, driving clean manufacturing and delivering new economic opportunities nationwide," U.S. Department of Energy, published October 13, 2023.

153 "CX-027936: Metal-organic framework-based heterostructure electrocatalysts with tailored electron density distribution for cost-effective and durable fuel cells and electrolyzers," U.S. Office of NEPA Policy and Compliance, published April 18, 2023.
"ElectroCat: Electrocatalysis consortium," Office of Energy Efficiency & Renewable Energy, accessed October 18, 2023.

154 "Fuel-cell waste reduction goes platinum," U.S. Office of Science, published June 7, 2022.

155 Hydrogen and Fuel Cell Technologies Office, *U.S. National Clean Hydrogen Strategy and Roadmap* (Washington: U.S. Office of Energy Efficiency & Renewable Energy, August 2023), 57.

156 Hydrogen and Fuel Cell Technologies Office, *U.S. National Clean Hydrogen Strategy and Roadmap* (Washington: U.S. Office of Energy Efficiency & Renewable Energy, August 2023), 71.

The US Hydrogen Strategy and Roadmap only mentions PGMs in the context of recycling, reducing their use and the development of substitutes including through the roll-out of low-PGM fuel cells. There are no projects mentioned that would increase domestic PGM production or that focus on cooperation with South Africa.

Domestic production

The US is the fifth-largest PGMs producer worldwide (after South Africa, Russia, Zimbabwe, and Canada) and the fourth-largest palladium producer (after Russia, South Africa, and Canada), but it is unable to meet domestic demand. In 2021, US consumption of palladium was 81.4 tonnes, while its domestic production was only 13.7 tonnes. For PGMs, its consumption was 53.5 tonnes, while domestic production was only 4 tonnes.[157]

There are two PGMs/palladium mines located in the US: Stillwater Mine and East Boulder Mine, both located in Montana. These two mines are owned by the South African mining company Sibanye-Stillwater.[158]

US involvement in South Africa

Although the United States has the African Growth and Opportunity Act and the Trade, Investment and Development Cooperative Agreement with the Southern African Customs Union (which includes South Africa), it does not have a formal free trade agreement with South Africa. This means that IRA tax credits do not apply to the import of technologies containing South African PGMs.[159]

Figure 8 (on page 40) highlights the limited involvement of US companies in the South African PGMs industry. The strongest connection between the two is the fact that South Africa's Sibanye Stillwater owns the Stillwater mines in Montana.

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157 Ruth F. Schulte, *Platinum-Group Metals* (Washington: U.S. Geological Survey Mineral Commodities Summaries, January 2023), 1-2.

158 "Stillwater & East Boulder," Sibanye Stillwater, accessed October 18, 2023.
"Profiling the top five platinum producing countries in the world," NS Energy, published October 4, 2019.

159 "Free Trade Agreements," Office of the United States Trade Representative, accessed October 18, 2023.
Witney Schneidman, "Africa's critical minerals could power America's green energy transition," *Foreign Policy*, August 3, 2023. https://foreignpolicy.com/2023/08/03/africa-minerals-biden-ira-green-energy-agoa/

Implications for Europe and the Netherlands

South Africa is rich in natural resources and is the world's most important producer of platinum group metals. It has dominant market shares both in extraction and processing. The possibility that platinum-based technologies could also play a central role in the hydrogen economy raises the prospect that South Africa's importance will continue to grow, but this is all but certain. Yet, despite the government's ambition to promote more economic activity in its platinum sector, it generally continues to take a rather liberal approach to platinum exports. Contrary to other countries in the region, South Africa, for now, does not seem intent on imposing stringent controls on the export of PGMs.

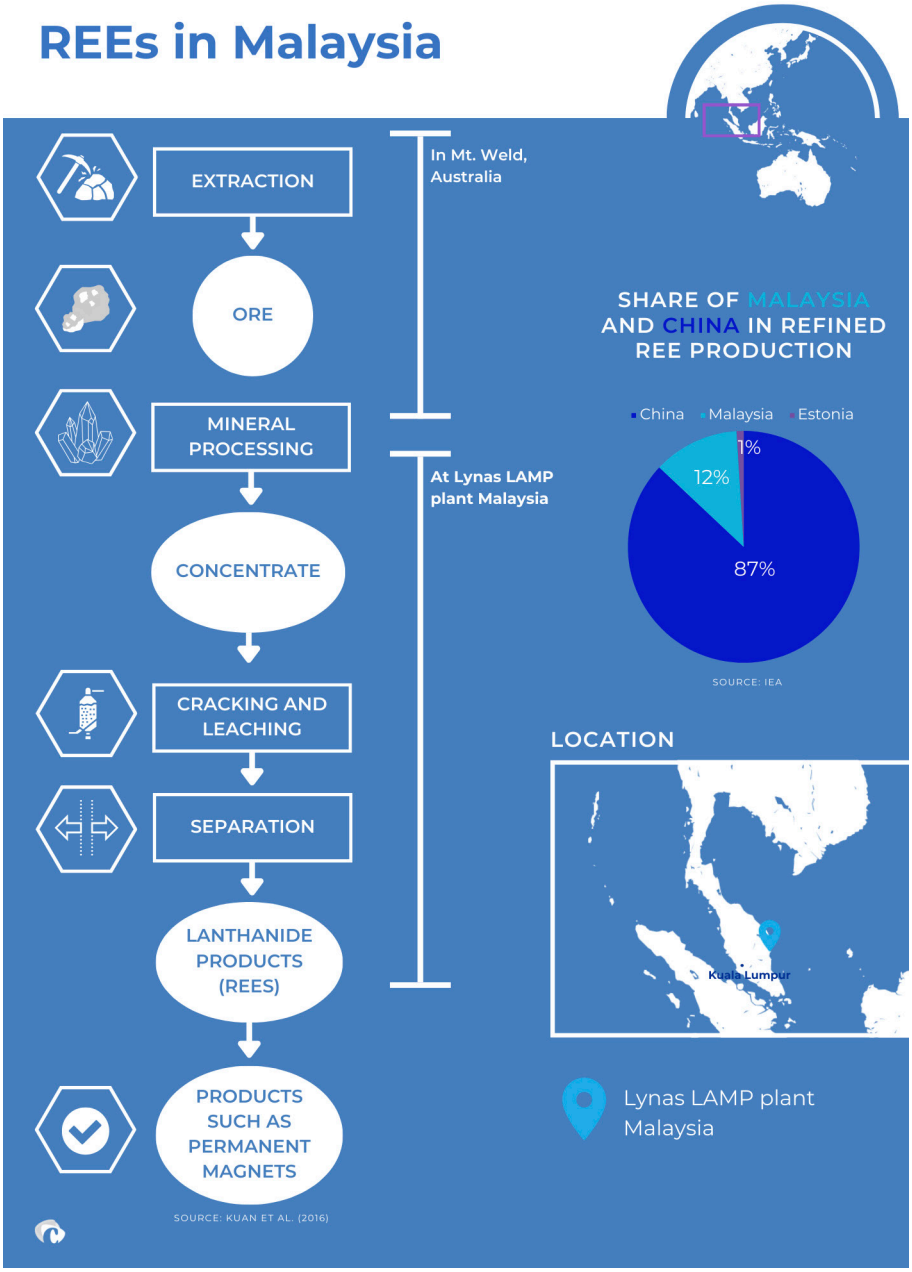
While global PGM production is characterised by a high degree of concentration in South Africa, it has not been accompanied by a high degree of resource nationalism. The composition of the domestic platinum sector seems to play an important role in this. South Africa's platinum sector is dominated by a handful of privately-owned and publicly-traded South African and British mining companies which have a strong interest in open markets. By contrast, **US and Chinese companies play a very limited role**. China's presence in other commodity sectors in South Africa however, could still give it a position of influence, but this may not directly impact platinum processing. There are reports that ownership of Amplats could change, though at the time of writing, this remains uncertain. It suggests however that monitoring ownership structures is a continuous process and the status quo may not be stable.

South Africa's PGM sector does face substantial domestic difficulties. **Stability of electricity supply is a major issue of concern and an impediment to energy-intensive activities like minerals processing.** Also, conflicts over labour rights and strike actions are a common feature in the mining sector, including in platinum processing. These domestic issues will need to be addressed if South Africa is to further develop its platinum sector.

The Netherlands and the EU could aim to ensure that South Africa remains a stable source of platinum group metals by helping to promote stability of the country's electricity grid and addressing labour grievances. This would be part of a broader, strategic development and sustainability agenda with the country, rather than one targeted specifically at the resources sector.

Meanwhile, the United States aims to reduce its reliance on platinum imports by investing in domestic recycling and promoting research into PGM-free catalysts and technologies. The Netherlands and the EU should consider doing the same. Given the Netherlands and the EU's ambitions to phase out combustion engines in the automotive sector by 2035, an EU-wide recycling effort to extract PGMs from catalysts and make them available for green applications would make sense. The Netherlands and the EU could aim to collaborate with the United States on PGM-free technologies and PGM recycling as part of their emerging transatlantic agenda on critical materials.

Figure 10 REE refining in Malaysia



Malaysia and Rare Earth Elements

Rare earth elements and strategic applications

Rare earth elements (REE), also known as Rare Earth Minerals, Rare Earth Metals or simply Rare Earths, are a group of 17 elements which include yttrium, lanthanum, cerium, praseodymium, neodymium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, and lutetium.[160] REEs can be divided into two categories – light and heavy – based on their atomic weight.[161]

Table 2 Light and Heavy REEs[162]

Light REEs	Heavy REEs
Lanthanum	Terbium
Cerium	Dysprosium
Praesodymium	Holmium
Neodymium	Erbium
Samarium	Thulium
Europium	Ytterbium
Gadolinium	Lutenium
	Yttrium

160 Scandium is sometimes included in the REE group, however, according to the US Geological Survey, "it does not occur in economic concentrations in the same geological settings as the lanthanoids and yttrium". Promethium is an REE but "not included in discussions of REE deposits because the element is rare and unstable in nature". Bradley S. Van Gosen, Philip L. Verplanck, Keith R. Long, Joseph Gambogi and Robert R, Seal II, *The Rare-Earth Elements – Vital to Modern Technologies and Lifestyles* (Reston: U.S. Geological Survey Mineral Resources Program, November 2014), 1.

161 Only Yttrium is light but included in the group of heavy REEs "because of its similar chemical and physical properties". Bradley S. Van Gosen, Philip L. Verplanck, Keith R. Long, Joseph Gambogi and Robert R, Seal II, *The Rare-Earth Elements – Vital to Modern Technologies and Lifestyles* (Reston: U.S. Geological Survey Mineral Resources Program, November 2014), 1.

162 Bradley S. Van Gosen, Philip L. Verplanck, Keith R. Long, Joseph Gambogi and Robert R, Seal II, *The Rare-Earth Elements – Vital to Modern Technologies and Lifestyles* (Reston: U.S. Geological Survey Mineral Resources Program, November 2014), 1.

Due to their unique properties, rare earths are used in a variety of strategic products, including in a wide range of green energy technologies, medical technologies, and high-end military equipment.[163] Particularly important are two types of permanent magnets that are produced with REEs: neodymium magnets and samarium-cobalt magnets. These magnets are used in electric vehicles[164] and wind turbines.[165] According to the International Renewable Energy Association, permanent magnets were responsible for 34% of REE demand and they expect this to rise to 40% by 2030.[166]

REEs are also used in military applications like high-precision lasers. Neodymium magnets are used in radar and sonar systems and satellite communications. Besides, REEs are also used in ammunition, missiles, military aircraft and infantry fighter vehicles.[167] **Advanced military technology would be unthinkable without the use of certain rare earths.**

The most important REE producer in the world is China, followed by the United States and Australia (see figure 11). China has near-monopolies in the field of extraction and processing. In 2022, it extracted 70% of the world's REEs, followed by the US with 14% (see figure 12). **In REE processing, China's dominance is even more pronounced. According to the IEA, in 2019, 87% of REE processing takes place in China, followed by Malaysia at 12%** (see figure 13).

163 For a solid overview of the different applications of the different Rare Earth Elements see, Volker Zepf, "An Overview of the Usefulness and Strategic Value of Rare Earth Metals," in *Rare Earths Industry* (2016), 3–17.

164 Jeff Shepard, "Rare earths and EVs – it's not about batteries," Battery Power Tips, January 23, 2023.

165 David Piper and Judith M. Guido, "Applications of magnets in wind turbines," Wind Systems, March 2021.

166 "The critical role of rare earth elements in the energy transition," Fuels and Blues, August 24, 2022.

167 Benedetta Giardi, Irina Patrahau, Giovanni Cisco and Michel Rademaker, *Strategic raw materials for defence; Mapping European industry needs* (The Hague: The Hague Centre for Strategic Studies, January 2023), 7.

Figure 11 REE mine production in 2022 in tonnes[168]

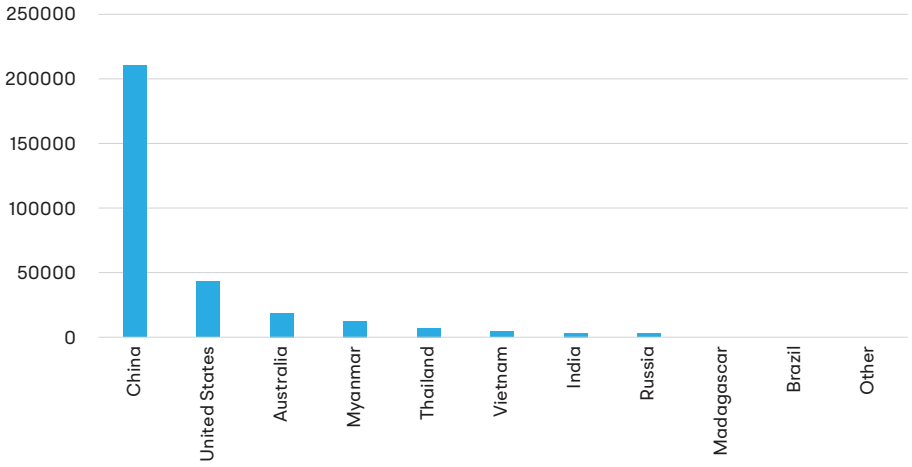
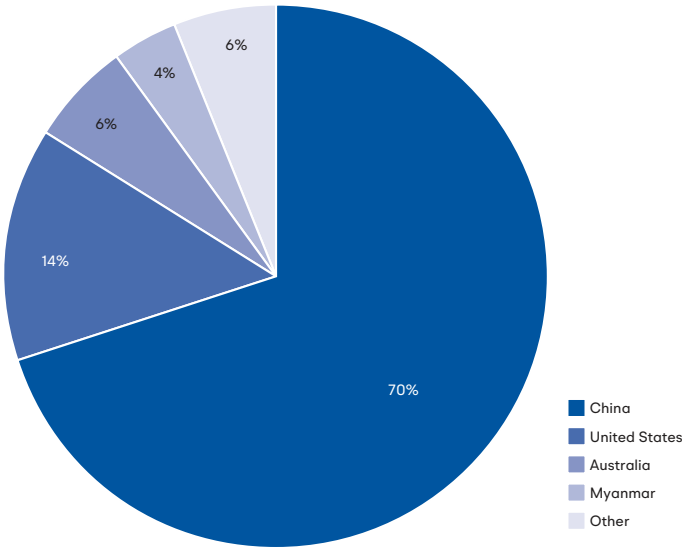
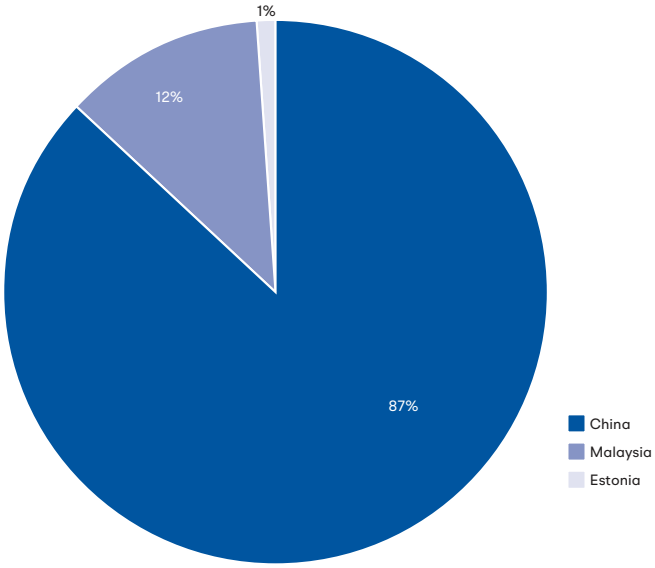


Figure 12 REE mine production in 2022[169]



168 Daniel J. Cordier, *Rare Earths* (Washington: U.S. Geological Survey, January 2023), 2.
169 Daniel J. Cordier, *Rare Earths* (Washington: U.S. Geological Survey, January 2023), 2.

Figure 13 REE processing in 2019[170]



One of the major downsides for the production of rare earths is its negative impact on the environment. Rare earths are not geologically rare, but they are dispersed. This means that REEs "are usually present in very low concentrations and are combined".[171] It means that mining them can have a larger impact than mining for other materials. It also means that extensive extraction and separation is needed, which "require large amounts of energy and water, and generate large quantities of waste".[172] After the ore is processed into concentrate, an intensive process of cracking, leaching and separation of the REEs from radioactive elements follows. As a result, mining residue usually contains radioactive elements like uranium and thorium, which creates health hazards for local residents and the surrounding environment.[173] The most notorious example is a 'lake' filled with radioactive waste from REE mining and processing in Inner Mongolia, China.[174]

170 David Piper and Judith M. Guido, "Applications of magnets in wind turbines," Wind Systems, March 15, 2021.

171 Mariana Walter, Caludia Custodio, Volahery Adriamanantenasoa and John Feffer, "Mapping the Impacts and Conflicts of Rare-Earth Elements," Foreign Policy in Focus, November 28, 2023.

172 ibid.

173 ibid.

174 Cécile Bontron, "Rare-earth mining in China comes at a hevy cost for local villages," The Guardian, August 7, 2012.

REE activities in Malaysia

Malaysia has a domestic reserve of REEs, although not a very large one. It is estimated at 30,000 tonnes (compared to 44 million tonnes in China).[175] This reserve is not actively mined at scale, but there is research being done into the availability of 'non-radioactive' REEs in different parts of Malaysia.[176]

Instead, **Malaysia's importance to global REE production is that it is home to a major REE processing and refining plant: Lynas Advanced Materials Plant (LAMP)**. LAMP is one of the few REE processing and refining plants outside China. It is also one of the world's largest.[177] Located just outside Kuantan, LAMP produced around 12% of global refined REEs in 2019.[178]

Figure 14 Location of LAMP facility in Kuantan[179]

175 Sebastian Strangio, "Malaysia Flags Ban on Export of Rare Earth Minerals," The Diplomat, September 12, 2023.

176 Sharifah Mahsinah Abdullah, "SOP for mining of the non-radioactive rare earth elements approved by Cabinet," New Straits Times, June 17, 2023.

177 Collins Chong, "Malaysia needs to play rare earth card well," Malay Mail, January 12 2023. "Gearing Malaysia as a Rare Earth Elements (REEs) Powerhouse," Malaysian Investment Development Authority, February 2022. https://www.mida.gov.my/gearing-malaysia-as-a-rare-earth-elements-rees-powerhouse/

178 Pavel Bilek, *ASEAN-IGF Minerals Cooperation: Scoping study on critical minerals supply chains in ASEAN* (Winnipeg: Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development, May 2023), 22.

179 Kai Lit Phua, "Rare Earth Plant in Malaysia: Governance, Green Politics and Geopolitics," Journal of Southeast Asian Studies 5, 3 (2016):443-462

LAMP mainly produces light rare earths including cerium, lanthanum, neodymium and praseodymium in different chemical compositions.[180] The plant has been in operation since 2012.[181] LAMP is owned by Lynas Malaysia Sdn. Bhd., wholly owned by the Australian Lynas Corp. Ltd. The company is listed on the Australian Securities Exchange. The company has two major active operations: a rare earth mine in Mount Weld in Western Australia, which sources its processing and refining facility, LAMP in Malaysia. The company owns and operates one of the few (if not the only) integrated REE production process without Chinese involvement.

A global boom in REE prices in the early 2010s offers the background to the start of the LAMP facility in Malaysia. In 2010, possibly inspired by an incident between China and Japan in the East China Sea, China cut its exports of rare earths to Japan.[182] It led to a surge in prices: some REEs increased four- to six-fold in 2010 and 2011.[183] It also led to growing concerns among Western governments about their economic dependence on China. In response, an exploration boom began as companies and countries started to look for ways to expand rare earth supplies.[184] Soaring REE prices and a push for diversification stimulated Lynas to set up a refining plant in Malaysia.

180 Spencer D. Buteyn, "The Mineral Industry of Malaysia," in *2019 Minerals Yearbook* (Washington: U.S. Geological Survey, July 2023), 2.

181 "Lynas Malaysia, Kuantan, Malaysia," Lynas Rare Earths, Accessed December 12.

182 James Pamment et al., *The 2010 Senkaku crisis* (Riga: NATO Strategic Communications Centre of Excellence, 2019), 173.

183 Keith Bradsher, "Supplies Squeezed, rare Earth Prices Surge," The New York Times, May 2, 2011. I

184 Holder Paulick and Erika Machacek, "The global rare earth element exploration boom: An analysis of resources outside of China and discussion of development perspectives," *Resources Policy* volume 52 (2017): 134-153.

Figure 15 Light rare earth metal oxide prices per kg[185]

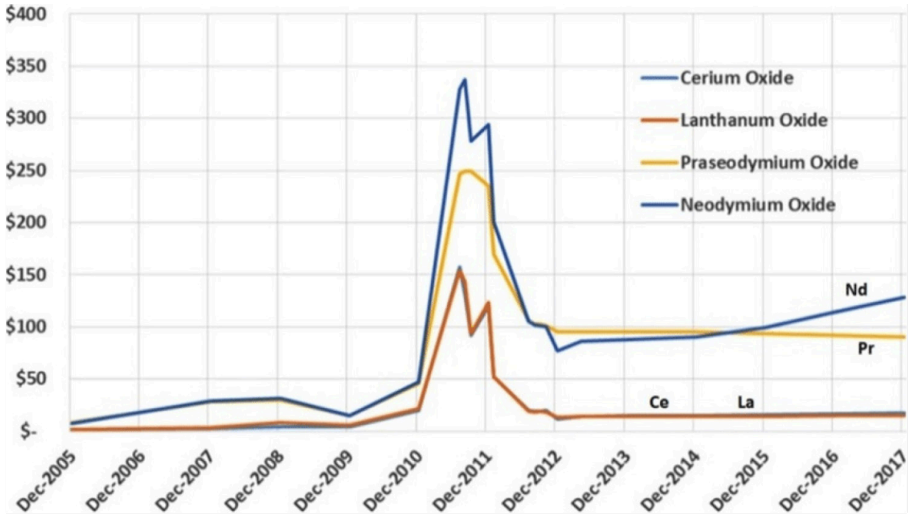
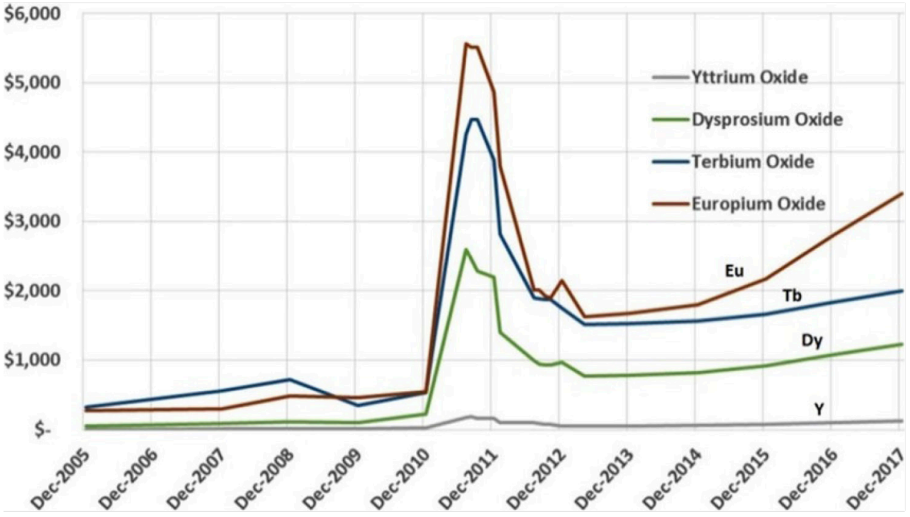


Figure 16 Heavy rare earth metal oxide prices per kg[186]



185 George Barakos, Helmut Mischo, Jens Gutzmer, *Status Quo and Future Evaluations of Global Rare Earth Mining (with Respect to Special Rare Earth Element-industry Criteria)* (Sydney: Third International Future Mining Conference, November 2015), 23.

186 George Barakos, Helmut Mischo, Jens Gutzmer, *Status Quo and Future Evaluations of Global Rare Earth Mining (with Respect to Special Rare Earth Element-industry Criteria)* (Sydney: Third International Future Mining Conference, November 2015), 24.

Besides LAMP, Lynas is now also working on two new projects; a rare earth separating and processing facility in Kalgoorlie, Western Australia and a rare earth processing facility in the US.[187] The new Kalgoorlie facility started production in December 2023 and the US facility is expected to be operational between June 2025 and June 2026.[188]

Environmental and health concerns

There have been two previous REE mining operations in Perak: the Asian Rare Earth (ARE) and Malaysian Rare Earth Corporation Plant (MAREC). MAREC was opened in 1976 but shut down in 1982 when ARE began its operations. ARE's largest shareholder was Japan's Mitsubishi Chemical Industries Ltd., which had a 35% stake in the plant.[189]

ARE and MAREC produced yttrium from monazite. Monazite does not only contain yttrium but also radioactive residue from thorium and uranium.[190] In the 1980s, ARE was responsible for **radioactive pollution in Bukit Merah in Perak**. According to residents of a nearby town, radioactive waste pollution resulted in sudden cases of leukaemia and at least 7 deaths, as well as birth defects and other health issues.[191]

ARE was closed in 1994. According to the New York Times, environmental concerns lay at the heart of the closure. Local protestors played an important role persuading Japanese politicians to pressure Mitsubishi to close the plant.[192]

The dangers posed by radioactive waste and materials feature prominently in the Malaysian debate on the further development of the country's REE industry. It explains why there is a strong emphasis by the government on pioneering 'non-radioactive' REE processing, even though this is not yet technologically feasible.[193]

187 Lynas Rare Earths, *2023 Annual Report* (Perth: Lynas Rare Earths, October 2023), 15.

188 "Lynas feeds first material to Kalgoorlie rare earth processing facility," NS Energy, December 7, 2023. Lynas Rare Earths, *2023 Annual Report* (Perth: Lynas Rare Earths, October 2023), 15.

189 "Chronology of events in the Bukit Merah Asian Rare Earth development," Consumers' Association of Penang, accessed December 12.

190 "1982 Bukit Merah radioactive pollution," Wikipedia, accessed December 12.

191 Keith Bradsher, "Mitsubishi Quietly Cleans Up Its Former Refinery," The New York Times, March 8, 2011.

192 ibid.

193 Sharifah Mahsinah Abdullah, "SOP for mining of the non-radioactive rare earth elements approved by Cabinet," New Straits Times, June 17, 2023.

REE Policy

Malaysia

Malaysia does not have large-scale REE mining operations, and its only REE processing facility is LAMP. The government, however, is planning to start up new mining projects, mostly in order to move from upstream (mining) and midstream (processing) activities to develop a downstream industry.[194] It wants to strike a balance between economic nationalism and the environment: on the one hand promoting its domestic resources sector through export controls and on the other hand taking a tough stance against the environmental impact associated with REE processing.

Government licenses and LAMP operations

In order to continue its operations, LAMP needs to renew its licences with the Malaysian government. One of the most important issues here is the radioactive waste LAMP produces.[195]

In February 2023, Lynas' licence was renewed for three years, but stringent conditions "prohibiting the production of radioactive waste in the country" were put in place.[196] These conditions would make processing of rare earths more difficult, or even impossible.[197] The company stated that it would temporarily shut LAMP if the conditions "prohibiting the import and processing of lanthanide concentrate remained on July 1 [the date of the new license]".[198] The process dragged on. On 22 October, the Malaysian newspaper New Straits Times reported that Lynas would cease part of its operations in Malaysia at the start of November.[199] The government gave Lynas an extension till 31 December "to

194 Tham Siew Yean and Neo Hui Yun Rebecca, "Malaysia's return to mining: Redeveloping Rare Earth Elements (REE)," ISEAS Yusof Ishak Institute, December 13, 2023.

195 Spencer D. Buteyn, "The Mineral Industry of Malaysia," in *2019 Minerals Yearbook* (Washington: U.S. Geological Survey, July 2023).

196 Rozanna Latiff, "Malaysia says Lynas' license could be revoke if it fails to comply with curbs," Reuters, February 15, 2023.

197 ibid.

198 Shahrin Aizat Noorshahrizam, "As Lynas bids goodbye to Malaysia, researchers prepare to extract REE using local technology," New Straits Times, October 22, 2023.

199 Shahrin Aizat Noorshahrizam, "As Lynas bids goodbye to Malaysia, researchers prepare to extract REE using local technology," New Straits Times, October 22, 2023.

prevent any disruptions to the global rare earths supply chain".[200] Two days later, on 24 October, Reuters reported that the Malaysian government had amended Lynas' licence, allowing the company to continue to import and process radioactive material (lanthanide concentrate from its Australian mine) until March 2026.[201] Malaysian Minister of Science and Technology Chang Lih Kang stated that this licence extension is contingent on Lynas extracting (radioactive) thorium from its waste.[202]

Export Ban and Renewed Interest in Mining

In 2021, Malaysia's National Mineral Industry Transformation Plan 2021-2030 was published. This Plan is focused on developing a mineral industry in Malaysia that includes the whole value chain (upstream, midstream and downstream). The Plan includes several minerals such as bauxite and tin, but also "non-radioactive" REEs.[203]

Malaysia is now planning to introduce an export ban on REEs, aimed at raw materials (not the processed rare earths that LAMP produces). This was announced by the Malaysian Prime Minister Anwar Ibrahim in parliament in September 2023. The reasoning behind the export ban is "to ensure that the value supply chain of rare earth elements remains in the country".[204] This plan seems to apply to the REE reserves that Malaysia has, which have not been extensively mined. With this step Malaysia will follow a trend of introducing export bans on raw materials, like Indonesia has done with nickel ore.

200 Lynelle Tham and Faiz Zainudin, "Lynas Malaysia's operating licence renewed," Free Malaysia Today, October 24, 2023.

201 Rozanna Latiff, Danial Azhar and A. Ananthalakshmi, "Malaysia allows Lynas to import radioactive raw material until 2026," Reuters, October 24, 2023.

202 Norman Goh, "Malaysia allows exports of processed rare earths: minister," Nikkei Asia, October 24, 2023.
Rozanna Latiff, Danial Azhar and A. Ananthalakshmi, "Malaysia allows Lynas to import radioactive raw material until 2026," Reuters, October 24, 2023.
Lynelle Tham and Faiz Zainudin, "Lynas Malaysia's operating licence renewed," Free Malaysia Today, October 24, 2023.

203 Tham Siew Yean and Neo Hui Yun Rebecca, "Malaysia's return to mining: Redeveloping Rare Earth Elements (REE)," ISEAS Yusof Ishak Institute, December 13, 2023.

204 Norman Goh, "Malaysia plans to ban exports of rare earth minerals," Nikkei Asia, September 11, 2023.

China

REE as a critical material and domestic production

China is the world's largest producer and refiner of REEs. It also has the world's largest known reserves. Around half of the world's REE reserves are in China. As an indication, 210.000 tons of REE were produced in China in 2022, which represents around 70% of the world's total. Around 85% of REE refining capacity is located in China.[205] This makes the rest of the world heavily dependent on Chinese REE supply chains.

The Chinese government has recognized the strategic importance of REEs since at least the 1990s. During his Southern Tour in 1992, Deng Xiaoping said: "There is oil in the Middle East and rare earths in China. China's rare earth resources account for 80% of the world's known reserves. Its status is comparable to that of oil in the Middle East and is of extremely important strategic significance. We must do a good job in rare earth matters and give full play to the advantages of our country's rare earths".[206] According to an article on the Youth Page of the Chinese People's Political Consultative Conference (an advisory body part of the CCP's united front), REEs were already considered important even before Deng, as REE extraction was included in the first science and technology development plan in the 1950s by premier Zhou Enlai.[207]

In China's more recent national mineral resources plan (2016-2020), REEs are included as one of 24 strategic minerals. Compared to other critical raw materials, due to the size of China's domestic REE industry, REEs get a lot of attention in the plan. For example, the plan seeks to establish government control over the mining of REEs, including through a traceability system and a controlled total mining amount of 140,000 tons per year.[208]

In 2016, the Ministry of Industry and Information Technology published the Rare Earth Industry Development Plan (2016-2020) which states that "the development of the rare earth industry should be driven by innovation, high-end

205 Mai Nguyen and Eric Onstad, "China's rare earths dominance in focus after it limits germanium and gallium exports," Reuters, December 21, 2023.
206 Duan Qiming 段启明, "Focus on China's rare earths," CPPCC, May 4, 2011.
207 ibid.
208 Ministry of Land and Resources, *National Mineral Resources Plan (2016-2020)* (Beijing: Ministry of Land and Resources, November 2016), 30 & 37.

applications of rare earths should be expanded, and the high-quality development of the rare earth industry should be boosted".[209] The State Council's New Energy Vehicle Industry Development Plan (2021-2035) mentions that "low-cost rare earth permanent magnet materials" are a key technology.[210] It underlines the strategic importance Beijing allocates to rare earths and the role that the state has in channelling it.

Export controls

Export quotas and restrictions are a part of Chinese REE policy, and REE export controls are part of China's toolkit of economic statecraft.[211] Its most notable use was the restriction of REE exports to Japan in 2010. This heavily impacted the Japanese electronics and green technology industry.[212] Since then, the Chinese government has tightened its control over REE exports. In January 2021, the Chinese Ministry of Industry and Information Technology published the draft Regulations on Rare Earth Management. They state that the Export Control Law (adopted in October 2020)[213] is applicable to REE exports.[214] On 30 December 2022 the Ministry of Commerce and Ministry of Science and Technology published a list of items prohibited from export. It includes: "Nonferrous metal smelting and rolling: extraction, processing and utilization technology of rare earth".[215]

209 Lei Zhou, Wen Xiao and Na Yan, "International comparative research on the relevance of science and technology and the innovation ability of the rare earth industry – from the perspective of technology – industry mapping based on patent information," *Resources Policy* 80, 103257 (2023): 1.

210 Guo Ban Fa, *The General Office of the State Council on the issuance of the new energy vehicle industry: Notice of the development plan (2021-2035)*, no. 39 (Beijing: General Office of the State Council, October 2020).

211 Nabeel A. Mancheri, Benjamin Sprecher, Gwendolyn Bailey, Jianping Ge and Arnold Tukker, "Effect of Chinese policies on rare earth supply chain resilience," *Resources, Conservation and Recycling* 142 (2019): 101-112.

212 SEO, Clingendael and TNO, *Geo-economische monitor: Strategische afhankelijkheden, economische beïnvloeding, kennispositie and investeringsstromen* (Amsterdam: SEO Economisch Onderzoek, December 21, 2022), 122.

213 Changhao Wei, "NPCSC passes export control law & biosecurity law, updates patent law, national flag/emblem laws, election law & minors protection," NPC Observer, October 17, 2020.

214 Sofia Baruzzi, "China tightens control over management of rare earths," China Briefing, February 25, 2021.

215 KPMG, "China plans to revise the list of technologies prohibited and restricted from export to PRC," February 2023, 1-7.

In November 2023, the Chinese Ministry of Commerce included REEs in a list of commodities for which import and export reporting is required: "traders must provide real-time reports, including country of shipment, the date the contract was signed, the quantity, the date loaded, as well as ship and port of arrival for customs clearance"[216] of rare earth metals and oxides for the next two years (until October 2025). **In December 2023, the Chinese government restricted the export of technology to make rare earth magnets.**[217]

Chinese involvement in Malaysian REE

In 2019, a Memorandum of Understanding (MoU) was signed between the Perak government and China's Chinalco GXNF Rare Earth Development "for the exploration of rare earths in Perak", close to the original ARE plant. This raised concerns, for example with the NGO Friends' of the Earth Malaysia (SAM). It released a statement calling it "highly irresponsible" to start a process leading to REE mining in Perak. SAM mentions the earlier radioactive poisoning case in Bukit Merah and calls on the Perak state government to block REE extractive activities[218]. In turn, the Ministry of Water, Land and Natural Resources clarified that this MoU only relates to researching REE deposits, not mining.[219] It remains to be seen whether this initiative will materialize into a functioning plant. If so, it would change Malaysia's current position as a source of non-Chinese REEs and increase Chinese influence in Malaysia's extractive industries.

United States

REE as critical material and its import from Malaysia

The US critical mineral list includes 16 out of 17 REEs: all except promethium. The 2023 Department of Energy Critical Materials Assessment projects praseodymium as 'near-critical' in the short term and 'critical' in the medium term. Dysprosium, neodymium, and terbium are considered 'critical' in the short and the medium term.

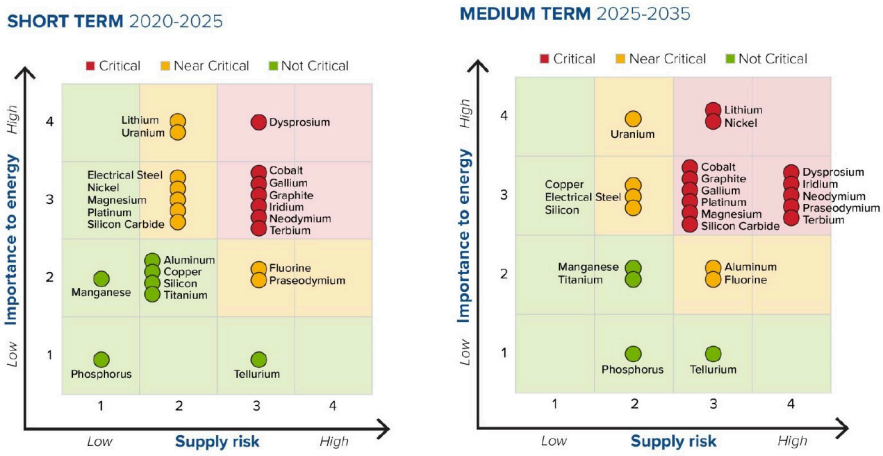
216 "China rattles rare earths export sabers," Adamas Intelligence, November 7, 2023.

217 Siyi Liu and Dominique Patton, "China bans export of rare earths processing tech over national security," Reuters, December 22, 2023.

218 Meenakshi Raman, "Move to embark on rare-earth mining in Perak is highly irresponsible," Sahabat Alam Malaysia, November 27, 2019.

219 "Perak rare earth deal only for research, not mining, says ministry," Free Malaysia Today, November 28, 2019.

Figure 17 Critical Minerals Assessment Short and Medium Term (US DOE)



Malaysian REE exports have helped to reduce Washington's import reliance on China. Between 2014 and 2017, Malaysia was not a noticeable source of US REE imports, but in 2018-2021 it became the second largest source: 8% of US REE imports originate there.[220] The US imported 74% of its RE compounds and metals from China between 2018-2021, down from 80% between 2014-2017.[221]

US domestic production

Since 2019, the US is the world's second largest miner of REEs. In 2022, 43,000 tonnes of REE were mined in the US (compared to 210,000 tonnes in China).[222] There is currently one operational REE mine in the US.[223] The US company MP Materials owns the REE mine in Mountain Pass, California. However, MP is dependent on China for refining the ores. MP's second largest shareholder, Shenghe Resources (盛和资源), which owns some 7.5%, is the purchaser of REE ore from the mine.[224] It means that REE ore extracted at

220 Mai Nguyen and Eric Onstad, "China's rare earths dominance in focus after it limits germanium and gallium exports," Reuters, December 21, 2023.

221 ibid.

222 Daniel J. Cordier, *Rare Earths* (Washington: U.S. Geological Survey, January 2023), 2.

223 Ernest Scheyder, "EXCLUSIVE U.S. bill would block defense contractors from using Chinese rare earths," Reuters, January 14, 2022.

224 "MP Materials," Wikipedia, last edited October 18, 2023.

Mountain Pass is shipped to China for processing. To address the undesired dependency this has created, the US government has taken a number of concrete steps to promote domestic refining and processing.

The US Department of Defense (DoD) has awarded MP Materials USD$ 9.6 million in 2020 under the Defense Production Act to develop the capability to process Light REEs at Mountain Pass.[225] In 2022, the DoD awarded another USD$ 35 million to do the same for Heavy REEs.[226]

In 2021 the DoD awarded Lynas "a Defense Production Act (DPA) Title III technology investment agreement to establish domestic processing capabilities for light rare earth elements."[227] A year before, Lynas signed "a Phase 1 contract with the U.S. Department of Defense for an engineering and market feasibility study for the design of a heavy rare earth separation facility in the United States".[228] Both facilities will be based in Hondo, Texas.[229] In June 2022, Lynas signed a contract with the Pentagon, worth USD$ 120 million, as next-stage funding for heavy REE processing.[230] In July 2023 it was reported that this contract was updated and the US government doubled the size of the contract to USD$ 258 million. The facility would supply the DoD as well as commercial customers with REEs.[231]

The US government is investing substantial funds to increase domestic production and to become less reliant on China for its REE processing. It is a clear example of state intervention to reduce unwanted dependencies, promoting domestic development to secure the supply of critical metals.

225 "DOD announces Rare Earth Element awards to strengthen domestic industrial base," U.S. Department of Defense, published November 17, 2020.

226 "DOD awards $35 million to MP Materials to build U.S. heavy Rare Earth separation capacity," U.S. Department of Defense, published February 22, 2022.

227 "DOD announces Rare Earth Element award to strengthen domestic industrial base," U.S. Department of Defense, published February 1, 2021.

228 "Joint Statement on Australia-U.S. Ministerial Consultations (AUSMIN) 2020," U.S. Department of Defense, published July 28, 2020.

229 "DOD announces Rare Earth Element award to strengthen domestic industrial base," U.S. Department of Defense, published February 1, 2021.

230 Praveen Menon and Riya Sharma, "Australia's Lynas gets $120 mln Pentagon contract for U.S. rare earths project," Reuters, June 15, 2022.

231 "Lynas Rare Earths signs updated contract with US government for Texas facility, shares rise," Reuters, August 1, 2023.

The above-mentioned investments underline this, as do two feasibility studies by the Department of Energy into how "critical minerals [can be extracted] from coal mine waste streams".[232] The studies cost USD$ 16 million and are part of the Bipartisan Infrastructure Law, meant to aid in "the development of a first-of-a-kind rare earth element and critical minerals extraction and separation facility".[233] In April 2023, a bill entitled "Rare Earth Magnet Manufacturing Production Tax Credit Act of 2023" was introduced in Congress.[234] If the bill is passed and becomes law it will create "a tax credit for the domestic production of rare earth magnets".[235] The US is investing in the establishment of domestic REE processing facilities and supporting the domestic production of REE magnets. Alongside domestic mining, it illustrates that the US is pursuing a deliberate policy to significantly reduce its dependence on Chinese-sourced REEs.

Implications for Europe and the Netherlands

Malaysia plays a key role in the global supply of rare earth elements. It hosts the only major non-Chinese REE processing facility currently in operation, which is owned and operated by the Australian rare earth mining company Lynas. Even US rare earth ores are shipped to China for processing. As Europe's dependence on the technologies that contain rare earth elements continues, and the likelihood of Chinese economic coercion based on REE exports increases, the Lynas facility, and Malaysia's geopolitical relevance rises.

However, the refining of REE ores is ecologically damaging and creates radioactive residues. This puts pressure on the Malaysian government to toughen its licensing requirements, which threaten the future of Lynas' operations in the country. Simultaneously, China is interested in making inroads into Malaysia's REE sector, which would lead to much-desired domestic economic development but would raise questions regarding China's increased economic influence over Malaysia, alongside environmental concerns.

232 "Biden-Harris administration invests $16 million to build America's first-of-a-kind critical minerals production facility," U.S. Department of Energy, published April 4, 2023.

233 ibid.

234 U.S. Congress, House Committee Ways and Means, *Rare Earth Magnet Manufacturing Production Tax Credit Act of 2023*. H.R.2849. 118th Cong, *Congressional Record*, (April 25, 2023).

235 ibid.

China has toughened its export policies of rare earths and the associated mining and processing technologies. It signals that Beijing is increasingly prepared to use its dominant position in REE markets for geopolitical and economic leverage.

Meanwhile Lynas is developing new REE processing facilities in Australia and the United States, which could become complements – if not alternatives – to the site in Malaysia. The US government is spending hundreds of millions of dollars to set up a domestic REE processing capability. For the United States, this is a national security matter. US military technology, among other things, is dependent on a secure supply of REEs.

In the short-term, the EU and the Netherlands should explore opportunities with Malaysia to expand cooperation on REE processing. The EU imported 18,000 tonnes of REE in 2022, of which 40% originated in China and 31% in Malaysia.[236] The EU and the Netherlands have an interest to ensure that non-Chinese sources of REE supply are available. Since Lynas is the owner of the REE metals that are produced in Malaysia, the Netherlands should also reach out directly to Australia to facilitate cooperation between Dutch companies and the Australian mining company. Closer cooperation with the US and Australia on REEs should also be considered. A question to be addressed is whether European customers will also be able to purchase processed REEs from Lynas' new US and Australian facilities.

The reason China has been able to establish such a dominant market position in REEs is not just because of the geological concentration of certain deposits in China, but primarily because the Chinese government sees the ecological and radioactive damage associated with REE processing as an acceptable price to pay for the economic and geopolitical returns. It has made China an indispensable partner when it comes to developing green technologies. For this reason, the EU and the Netherlands should continue to cooperate with China on decarbonisation. However, the EU and the Netherlands should increase research and innovation into 'non-radioactive' REE processing techniques. Cooperation on this with Malaysia seems straightforward, as this is currently the main reason why processing in Malaysia might be discontinued. But so too should the Netherlands and the EU engage with Australia and the United States, and

236 "Trade in rare earth elements increases in 2022," Eurostat, published November 13, 2023.

explore cooperation with Lynas or MP Materials to promote non-radioactive REE processing alternatives.

A technological breakthrough in this area would have major ramifications. Advances in the field of more sustainable, non-radioactive processing techniques which reduce the downsides of REE production would increase the chances for REE production within the EU's borders, as well as give a boost to the diversification of processing globally. This would go a long way to address current geopolitical worries about REE dependencies on China. Nevertheless, given the timelines involved, for the short- to medium-term, that dependence on China will remain.

The EU and the Netherlands should therefore also invest in recycling and innovation in the use of REEs. This ranges from research into the potential substitution of certain REEs in high-tech products – or reduction of the volumes of REEs required – to investing in circularity through the development of an EU-wide REE recycling ecosystem.

Conclusion

Nickel: Indonesian, Chinese, and US' policies

The Indonesian government has implemented an export ban on nickel ore since 2020. Indonesia's goal is to stop ore mined in the country from being shipped directly to other countries, and to stimulate the development of a domestic value chain that includes mining nickel ore, class-1 nickel processing, manufacturing of EV batteries and eventually even EVs themselves.

The export ban led to a large influx of Chinese investments in the Indonesian nickel industry. All three currently operational HPAL facilities that produce battery-grade nickel rely on Chinese investments and exist due to Chinese technology. Two of the three have a Chinese majority stake, the other has significant Chinese shareholders. It has created a situation where Chinese companies – many of which are invested in the HPAL facilities – are able to source Indonesian MHP at beneficial rates. Indonesia's HPAL facilities have become an integral part of the Chinese battery supply chain.

Nickel is considered a critical raw material by China, but not nearly enough nickel is produced domestically to meet Chinese demand. This is where Indonesia's HPAL facilities come in. The Industrial Park where two of the three HPAL facilities are located is considered a Belt and Road Initiative project by the Chinese government. Illustrative is that both the Indonesian president and the Chinese president were present at the signing ceremony for the Industrial Park.

Since 2022, the US views nickel as a critical material. As a policy response, the US government has prioritized domestic nickel production. Washington has important concerns about the level of Chinese involvement in the Indonesian nickel sector, which limit its enthusiasm to strike a strategic resources deal with Jakarta. Besides, there are concerns over the environmental damage and labour conditions in the sector. The nickel industry is seen to cause deforestation and biodiversity loss, and deadly accidents have occurred in recent years related to the safety conditions of workers.

PGMs: South African, Chinese, and US' policies

The main players in the PGM processing industry in South Africa are multinationals whose shares are traded on the Johannesburg and/or London

stock exchanges. American and Chinese parties do not play a major role in the PGM industry in South Africa.

The South African mining sector faces major challenges. Firstly, poor labour conditions have regularly led to strikes, at times triggering riots and even deaths. Secondly, there is a systemic electricity shortage in South Africa which creates uncertainty for the PGM industry.

The South African economy is struggling, as GDP per capita is now lower than in 2008 and unemployment is high. South Africa wants to use its dominant position in the PGM supply chain to spur development. As the global economy pivots away from combustion engines, South Africa sees the use of PGMs in hydrogen technologies as an alternative that will sustain demand for platinum. Unlike other countries in Southern Africa such as Namibia and Zimbabwe, there is no evidence that South Africa is seeking to introduce an export ban or export restrictions for PGMs.

PGMs are not included in the Chinese list of critical minerals, and there is only one company with 45% Chinese ownership active in the South African PGM mining industry. This is a relatively small player and the opening of its mine is currently facing delays.

PGMs are included in the US' list of critical minerals. The US is pursuing a strategic policy to reduce its reliance on PGM imports. It is focused on recycling, upcycling and demand reduction by developing technologies that rely less on PGMs.

REEs: Malaysian, Chinese and US' policies

REEs are used in many strategic products, including in green energy technologies and advanced military systems. In particular, REEs are important for permanent magnets, which are used in electric vehicles and wind turbines.

Even though China is the leading producer and processor of REEs, Malaysia also plays a significant role: 12% of global REE processing takes place in Malaysia (2019). This occurs at one location, in Kuantan at the Lynas Advanced Materials Plant (LAMP). The Australian mining company extracts REE ore in Australia and afterwards the 'concentrate' is exported to Malaysia to be further processed into a usable product at LAMP. Lynas started processing REEs in Malaysia after a market scare – connected with an incident between China and Japan that

coincided with a drop in Chinese REE exports to Japan – led to soaring prices and geopolitical concerns.

A radioactive spill in a village occurred at REE mines in Malaysia in the 1980s, after which several people died from cancer. In the 1990s, the mines were closed. However the radioactivity associated with REE mining and processing still plays a large role in the Malaysian debate. The licence that LAMP operates under in Malaysia has been in doubt several times because of the radioactive waste associated with the LAMP facility. LAMP's licence has currently been renewed until 2026.

A recent development is that the Malaysian government is interested in new REE mines, although little more has been done than mapping studies into the availability of REE deposits. The Malaysian government additionally wants to introduce an export ban, which would prohibit the export of raw REE ore if mining were to take place, similar to the Indonesian export ban.

The Chinese government clarified in 2021 that their new Export Control Law also applies to REEs. In 2022, a new list was published with goods that will be covered by export controls, and includes extraction, processing and other technologies for rare earths. In 2023, the Chinese government made import and export reporting mandatory for REEs, and announced export restrictions on REE magnet technology.

In the US, REEs are also considered a critical mineral. The US is the second largest miner of REEs in the world, though it mines significantly less than China. The only operational REE mine in the US sends its ore to China for processing. This has sparked national security concerns. The US government is now committed to increasing domestic production as well as domestic processing of REEs. It is providing financing for two processing facilities in the US, including by Lynas. Australia is also considering developing a REE processing facility.

Similarities and differences in policy

Similar to Indonesia's implementation of the nickel ore export ban, Malaysia's government is discussing a rare earth ore export ban. Although rare earths are not currently mined at scale in Malaysia, if they were to be in the future, Malaysia would seek to benefit from its current position as a processing hub for rare earths. The South African government does not have a similar ban in mind when it comes to PGMs. Although resource nationalist policies – including ore

export bans – have increased globally in recent years, not all strategic mineral producing and processing countries pursue this route.

American and Chinese policies show several similarities. Both are primarily concerned with reducing their dependence on others and focus on domestic production and refining where possible, such as in the case of nickel and REEs. PGMs are an exception: in the US there is a focus on recycling, innovation and substitution, while China is also investing in hydrogen electrolysis technology that does not make use of PGMs.

Market composition and geopolitics

The market composition of the processing sector in each of the countries studied here stands out as an important factor to understand the geopolitical dynamics connected to the security of supply of strategic metals.

In the case of nickel, Chinese investments in the Indonesian nickel (processing) sector have increased in response to the Indonesian export ban. This export ban has created a market situation in which the few domestic buyers of nickel ore (including Chinese buyers in Indonesia) have a large amount of influence because the domestic sellers of nickel cannot export abroad. A result of the dominance of Chinese companies in the Indonesian nickel sector is scepticism among US policymakers when it comes to the possibility to negotiate a nickel deal with Indonesia. That same scepticism should impact European considerations as well.

In the case of PGMs, there is no explicit geopolitical influence taking place, which is in part related to the composition of the South African PGM sector. This market is not characterised by a large number of foreign players, but instead dominated by a few publicly traded companies with their headquarters located in South Africa and the UK. The South African government is also currently pursuing a relatively liberal approach to the sector.

Malaysia's position in the global REE supply chain is driven by geopolitics. Its geopolitical relevance with regards to global REE production is based on the presence within its borders of one company, Australia's Lynas. In the early 2010s, Chinese REE export restrictions in conjunction with an incident in the East China Sea led to Lynas' investment in Malaysia. Lynas now operates the only non-Chinese REE extraction-processing combination.

The Indonesian, South African, and Malaysian governments have the ability and ambition to use the position of their industries in the global supply chains for strategic metals strategically – to gain investments, to boost employment, or even for geopolitical leverage – but their positions are precarious.

The precarious geopolitical position of these mineral-processing countries is a result of the uncertainty regarding technological, geopolitical and market developments. For example, if LFP and sodium-ion EV batteries become more prominent, nickel will no longer be as essential for EV battery production as it is today, impacting Indonesia's economic and geopolitical weight. For South Africa, the possibility that non-PEM hydrogen technologies (like alkaline electrolysis that does not rely on PGMs) become more promising to build a hydrogen economy, could undermine South Africa's PGM business case. Malaysia's influential position in global REE production is due to it being part of the only non-Chinese REE supply chain. But Lynas is building an REE processing plant in Australia and one in the United States, which means that Malaysia's economic and geopolitical bargaining position will suffer.

Implications for the Netherlands and Europe

The findings above indicate that formulating a policy towards critical resource-processing countries requires a high degree of granularity and understanding of domestic market dynamics. There is no one-size-fits-all approach. In some countries, resource nationalism is a major feature. In others, geopolitical pressures do not play a significant role. Though every country faces its share of challenges – particularly related to environmental, sustainability and labour concerns – market composition and ownership structures in the processing sectors differ. They should be a key component in any security of supply policy that the Netherlands or the EU develops for critical metals.

In the case of nickel, Indonesian MHP does not qualify as an option to diversify away from China. European governments and companies could however, invest in setting up an alternative nickel ecosystem in Indonesia, starting with upstream extraction, but this would be very costly and politically problematic given that the EU has a WTO complaint against Indonesia's nickel export ban. If resolved, the EU and the Netherlands could explore Indonesian-European cooperation in upstream nickel development.

Although it is unlikely to lead to results very quickly, the EU and the Netherlands could also work with the Indonesian government to promote more sustainable

processing techniques. Another possibility would be to reach out to Chinese nickel producers and processors in Indonesia to discuss more sustainable processing techniques as well as improve labour conditions. All these options, however, face difficulties. Therefore, the ultimate aim for both the Netherlands and the EU should be to reduce their nickel demand through investment in substitution, innovation and circularity. One example is investing (more) into research to reduce the nickel content in batteries and stimulating the further development of nickel-free batteries. The United States is very active in this field and transatlantic cooperation on recycling and substitution should be beneficial.

In the case of PGMs, the Netherlands and the EU could aim to ensure that South Africa remains a stable source of PGM production by helping to strengthen its electricity grid as well as helping address issues surrounding labour conditions. This could be part of a broader development agenda with South Africa. They should furthermore consider reducing their reliance on platinum imports by investing in domestic recycling and promoting research into PGM-free technologies. This is possible either by taking inspiration from the US approach, or by seeking to collaborate directly with the US.

In the case of REEs, it is in the EU's and the Netherlands' interest to ensure the availability of a non-Chinese REE supply chain. Considering that Lynas is the owner of the mine and processing facility involved in the only currently existing non-Chinese supply chain, the Netherlands could reach out to Australia to facilitate cooperation between Dutch companies and Lynas.

In response to Chinese dominance in the REE market, the EU and the Netherlands should increase research into 'non-radioactive' REE processing techniques, and cooperate with Malaysia, Australia and the US, on non-radioactive alternatives. The EU and the Netherlands should also invest (more) in recycling and innovation to increase the prospects for sustainable European REE production, which is one of the surest ways to guarantee security of supply. While Europe's dependence on China will remain in the short- to medium-term, breakthroughs in REE processing techniques would go a long way to address geopolitical concerns surrounding REEs.

From all three cases it becomes apparent that close transatlantic cooperation on strategic metals may be beneficial. The United States is investing significant funds into reducing its reliance on foreign imports of REEs, nickel and PGMs. It does so by supporting domestic production and processing, and investing in

research, recycling and innovation. In some important respects, the US is further ahead than Europe. A transatlantic agenda for critical raw materials should aim to strengthen cooperation in these areas of common interest.

Possibilities for further research

The findings in this report have shown that individual case studies into the processing of strategic minerals are relevant and necessary to understand the broader geopolitical and socio-economic dynamics influencing that particular mineral's supply. This report only looked at three strategic minerals and three countries. This informs the possibilities of reducing unwanted dependencies for Europe. Further research could be conducted into other strategic minerals and key resource-processing countries.

Another relevant direction for further research would be to move up the value chain, from mineral processing to manufacturing (of EV batteries or EVs for example), to understand how resource nationalist policies, geopolitical considerations and the domestic market composition shape dynamics and dependencies downstream. One example related to the nickel case study is Chinese carmaker BYD's January 2024 decision to invest in an EV factory in Indonesia, which shows that further research related to strategic minerals policy, vertical integration and product manufacturing that takes place higher up in the value chain could be beneficial.