The Hague Centre
for Strategic Studies

Securing Europe's Clean Tech Future

Supporting Industry Stockpiles of Critical Raw Materials in the Netherlands

Irina Patrahau and Ron Stoop

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Invest-NL is the National Promotional Institution of the Netherlands, committed to driving a sustainable and innovative future. We accelerate and finance major societal transitions in the fields of Agrifood, Biobased & Circular Economy, Deep Tech, Energy, and Life Sciences & Health. As a system player, we connect innovative entrepreneurs, financiers, knowledge institutions, and governments—both in the Netherlands and abroad. We remove barriers, mobilise capital, and help develop emerging sectors. Through capital, expertise, and new financial instruments, we invest in tomorrow's solutions. Where the market hesitates, we take the first step. That is how we create impact.

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Summary

Building resilience through voluntary mineral stockpiles

Stockpiling is a strategy that helps ensure the availability of goods and overcome short-term disruptions in situations of market turbulence. Increasingly, governments and industrial actors are exploring options to build critical raw materials (CRM) stockpiles. In July 2025, the EU released its Stockpiling Strategy as part of its Preparedness Union Strategy, covering a range of goods including CRM.[1] Stockpiling emergency reserves remain a sovereign capability of member states, and countries like the Netherlands, Finland, Germany, Italy and France are increasingly looking at building or expanding their national strategic stockpiles to cover critical minerals.

In assignment of Invest-NL, the Netherlands' National Promotional Institution (NPI), this report analyses the potential for public instruments to support private CRM stockpiles in the clean tech sector. As private actors can be reluctant to establish mineral stockpiles due to the high associated costs, it becomes a question of public interest whether companies engaged in strategic sectors should be supported in their business continuity by public instruments.

This report goes beyond existing research by (1) focusing on stockpiling as a strategy with primarily economic objectives, unlike broader approaches that account for national security goals; (2) taking into account sustainable material sourcing as the supporting objective; (3) investigating ways in which public funding can be used to support private voluntary CRM stockpiling; and (4) zooming in on Dutch and European CRM demand in the clean tech sector by 2030 as case studies.

The research combines desk research with primary data collection, including insights from thirteen companies across the Dutch clean tech supply chain about challenges and opportunities for establishing a stockpile; and seven interviews with other relevant stakeholders like representatives of port authorities, warehousing companies and the metal recycling sector in the Netherlands.

Insights from the Dutch clean tech industry

Thirteen Dutch companies in the clean tech supply chain have been surveyed or interviewed. The type of companies queried range from black mass recyclers and specialty materials manufacturers to product manufacturers that use forms of CRM as input materials. This analysis yielded three main takeaways, detailed below.

First, CRM users in the Dutch clean tech sector have differing consumption patterns. Small CRM users (annual use under 50.000 kg) report a highly diverse use of critical raw materials. These companies are often involved in early-stage technologies and niche

1 European Commission, *EU Stockpiling Strategy: Boosting the EU's Material Preparedness for Crises* (2025), https://civil-protection-humanitarian-aid.ec.europa.eu/what/civil-protection/stockpiling_en.

products. Moderate CRM users (annual use above 50.000 but below 1.000.000 kg) relied on a narrower set of critical raw materials. These include graphite, cobalt, nickel, manganese, and two different forms of platinum group metals (PGM): platinum and iridium. Most of these companies were active in the recycling or refining industries of CRM. Large CRM users (annual use above 1.000.000 kg) generally use CRMs in large, standardised forms, often in infrastructure or heavy industry. The materials used include iron, vanadium, copper, aluminium, palladium and a few other specialty metals.

Second, stockpiling is not a common practice for clean tech companies in the Netherlands**.** None of the small CRM users reported having any stockpiles, which is not surprising considering their position as startups or scaleups. For moderate CRM users, stockpiling is a bit more common. A large share of these users has changed their CRM strategy in the last 2-3 years, highlighting changing attitudes as a result of more frequent supply chain disruptions. Large CRM users report a higher share of stockpiling. These reserves were generally geared towards manufacturing continuity in business-as-usual scenario, and less equipped to deal with geopolitical shocks that could have a longer time horizon.

Third, the majority of surveyed companies see strategic value in the establishment of a public-private stockpile, given certain key conditions are met. These conditions centre around proper market design for such a stockpile to succeed. A repeated argument in favour of stockpiling is the fact that it could improve price stability, which could lead to more security for companies and investors. Some companies suggest that coordination at the EU level would be essential.

Designing a stockpile for Dutch industry

A four-step approach for establishing this stockpile is developed, following the stockpiling cycle defined by the EU: planning, purchasing, managing and deploying.[2] This is consistent with the methodology developed in 2025 for the Dutch national strategic stockpile programme.

Planning: A stockpiling programme for the Dutch clean tech industry should start by focusing on small and medium enterprises that are trying to expand operations but that are too small to be able to stockpile their own materials. This also makes them very vulnerable to global supply chain disruptions.

Purchasing: As sustainability is central to the stockpile objectives, the needs of Dutch clean tech companies should be fulfilled through procurement agreements for circular and/or sustainably sourced materials.

Managing: A voluntary company stockpile financed through public instruments combines the pros of a public-private collaboration and mitigates the negative impacts. As such, the efficiency, expertise and flexibility of the private sector would be maintained, while the overall stockpile objectives would be aligned with public interests and not solely commercial.

Deploying: Using the services of specialised logistics providers would be the most effective way of arranging the physical conditions of the stockpile given that they have the infrastructure, expertise and human capital to arrange this in the most effective way.

2 European Commission, *EU Stockpiling Strategy: Boosting the EU's Material Preparedness for Crises*.

The European dimension

Instead of designing 27 separate CRM stockpiling systems across every EU member state, a European approach could be highly beneficial for two reasons. First, the CRM demand of individual EU members like the Netherlands is relatively low, so the costs of setting up a stock-piling system could be reduced when coordinating with other countries. Second, the clean tech manufacturing objectives under the Net Zero Industry Act (NZIA) are set at the European level to promote specialization in different member states and avoid duplication of efforts.

Generally, a cross-European initiative would be best supported through governmental involvement. This could follow the model implemented through the rescEU programme in Finland. In 2023 and 2024 the EU established two large stockpiles of Chemical, Biological, Radiological, and Nuclear (CBRN) and medical supplies on the basis of EU funding/ownership and Finnish management.[3] Finland was likely chosen both due to its existing expertise and its relative proximity to the ongoing conflict in Ukraine and Russia generally. Were a CRM stock-pile to be set up on an EU-wide basis, the Netherlands could be a prime location for a larger portion of said stockpile especially in the battery and electrolysers sectors, given its domestic industrial priorities, its status as Europe's largest maritime trade hub, and its positioning on the Rhine River.

Without a governmental mandate, the stockpile becomes voluntary for companies, with the offer of financial assistance from institutes like Invest-NL. If companies from other countries wanted to be involved in a stockpile in the Netherlands, this would (1) have to include Dutch companies; and (2) require the involvement of Invest-NL's counterparts in those countries. Otherwise, the Netherlands becomes simply a location for other countries' stockpiles, and the stockpile becomes unable to contribute to Dutch / European public interests.

Conclusions

1. Stockpiling systems specifically designed for industrial business continuity and sustain-able sourcing do not yet exist, but they could be an effective instrument to pair private inter-ests with broader public strategic goals.
2. Both the Dutch and European clean tech companies could benefit from private stockpiling, but the scale of the Dutch industry is too small for an industry-wide stockpile.
3. Within clean tech, a focus on materials for batteries and electrolysers for a stockpile in the Netherlands could be interesting from both a national and European perspective.
4. Many companies that are starting up sustainable primary production (mining and refining) and recycling could significantly benefit by the scale of a stockpile for offtake.
5. The Netherlands is an attractive location for a Northwestern European or pan-European stockpile.
6. Without a government mandate, the options for a stockpile in the Netherlands are strongly dependent on company willingness to participate.
7. In the European context, supporting public-private partnerships for stockpiles is difficult to arrange without a governmental mandate.

[3] 'RescEU Stockpiling in Finland', Sisäministeriö, accessed 12 June 2025, https://intermin.fi/en/project/resceu-stockpiling.

Recommendations

1. **Support the scale-up of small and medium-sized enterprises in the clean tech sector through stockpiling.** Invest-NL can support Dutch companies in the clean tech sector to establish voluntary stockpiling through co-financing arrangements with other public and private actors. The starting point should be on SMEs that are trying to expand operations but that are too small to be able to stockpile their own materials. This is in line with Invest-NL's ambition of supporting the development of innovative companies in the clean tech sector.

2. **Link the support for voluntary stockpiling to ESG goals.** By supporting voluntary stockpiling, Invest-NL can incentivize companies to adopt sustainable and responsible sourcing practices. As a financer, Invest-NL could reward companies that build their stockpiles in line with ESG standards and responsible supply chain principles. This would reinforce alignment with the Dutch National Raw Material Strategy and broader public sustainability objectives.

3. **Complement national efforts for a national security stockpile.** Invest-NL's role as a public impact investor with a mandate to accelerate societal transitions could be leveraged to support private stockpiles in strategic sectors. This voluntary industry-driven mechanism should complement efforts by the Dutch government to develop a stockpile program for national security purposes, which would potentially involve mandatory reserves and public financing.

4. **Explore regional cooperation for enhanced effectiveness.** The Dutch clean tech sector is too small to require a sector-wide stockpile, so a wider geographical focus would be more effective. A decentralised approach to European stockpile could be pursued. This arrangement could start with a smaller group of countries to pilot the idea and ensure relative speed of action, and, if successful, expand toward other regions in the EU. In first instance, it could start with the countries with which the Netherlands already has close industrial ties with: Germany, Belgium and France. Coordination with the Dutch government and the European Commission would be essential to manage cross-border complexity and ensure coherence with the European Stockpiling Strategy.

5. **Expand approach beyond clean tech.** Invest-NL can extend its support to other sectors of strategic importance in addition to clean tech, following the four stage approach presented in this report. Clean tech can be a pilot, which can later be expanded to other sectors too. Companies in the digital technologies, life sciences and healthcare sectors are part of the Dutch National Technology Strategy may also be interested in public-private arrangements for stockpiling. These initiatives can also be pursued in a European context to maximise impact.

1. Introduction

The global mineral market has been in turmoil and the European Union's (EU) mineral dependencies on foreign unfriendly actors for its strategic goods is substantial. In response, both governmental and non-governmental actors have been looking for ways to establish critical raw material (CRM) stockpiles. This is encouraged by the EU Critical Raw Materials Act (CRMA) as a key strategy for supply risk preparedness and mitigation. In July 2025, the EU released its Stockpiling Strategy as part of its Preparedness Union Strategy, covering a range of goods like emergency and disaster response supplies, medicines, CRM, energy equipment, and potentially food and water security related products.[4]

EU member states are increasingly looking at expanding their national strategic stockpiles to cover critical minerals. In the Netherlands, the government has agreed in October 2024 to investigate the potential for stockpiling CRM by means of two pilot projects.[5] In 2025 it was decided to focus on military ships and healthcare systems. Moreover, Finland, for example, has one of the most advanced stockpiling systems in the EU, which may be expanded toward critical minerals too.[6] Ministers of Economic Affairs from Germany, France and Italy agreed to cooperate on mineral security strategies, including stockpiles.[7]

Companies are looking into it too. Privately held stockpiles are not aimed at strategic political goals. They serve short-term operational needs. Through 'just-in-case' inventory strategies, companies store materials, components and/or products in larger amounts so that they can overcome short-term disruptions in supply chains.

Establishing a stock of materials to overcome short-term supply disruptions appears as an attractive intervention. It is a relatively easy fix to the risky import dependencies that have been built over decades. A stockpile can be established more rapidly than opening a mine or establishing a refining facility. These take many years to design, obtain a permit for and build, in addition to their significant costs.

Yet building an effective stockpile is a complex process. The set-up of a CRM stockpiling system is highly dependent on its objectives. A choice has to be made of which materials to be stockpiled and in which form (e.g., lithium can be stored as lithium carbonate, lithium hydroxide, or lithium metal), depending on existing needs and technically ability to use it. The

4 'EU Preparedness Union Strategy to Prevent and React to Emerging Threats and Crises', European Commission, March 2025, https://ec.europa.eu/commission/presscorner/detail/en/ip_25_856; European Commission, *EU Stockpiling Strategy: Boosting the EU's Material Preparedness for Crises*.

5 'Kamerbrief Voorraadvormingsprogramma Kritieke Grondstoffen', Rijksoverheid, 28 October 2024, https://www.rijksoverheid.nl/documenten/kamerstukken/2024/10/28/kamerbrief-voorraadvormingsprogramma-kritieke-grondstoffen.

6 Aku-M. Kahkonen and Robin Forsberg, *Preparing for a Rainy Day: What Can Eu Member States Learn from Finland's Approach to Resilience?* (OIIP - Austrian Institute for International Affairs, 2024), http://www.jstor.org/stable/resrep65649.

7 'Sustainable Supply of Critical Raw Materials: Economic Affairs Ministers from Germany, France and Italy Agree on Close Cooperation in the Areas of Extraction, Processing and Recycling', German Federal Ministry for Economic Affairs and Energy, 2023, https://www.bundeswirtschaftsministerium.de/Redaktion/EN/Pressemitteilungen/2023/06/20230626-sustainable-supply-of-critical-raw-materials-germany-france-and-italy-cooperation.html.

management system and financing structure depend on the legal framework, the involvement of public and private actors, and the liquidity of the specific market.

Notable research has been conducted since 2022 on the topic of mineral stockpiling, which is an important building block for this study. Rietveld et al. in 2022 and Ritoe in 2024 analyse stockpiling as a strategy to increase security of supply and support national security objectives in the Netherlands and the EU.[8] The study by Moerenhout et al. in 2025 focuses on ways in which the United States National Defence Stockpile can be updated.[9] These are used as important background information for this study. The methodology developed in 2025 for the Dutch national strategic stockpile programme is also used in this report, to ensure consistency and coherence in approaches.

In assignment of Invest-NL, the Netherlands' National Promotional Institution (NPI), this report analyses the potential for public instruments to support private CRM stockpiles. Such a stockpile has two objectives: (1) the business continuity of companies in the clean tech sector; and (2) sustainable material sourcing. It thus promotes two strategic priorities in the Netherlands and the EU. On the one hand, it would enhance the strategic autonomy of the clean tech sector, supporting a secure energy transition in the EU. On the other hand, it would act as an offtaker for more sustainable sourcing.

This report goes beyond existing research by (1) focusing on stockpiling as a strategy with primarily economic objectives, unlike broader approaches that account for national security goals; (2) taking into account sustainable material sourcing as the supporting objective; (3) investigating ways in which public funding can be used to support private voluntary CRM stockpiling; and (4) zooming in on Dutch and European CRM demand in the clean tech sector by 2030 as case studies.

The report combines desk research with primary data collection, including insights from thirteen companies across the Dutch clean tech supply chain about challenges and opportunities for establishing a stockpile; and seven interviews with other relevant stakeholders like representatives of port authorities, warehousing companies and the metal recycling sector in the Netherlands.

The rest of the paper proceeds as follows. The next two parts outline the characteristics of a stockpiling system that supports business continuity and sustainable sourcing; and discuss the necessary steps for designing such a stockpile. The methodology is also used The fourth section focuses on the needs of Dutch industry and possibilities for a stockpile that supports these needs. It makes use of a survey to derive the Dutch clean tech industry's CRM needs and their perspectives on the potential design and effectiveness of a stockpile. The fifth part goes beyond the national-level perspective and explores possibilities for a European stockpiling system located in the Netherlands. Finally, it draws conclusions and makes recommendations on the role that Invest-NL can play in supporting these.

8 Elmer Rietveld et al., *Strengthening the Security of Supply of Products Containing Critical Raw Materials for the Green Transition and Decarbonisation* (European Parliament Think Tank, 2022), https://www.europarl.europa.eu/cmsdata/267347/QA-04-22-302-EN-C.pdf; Jeff Amrish Ritoe, *Een studie naar de haalbaarheid van een nationaal programma voor de opslag van kritieke grondstoffen ter versterking van Europese waardeketens* (2024), https://open.overheid.nl/documenten/9e800110-ceb9-4180-a144-3ee92c1b7f4b/file.

9 Tom Moerenhout et al., *Five Key Decisions to Revitalize US Critical Mineral Stockpiles* (Center on Global Energy Policy, 2025), https://www.energypolicy.columbia.edu/publications/five-key-decisions-to-revitalize-us-critical-mineral-stockpiles/.

2. Rationale

This section details the rationale behind establishing a private mineral stockpile that fulfils economic and sustainability goals (including both circularity and responsible sourcing) in the clean tech sector in the Netherlands. After offering a brief overview of the different types of existing stockpiles, this section moves toward defining the characteristics of the newly proposed stockpile. It outlines the reasons behind investigating such a stockpile for the Dutch and European clean tech sectors, the legal framework, as well as the Netherlands as a prime location.

2.1. Existing governmental and privately owned stockpiles

2.1.1. Stockpiles for public interest

Stockpiling is a strategy adopted by governments to ensure the availability of goods in situations of market turbulence. Governments hold strategic reserves of oil, food, medicine and ammunition to ensure resilience to shortages in times of wars, pandemics, climate disasters. A strategic stockpile always supports disaster response and national security. As seen in Table 1, all stockpile regimes where the government is involved are primarily intended to support national security. Depending on the sector, the degree of private involvement varies (see section 3.3 Managing).

Apart from disaster response or military capability, governmental stockpiles can also have other national security objectives. A commonly found objective is economic, to support domestic industries in times of supply chain disruptions as well as to influence markets. This is typically done in the energy and digital sectors, like in the Republic of Korea and Japan. It is also done in the oil sector, as shown in Box 1 below. Stockpiling can also set a floor price that shields producers and consumers from volatility and price manipulation.[10] This could help build a stable diversified market for sustainable critical raw materials in Europe.

[10] Julia Payne et al., 'Exclusive: G7 Weighs Price Floors for Rare Earths to Counter China's Dominance, Sources Say', China, *Reuters*, 24 September 2025, https://www.reuters.com/world/china/g7-weighs-price-floors-rare-earths-counter-chinas-dominance-sources-say-2025-09-24/.

Table 1. Overview of major governmental stockpiling systems in China, Finland, Japan, Republic of Korea, Switzerland, The Netherlands, and the United States, based on publicly available information[11]

Country	Primary objective		Products included	Amount
	National security	Economic security		
China	x	x	N/A	N/A
Finland	x	x	'Critical goods'	N/A
Japan	x	x	34 materials	60 days consumption public stocks (up to 180 days for high-risk materials), 18 days consumption private stocks
Republic of Korea	x	x	35 materials	Between 100-180 days consumption, depending on material risk
Switzerland	x	x	Food, energy, pharmaceuticals, industrial goods	N/A
The Netherlands	x	x	Crude oil and oil products	90 days of net import and 61 days of inland consumption
United States	x		49 materials and alloys	"NDS inventories cover 37.9% of projected military shortfalls, 7.5% of essential civilian demand shortfalls, and 6.2% of total net shortfalls in base case national emergency scenarios"[12]

Examples of government mandated stockpiles of critical minerals are included in Figure 1. The US National Defence Stockpile (NDS) is part of the US Department of Defence and stockpiles raw materials for defence purposes. Their activities are underpinned by the Strategic & Critical Minerals Stock Pile Act of 1939.[13] China hosts its stockpiled CRM under the National Food and Strategic Reserves Administration (NFSRA), which was established by a merger of previous administrative bodies in 2018.[14] Russia has a precious minerals stockpile managed by Gokhran, a federal government institution established in 1998.[15]

11 For comprehensive studies, see Elmer Rietveld et al., *Strengthening the Security of Supply of Products Containing Critical Raw Materials for the Green Transition and Decarbonisation* (European Parliament Think Tank, 2022), https://www.europarl.europa.eu/cmsdata/267347/QA-04-22-302-EN-C.pdf; Jeff Amrish Ritoe, *Een studie naar de haalbaarheid van een nationaal programma voor de opslag van kritieke grondstoffen ter versterking van Europese waardeketens* (2024), https://open.overheid.nl/documenten/9e800110-ceb9-4180-a144-3ee92c1b7f4b/file; Moerenhout et al., *Five Key Decisions to Revitalize US Critical Mineral Stockpiles*.

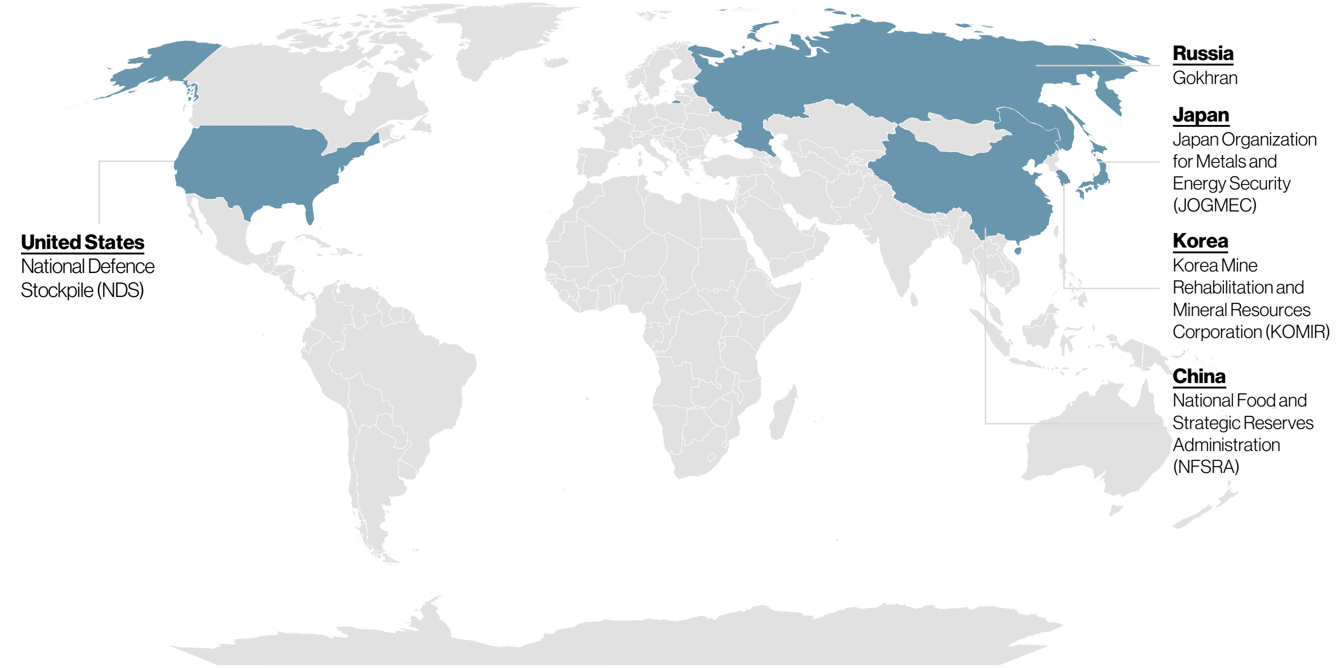
12 'Emergency Access to Strategic and Critical Materials: The National Defense Stockpile', legislation, accessed 21 August 2025, https://www.congress.gov/crs-product/R47833.

13 'Strategic and Critical Materials Stock Piling Act – Policies', IEA, accessed 21 August 2025, https://www.iea.org/policies/15534-strategic-and-critical-materials-stock-piling-act.

14 '【国家粮食和物资储备局正式挂牌】-国家发展和改革委员会', accessed 25 August 2025, https://www.ndrc.gov.cn/fzggw/wld/zy/lddt/201804/t20180406_1167060.html.

15 'Federal Law of the Russian Federation "About Precious Metals and Gemstones"', accessed 25 August 2025, https://cis-legislation.com/document.fwx?rgn=1756.

Figure 1. Overview of countries with strategic stockpiles of critical raw materials, 2025



The Korea Mine Rehabilitation and Mineral Resources Corporation (KOMIR) is the South Korean state-owned agency for CRM stockpiles and operates a strategic stockpile with both a national security and economic function.[16] The Korean system does not only release CRM stockpiles during emergencies, but also when industries need additional supply in the short-term.[17] In this case, the stockpile lends material to a company, who returns it to the stockpile at a later stage. If an emergency is recognized, the Korean government sells materials to companies at favourable prices. To the extent possible, they try to match the company needs with the appropriate amounts. When this is not possible, small and medium-size enterprises are given priority.

A governmental stockpile for public interest can also have secondary objectives.[18]

First, it can be an offtaker for mining, processing and recycling activities, supporting the development of such capacities domestically or abroad. A stockpile can be a guaranteed consumer of mineral production facilities, supporting the business case of emerging companies. It can also support socially and environmentally responsible sourcing of primary and secondary materials by using its purchasing power to favour certain responsible producers over offenders of economic, social and governance (ESG) principles.

Second, a stockpile can help maintain and even expand domestic downstream capacity by selling low-cost products to industries during market instability. This is a more targeted approach to an economic stockpile compared to a stockpile that releases product into the market for the benefit of industry as a whole.

16 'Korea to Launch New Mining Agency on Sept. 10 - The Korea Herald', accessed 25 August 2025, https://www.koreaherald.com/article/2675425.

17 'Mineral Resource', KOMIR, accessed 5 August 2025, https://www.komir.or.kr/eng/contents/182.

18 Moerenhout et al., *Five Key Decisions to Revitalize US Critical Mineral Stockpiles*.

Third, a stockpile can provide geopolitical leverage. On the one hand, it can protect and deter against economic coercive measures of other governments, as the potential effect of these measures would be mitigated. On the other hand, it can be used as an offensive tool to influence markets for geopolitical reasons. The release of stockpiled materials can reduce global prices and affect the business prospects of emerging companies.

Fourth, a stockpile can function as an exchange and influence market developments. A government-mandated 'stockpile' with a private market orientation is the Shanghai Futures Exchange (SHFE), and has a slightly different structure. The SHFE is a state-owned and state-supervised commodities futures exchange.[19] They operate with warehouses under private ownership and stocks being owned by market participants. The SHFE publishes stock levels daily and does not hold long-term strategic stocks of CRM.[20]

Box 1: Oil stockholding in the Netherlands

Strategic oil reserves held by national governments under International Energy Agency (IEA) monitoring and regulated at the EU and national levels, are another notable type of national security reserves with an economic function.[21] Strategic oil reserves have been collectively released five times since their inception in 1974.[22] The goal of such a release has always been to provide liquidity to the global oil market and stabilise prices, supporting national security and domestic industries.

The Netherlands is bound to the EU and IEA oil stockholding obligation, amounting to 90 days of net imports or 61 days of inland consumption of crude oil and oil products. COVA (Centraal Orgaan Voorraadvorming Aardolieproducten) owns about 80% of stocks, while industry is obliged to store the rest.[23] COVA does not own infrastructure, so it closely cooperates with tank storage companies and salt caverns where the products are stored. COVA develops long-term agreements with companies to store and ensure timely delivery of the product when needed.

The Dutch law offers the possibility to both COVA and industry to fulfil their stockholding obligation either by physically owning the oil or by purchasing Compulsory Storage Obligation (CSO) tickets.[24] The tickets are option rights to third-party stocks in exchange for a fee. Owning a CSO ticket means that the ticket holder will have the right to purchase the associated physical stocks during crisis.

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19 'Overview', accessed 21 August 2025, https://www.shfe.com.cn/eng/AboutSHFE/Introduction/Overview/.

20 'Daily Data', accessed 21 August 2025, https://www.shfe.com.cn/eng/reports/StatisticalData/DailyData/?query_params=dailystock.
'DELIVERY RULES OF THE SHANGHAI FUTURES EXCHANGE', accessed 21 August 2025, https://www.shfe.com.cn/eng/services/Rules/SHFERules/202508/t20250807_828557.html.

21 Council Directive 2009/119/EC of 14 September 2009 Imposing an Obligation on Member States to Maintain Minimum Stocks of Crude Oil and/or Petroleum Products (2009), http://data.europa.eu/eli/dir/2009/119/oj/eng; 'Oil Security and Emergency Response', IEA, 2024, https://www.iea.org/about/oil-security-and-emergency-response.

22 IEA, 'Oil Security and Emergency Response'.

23 'Our Commitment', *COVA*, n.d., accessed 5 August 2025, https://cova.nl/en/our-commitment/.

24 'Stock Management', COVA, accessed 5 August 2025, https://cova.nl/en/stock-management/.

2.1.2. **Stockpiles for private interest**

Companies hold commercial inventories to ensure the continuity of their business operations. Generally, these stockpiling initiatives serve a different purpose than the government-mandated stockpiles. They are not aimed at strategic political goals but rather serve operational needs of companies. Voluntary, privately run long-term strategic stockpiles with a clear strategic or political focus currently do not exist.

Over the last three decades, companies relied heavily on 'just-in-time' strategies that minimized available inventories to increase cost effectiveness. That was made possible by the deeply integrated global supply chains with very short delivery times. For a short period, the supply chain disruptions emerging from the Covid-19 pandemic made companies expand their inventories to mitigate risks. They adopted a 'just-in-case' strategy. This implies that they store materials, components and/or products in larger amounts so that they can overcome short-term disruptions in supply chains.

Privately run CRM warehousing operations across the globe tend to operate in a market-based environment, where stockpiling is based on supply and demand. Examples include the warehousing operation of the London Metals Exchange (LME), that cover a variety of metals and support the LME's trading function, and the Glencore cobalt stockpile, established due to uncertainty in the Democratic Republic of Congo's export policies since 2023.[25]

Disruptions are continuing, though the urgency to keep more inventories seems to lack. With increasingly more types of goods affected by trade restrictions, licenses and other economic coercion tools, disruptions are becoming the norm. Nine out of ten respondents to the McKinsey Global Supply Chain Leader Survey reported that they encountered supply chain disruptions in 2024.[26] Still, the same McKinsey survey shows that almost half of the respondents are expecting to move back to inventories equal to pre-pandemic levels.[27] For companies involved in strategic industries, like energy, high tech or healthcare, this can be problematic not only from a business continuity perspective but also from a national security one.

This approach combines the private interest of business continuity with public interests related to a secure energy transition and sustainable sourcing."

2.2. **Stockpiles that combine public and private interests**

2.2.1. **Objectives**

This report explores ways in which a private CRM stockpile that supports business continuity and sustainability could be established with public support. As private actors can be reluctant to establish mineral stockpiles due to the high costs, it becomes a question of public interest whether companies engaged in strategic sectors should be supported in their business continuity by public instruments. Unlike a stockpile established primarily for national security, this

25 Pratima Desai and Felix Njini, 'Glencore Has Ceased to Stockpile Battery Material Cobalt', Commodities, *Reuters*, 7 August 2024, https://www.reuters.com/markets/commodities/glencore-not-stockpiling-battery-material-cobalt-any-more-2024-08-07/. 'Glencore Says Congo Export Ban May See Much of Its Cobalt Output Unsold by End-2025', Africa, *Reuters*, 6 August 2025, https://www.reuters.com/world/africa/glencore-says-congo-export-ban-may-see-much-its-cobalt-output-unsold-by-end-2025-2025-08-06/.

26 Knut Alicke and Tacy Foster, 'Supply Chains: Still Vulnerable', McKinsey & Company, July 2025, https://www.mckinsey.com/capabilities/operations/our-insights/supply-chain-risk-survey.

27 Alicke and Foster, 'Supply Chains: Still Vulnerable'.

stockpile focuses on (1) the secure economic development of companies in strategic sectors that depend on CRM; (2) the stimulation of more sustainable supply chains. This approach combines the private interest of business continuity with public interests related to a secure energy transition and sustainable sourcing.

Clean tech is selected as a starting point given the focus of the Dutch government and the EU writ large to build more secure and sustainable supply chains in this sector. Clean tech is the driving force behind the energy transition, and its supply chains are at high risk. The Dutch National Technology Strategy focuses on energy materials as one of its ten priorities, especially in relation to battery storage and electrolyzers for green hydrogen.[28] The Dutch National Raw Materials Strategy establishes circularity and innovation; sustainable EU mining and processing; and sustainable international supply chains; as three of its five strategic pillars.[29] A stockpile based on sustainable sourcing could fulfil all three of these pillars. The Net Zero Industry Act (NZIA) was developed in support of the EU's efforts to mitigate climate change and maintain industrial competitiveness, which require the expansion of its domestic manufacturing capabilities for clean tech.[30] This would reduce its vulnerability to supply chain disruptions given that most solar panels, permanent magnets for wind turbines, batteries for EVs and electrolyzers for green hydrogen are imported from China, India or other countries.[31]

2.2.2. Legal framework

For the purpose of this study, the stockpile can be held by the private sector on a voluntary basis, with no legal obligation.

For the purpose of this study, the stockpile can be held by the private sector on a voluntary basis, with no legal obligation. This can be partly supported by Invest-NL, a public impact investor operating on a market-conform basis, in combination with other investors. We consider this a governmentally-supported stockpile, built using public financing or other types of instruments, without a legal framework. This is different from a governmentally-mandated stockpile based on a legal framework.

In the Netherlands, there is no legal mandate to establish such a stockpile as of 2025. The Dutch government agreed in October 2024 to investigate the potential for strategic stockpiling CRM by means of two pilot projects, but that is focused on national security.[32]

2.2.3. Location: The Netherlands

The Netherlands could be a good stockpile location to support the Dutch and European the battery and electrolyser sectors. As mentioned above, the Dutch National Technology Strategy individuates batteries and electrolysers as two priority clean tech sectors. The Netherlands also has a very well-established end-of-life battery collection system and a battery recycling facility in the Port of Rotterdam. The electrolyser industry is at an earlier development stage, but there are several initiatives for pilots, testing and manufacturing the most advanced technologies. Batteries and electrolysers are also two of the five sectors that

28 Ministerie van Economische Zaken en Klimaat, *De Nationale Technologiestrategie* (2023), https://open.overheid.nl/documenten/67b0a9e1-135b-483f-9ed9-3aade270dbce/file.

29 Rijksoverheid, *Grondstoffen Voor de Grote Transities* (2022), https://www.rijksoverheid.nl/documenten/kamerstukken/2022/12/09/bijlage-nationale-grondstoffenstrategie.

30 'The Net-Zero Industry Act', European Commission, June 2024, https://single-market-economy.ec.europa.eu/industry/sustainability/net-zero-industry-act_en.

31 Agnieszka Widuto, *Clean Tech in the Energy Sector* (European Parliamentary Research Service, 2025), https://www.europarl.europa.eu/RegData/etudes/BRIE/2025/767198/EPRS_BRI(2025)767198_EN.pdf.

32 Rijksoverheid, 'Kamerbrief Voorraadvormingsprogramma Kritieke Grondstoffen'.

the European NZIA sets domestic manufacturing benchmarks for. As such, establishing a stockpile for these two technologies in the Netherlands would serve the Dutch market and, in turn, advance the broader European ambitions.

When it comes to logistics, the Netherlands has three attractive features: (1) knowledge of and infrastructure for metal warehousing; (2) advanced logistics and customs system supporting its function as a trade hub; and (3) advantageous location at the North Sea Coast and with good connections to the rest of Europe.

Frist, the Netherlands hosts companies with wide expertise in metal warehousing. Both warehouses authorised by the London Metal Exchange (LME) and independent companies are located in the various Dutch ports, including Rotterdam, Moerdijk and Vlissingen. The LME warehouse authorisation protocol requires not only existing experience in metal storage and logistics, but also multi-modal connectivity around the warehouse and the ability to deliver the material in short, predetermined periods. The presence of LME authorised warehouses points to strong knowledge, skills and infrastructure in the Netherlands. Independent storage companies in the Netherlands own the facilities and ensure full services for their customers, including transportation, storage and logistics. Customers can be traders, as well as consumers that need the products and do not have the facilities to store them in-house. As such, existing warehouses are owned by one logistics company that provides services for several customers at the same time.

The Netherlands could be a good stockpile location to support the Dutch and European the battery and electrolyser sectors.

Second, the Netherlands has a history as a trade hub among others due to its location, which means that its customs procedures are some of the most advanced in the world, infrastructure effective and well connected with most of Europe. The Netherlands is the second largest importer of CRM in the EU, after Germany, but a significant portion of these imports are further exported.[33] In 2023, 57.8% of Dutch CRM imports were directly re-exported, worth €7.3 billion.[34] An additional €5.1billion worth of imported materials are further processed in the Netherlands and exported as another type of good.[35] This shows that the Netherlands already fulfils a key European role in metals trade, so it would be a logical location for a European CRM stockpile.

The downside of physically having a stockpile, a low-value added activity that requires space in a densely populated country like the Netherlands, is mitigated by the fact that (1) the stockpile would support the business case of the Dutch and European clean tech sectors; (2) it would encourage sustainable supply chains and stimulate circularity; (3) stockpiles of minor metals like most CRM do not typically take much physical space; and (4) the Netherlands is a small well-connected country, so even if the stockpile is placed outside of the main industrial areas where space is scarce, the time and costs spent on logistics would still be relatively low compared to other countries.

33 Timon Bohn et al., 'Kritieke materialen in de Nederlandse toeleveringsketen', Centraal Bureau voor de Statistiek, 27 November 2023, https://www.cbs.nl/nl-nl/longread/rapportages/2023/kritieke-materialen-in-de-nederlandse-toeleveringsketen.

34 '6. Bestemming van Nederlandse import van kritieke materialen', Centraal Bureau voor de Statistiek, 29 September 2025, https://www.cbs.nl/nl-nl/longread/rapportages/2025/nederlandse-afhankelijkheid-van-kritieke-materialen/6-bestemming-van-nederlandse-import-van-kritieke-materialen.

35 Centraal Bureau voor de Statistiek, '6. Bestemming van Nederlandse import van kritieke materialen'.

3. Designing a private mineral stockpile with a public function

This section offers a step-by-step approach to designing the privately-held stockpile for public interest, as defined in section 2.2. above. It starts with the assumption that an agreement has been made to explore the establishment of a stockpile between one or more private companies with financial support from a public actor like Invest-NL. Based on that, the section is divided into four parts, following the stockpiling cycle defined by the EU: planning, purchasing, managing and deploying the stocks.[36] This is consistent with the methodology developed in 2025 for the Dutch national strategic stockpile programme.

3.1. Planning

In the planning phase, it is essential for the private and public actors to conduct a sector analysis to understand (1) the material needs for business continuity considering potential disruptions, and (2) existing industrial capabilities along the rest of the supply chain. This will inform the decision of which materials, at which stage in their supply chain and in which quantity they should be stockpiled to fulfil both private and public interests.

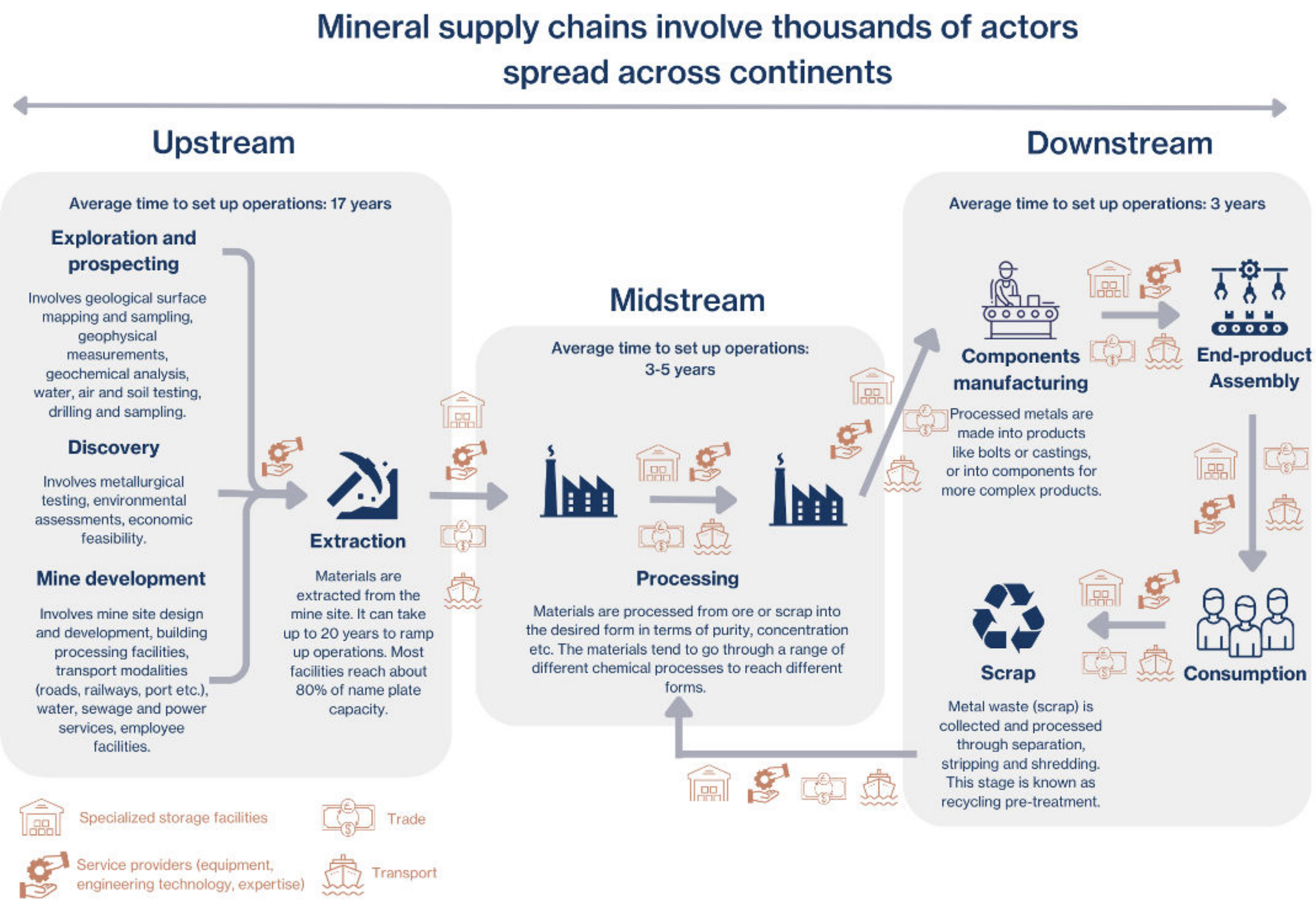
Considering the stockpile's goal of supporting business continuity, the first step is to determine what kind of stockpile would be useful for different businesses in times of disruption. Here, questions about what kind of materials, in which chemical form, and what amount of materials they use are essential.

The planning phase also involves a supply chain analysis, which informs the decision of the chemical form of the material to be stockpiled. Figure 2 shows simplified illustration of a mineral supply chain. The availability of (stockpiled) raw materials is only an advantage to the extent to which there is also processing capacity in the same region/country. At the same time, stockpiling processed materials is only useful if companies can use it in their manufacturing. As such, a strategic analysis along the supply chain is key to understand what the material needs are expected to be and how the industrial landscape will develop in the coming years.

[36] European Commission, *EU Stockpiling Strategy: Boosting the EU's Material Preparedness for Crises*.

At the same time, the more specialized the material in storage, the less versatile it is to be rotated from the inventory.[37] A stockpile becomes more financially attractive if it can address the needs of various companies at the same time, so it can be sold or lent and re-built depending on market conditions and the material's shelf life. For instance, lithium hydroxide monohydrate is used in the production of cathode active materials, which is a specific sub-market in the battery industry. The management system determines whether the stockpile is purchased, owned and managed by one company or more, as discussed in section 3.3. In general, a stockpile should either be used by the company holding it or, if not, be discarded of without significant financial loss.

Figure 2. Simplified mineral supply chain



This supply chain perspective is reflected in the stockpiling decisions taken by the governments of the US, Korea, Japan, and China. The US has a large defence industry that is supported by the processed materials and alloys in the National Defense Stockpile. Korea and Japan have important high-tech industries that use raw and processed materials and that can rely on the national stockpile for support in times of disruption. They have also built

37 Ritoe, *Een studie naar de haalbaarheid van een nationaal programma voor de opslag van kritieke grondstoffen ter versterking van Europese waardeketens.*

flexibility in their stockpile, as some materials are stored in larger amounts depending on how high the perceived supply risk is. China is one of the largest manufacturing countries in the world, meaning that its downstream sector uses significant amounts of raw and processed CRM. Even an announcement of a release of stock from China has a massive impact on global prices. At the same time, purchases of large quantities of materials for its stockpile can increase global market prices.

3.2. **Purchasing: Sustainable sourcing**

The purchasing stage involves the development of procurement agreements that support sustainable sourcing, which is one of the key objectives of the stockpile. Sustainable sourcing includes both primary sourcing from inside and outside of the EU certified to adhere to sustainable standards; and secondary sourcing.

Emerging trade platforms are working towards integrating sustainability and traceability into their trade platforms through artificial intelligence and blockchain.

Generally, the purchasing of large amounts of CRM for a stockpile has to account for the individual market dynamics of each mineral. CRM markets are relatively small compared to other natural resources like iron, oil or natural gas. Some of them, including copper, nickel, palladium and platinum, are traded on established exchanges, generally perceived as transparent and liquid markets.[38]

Coordination with trade platforms would be required when building a stockpile of one of the metals traded on that platform. The LME is the largest metal trading platform, owned by Hong Kong Exchanges and Clearing, a Chinese company.[39] Metals listed on the LME are also required to fulfil a set of responsible sourcing requirements.[40] To facilitate the widespread physical delivery of the metals traded on the LME, the exchange works with over 450 authorised storage facilities. The Shanghai Futures Exchange, focused on China's domestic market, and COMEX, focused on precious metals, are other established trade platforms. Emerging trade platforms like Savala, La Precio, and Mine Spider are working towards integrating sustainability and traceability into their trade platforms through artificial intelligence and blockchain.

Most of the CRM, however, are not traded on exchanges and price discovery remains very opaque. Some of these exchanges are trying to adapt to the growing importance of mineral markets and are adopting financially settled contracts for instance for cobalt metal or lithium hydroxide.[41] This can make the establishment of a stockpile more difficult to coordinate with existing market dynamics, but it remains nonetheless important in order to avoid market instability.

The purchasing phase of the stockpile could therefore be done in three ways, explained below.

38 Role of Metals in Transitional Energy Subcommittee within the CFTC Energy and Environmental Markets Advisory Committee, *Considerations on the Evolution & Development of Critical Minerals Markets* (2025), https://www.cftc.gov/media/12436/EEMAC_CriticalMineralsMarkets0625/download.

39 The London Metal Exchange (LME) is owned by Hong Kong Exchanges and Clearing Limited (HKEX). HKEX acquired the LME in 2012 for approximately £1.4 billion. The LME is a wholly owned subsidiary of LME Holdings Limited. LME Holdings Limited itself is part of the HKEX Group, making HKEX the ultimate owner.

40 The London Metal Exchange, 'Responsible Sourcing', Lme, accessed 5 August 2025, https://www.lme.com/Sustainability-and-Physical-Markets/Sustainability/Responsible-sourcing.

41 Role of Metals in Transitional Energy Subcommittee within the CFTC Energy and Environmental Markets Advisory Committee, *Considerations on the Evolution & Development of Critical Minerals Markets*.

3.2.1. Offtake agreement with recycling facilities

The first and most straightforward option is for companies building a stockpile to make an offtake agreement with one or more recycling facilities. One of the key challenges to expanding domestic recycling of CRM in Europe is the competitive disadvantage compared to countries with far laxer economic, social and governance (ESG) standards. There is a large mismatch between the prices of primary and secondary materials, making it difficult for companies to establish a business case. Turning the stockpile into an offtaker for recycling facilities guarantees security of demand for said facility for a longer period of time. It will likely drive up the purchasing costs but it will also ensure that the public and/or private funds spent on a stockpile go back into the domestic – or European – economy and support strategic goals.

3.2.2. Responsible sourcing based on established certification schemes

The second option implies the introduction of non-price criteria in purchasing agreements for the stockpile, requiring (a portion of) European-produced materials and responsibly sourced materials from non-EU countries. For both of these, traceability is essential.

Raw material traceability has been a key concern of policymakers and industry for years. The Conflict Minerals Regulation in the EU and the Dodd Frank Act in the US have been early attempts to regulate the responsible sourcing of raw materials. In 2024, the EU CRMA (Critical Raw Materials Act) included the goal of establishing the authority to certify certification schemes that exist among non-governmental and industry bodies for the purpose of clarifying which schemes should be considered reliable measures of sustainability, with certification of a given project under such a scheme improving its applicability for being designated a "strategic project" by the EU.[42] Certifying bodies will apply to the EU for recognition as a reliable standard.[43]

There are many voluntary raw materials extraction sustainability certification schemes of varying reliability in operation globally. As shown in Box 2, there is a high degree of fragmentation among many of these standards when it comes to the part of the supply chain covered, the materials considered for certification, and the industrial- and public support for each of them.[44] This is why there are significant efforts in place to consolidate the various certification schemes into one comprehensive mechanism. More information is available in Box 2 below.

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42 Regulation (EU) 2024/1252 of the European Parliament and of the Council of 11 April 2024 Establishing a Framework for Ensuring a Secure and Sustainable Supply of Critical Raw Materials and Amending Regulations (EU) No 168/2013, (EU) 2018/858, (EU) 2018/1724 and (EU) 2019/1020 (Text with EEA Relevance) (2024), http://data.europa.eu/eli/reg/2024/1252/oj/eng. Pg. 13-14.

43 Regulation (EU) 2024/1252 of the European Parliament and of the Council of 11 April 2024 Establishing a Framework for Ensuring a Secure and Sustainable Supply of Critical Raw Materials and Amending Regulations (EU) No 168/2013, (EU) 2018/858, (EU) 2018/1724 and (EU) 2019/1020 (Text with EEA Relevance) (2024) http://data.europa.eu/eli/reg/2024/1252/oj/eng. Pg. 41-42.

44 Thania Nowaz et al., 'Navigating the Mining Industry Challenges: An Introduction to the CERA 4in1 Standards', *BHM Berg- Und Hüttenmännische Monatshefte* 170, no. 2 (2025): 108–15, https://doi.org/10.1007/s00501-025-01556-x. pg.

3.2.3. A combined approach

Combining the two above-mentioned approaches is likely to be the most effective option for creating the stockpile. The European CRM recycling sector is growing at a relatively slow pace, with an average end-of-life recycling input rate of 8.2% across the 34 CRM.[45] This is expected to expand towards 2030 although the growth rate remains unclear. As such, fully relying on secondary materials produced in the EU is a risky approach. This can be supplemented by agreements with primary producers, either in the EU or in partner countries. The EU has formed partnerships on raw materials with thirteen countries.[46] The Commission also selected thirteen strategic projects outside of the Union, including in the United Kingdom, Canada, Zambia, Australia and New Caledonia.[47] Working with responsible suppliers via acknowledged certification schemes would diversify suppliers for the stockpile as well as support sustainability.

Box 2: Comparison of CRM certification schemes

There is a wide diversity among certification schemes in terms of the materials they focus on and the supply chain segment they cover. A comparison of five prominent schemes is in included in Table 2.[48] Most of them are quite well-established, while MaDITraCe is an emerging European effort. They are discussed below.

Table 2. Comparison of certification schemes for responsible sourcing

<table>
<tr><th colspan="2">Certification scheme</th><th>Materials</th><th>Supply chain segment</th></tr>
<tr><td colspan="2">Aluminium Stewardship Initiative (ASI)</td><td>Aluminium</td><td>Supply chain</td></tr>
<tr><td colspan="2">Initiative for Responsible Mining Assurance (IRMA)</td><td>All minerals</td><td>Mining</td></tr>
<tr><td colspan="2">MaDITraCe</td><td>Lithium, cobalt, natural graphite, rare earths</td><td>Supply chain</td></tr>
<tr><td colspan="2">Responsible Minerals Initiative</td><td>3TG (tin, tantalum, tungsten, gold), cobalt, mica</td><td>Smelting/Refining</td></tr>
<tr><td rowspan="4">Consolidated Mining Standard Initiative (CMSI)</td><td>The Copper Mark</td><td>Copper, molybdenum, nickel, zinc</td><td>Supply chain</td></tr>
<tr><td>Towards Sustainable Mining</td><td>All minerals</td><td>Mining</td></tr>
<tr><td>World Gold Council</td><td>Gold</td><td>Mining, retail investing, central bank gold holdings</td></tr>
<tr><td>International Council on Mining & Metals</td><td>All minerals</td><td>Mining</td></tr>
</table>

45 Milan Grohol and Constanze Veeh, *Study on the Critical Raw Materials for the EU 2023: Final Report* (Publications Office of the European Union, 2023), https://data.europa.eu/doi/10.2873/725585.

46 'Raw Materials Diplomacy', European Commission, accessed 25 May 2022, https://ec.europa.eu/growth/sectors/raw-materials/areas-specific-interest/raw-materials-diplomacy_en.

47 'Selected Strategic Projects under CRMA', European Commission, June 2025, https://single-market-economy.ec.europa.eu/sectors/raw-materials/areas-specific-interest/critical-raw-materials/strategic-projects-under-crma/selected-projects_en.

48 'Introduction to IRMA', *IRMA - The Initiative for Responsible Mining Assurance*, n.d., accessed 21 July 2025, https://responsiblemining.net/about/about-us/; 'ASI Home', Aluminium Stewardship Initiative, accessed 21 July 2025, https://aluminium-stewardship.org/; *About the Initiative - Consolidated Mining Standard Initiative*, 16 October 2024, https://miningstandardinitiative.org/about-the-initiative/.

IRMA and CMSI apply across all minerals, while ASI, as the name suggests, is limited to aluminium, bauxite, and alumina; and the RMI focuses on conflict minerals (tin, tantalum, tungsten and gold), cobalt and mica. All four standards cover a comprehensive range of performance criteria for sites that they investigate, including those laid out by the Commission, and use independent auditors in order to assess member companies' claims of compliance with said standards.[49]

These standards diverge in their governance structure. As noted by the Intergovernmental Forum on Mining Minerals and Sustainable Development and implied by the EU CRMA, initiatives that operate under multi-stakeholder governance structures are likely to have greater legitimacy.[50] While The Copper Mark claims to have a multi-stakeholder board,[51] the other members of the CMSI are directed by industry leaders, and stakeholders have had a purely advisory role in the formulation of the CMSI.[52] The ASI maintains two representatives from civil society on its eight person boards.[53] By contrast, IRMA provides equal representation to affected communities, organised labour, NGOs, finance, purchasers of materials, and mining companies including highly relevant NGO, indigenous, and labour organisations.[54]

In terms of materials traceability, The Copper Mark as an independent organisation, ASI, and IRMA each have their own standards on supply chain traceability and assurance for buyers of materials.[55] This is to ensure that materials from non-compliant extractive sites are not mislabelled as coming from sites with positive ESG records. IRMA's approach seeks to supplement both its own performance standard and other standards for mine sustainability and hopes to use traceability services and technologies such as blockchain, mineral ID scanning, and testing to provide scientifically facilitate tracing.[56]

The EU is also funding a project called MaDITraCe launched in 2023 and led by the French Geological Survey seeking to "reinforce the transparency, traceability, and sustainability of complex supply chains of CRM", piloting its approach on cobalt, lithium, natural graphite, and rare earth elements.[57] The project is 36 months long and its deliverables are accessible online.[58] It seeks to use the emerging technologies of material fingerprinting and artificial tagging of materials to create a "digital product passport" for materials to certify their sustainability as they pass through the supply chain. Additionally, this project seeks to develop the "CERA 4in1" certification system which seeks to establish standards for every stage of exploration, extraction, processing, and manufacturing and certify ESG compliance at each stage.[59] At present the certification scheme is expected to be completed in December of 2025. If successful, it could be the most comprehensive certification scheme for CRM available to the Commission.

49 *Consolidated Mining Standard Public Consultation Draft*, October 2024, https://miningstandardinitiative.org/consultation/; 'IRMA Standard', IRMA - The Initiative for Responsible Mining Assurance, accessed 18 July 2025, https://responsiblemining.net/irma-mining-standard/; *ASI Performance Standard V3*, April 2023, https://aluminium-stewardship.org/asi-standards/performance-standard.

50 'Navigating Global Sustainability Standards in the Mining Sector | International Institute for Sustainable Development', accessed 21 July 2025, https://www.iisd.org/publications/brief/global-sustainability-standards-mining. Pg. 4

51 'Governance', *The Copper Mark*, n.d., accessed 21 July 2025, https://coppermark.org/about/governance/.

52 *Frequently Asked Questions - Consolidated Mining Standard Initiative*, 16 October 2024, https://miningstandardinitiative.org/faqs/.

53 'ASI Board', *Aluminium Stewardship Initiative*, n.d., accessed 21 July 2025, https://aluminium-stewardship.org/about-asi/board.

54 'Board', *IRMA - The Initiative for Responsible Mining Assurance*, n.d., accessed 21 July 2025, https://responsiblemining.net/about/board/.

55 Nowaz et al., 'Navigating the Mining Industry Challenges'. Pg. 111

56 'Chain of Custody Standard', *IRMA - The Initiative for Responsible Mining Assurance*, n.d., accessed 21 July 2025, https://responsiblemining.net/what-we-do/standard/chain-of-custody/.

57 'About', MaDiTraCe Project, accessed 21 July 2025, https://maditrace.eu.

58 'MaDiTraCe Project', MaDiTraCe Project, accessed 9 September 2025, https://maditrace.eu.

59 'CERA 4in1- Certification of Mineral Raw Materials for Sustainable Development in Mining', MaDiTraCe Project, accessed 21 July 2025, https://maditrace.eu/cera4in1.

3.3. **Managing**

A stockpiling system can be managed through different constructions, depending on the ownership and operating arrangements made between governmental and industry actors. A stockpile that focuses on business continuity and sustainability will be developed in public-private cooperation, with implications for its financing. The management system and financing structure are discussed below.

3.3.1. **Management system**

Four typologies, or absolute models, of a stockpiling management system are presented in Table 3. They are developed based on the ownership of stock, operating arrangements (deciding when and how to use the stock), and logistics. Note that most stockpiling systems consist of a combination of these typologies, meaning that in practice they overlap. Box 3 includes an overview of the public-private systems in Finland and Switzerland.

Table 3. Typologies of stockpiling management systems

Typology	Owns stock	Operates stock
GOGO	Government	Government
GOCO	Government	Company
COCO	Company	Company
COGO	Company	Government

For each of these typologies, there is a third layer of complexity depending on who is responsible for logistics. Logistics arrangements have the following pros and cons:

- When logistics are done by a specialised company, the expertise, skills and preexisting arrangements of that company are leveraged. This reduces the costs and efforts of building a warehouse and a logistics system around it from scratch.
- Governmental control over logistics increases the security and reliability of the system as it reduced the risk of misuse for commercial purposes. At the same time, it is likely more expensive and can be less efficient given that governmental employees do not operate in the market and are typically less versed in these services.

The next sections assess the four typologies based on three indicators: alignment with public/private interests, efficiency and flexibility, costs.

3.3.1.1. **GOGO: Governmentally Owned and Operated**

In this type of system, the government owns and operates the stock. The US is an example of publicly owned and managed stocks. The US National Defense Stockpile (NDS) is managed by the Defense Logistics Agency, which in turn is part of the US Department of Defense.[60]

[60] 'Defense Logistics Agency: The Nation's Logistics Combat Support Agency', accessed 5 August 2025, https://www.dla.mil/.

The Korean and Japanese mineral stockpiling systems are owned and operated by the government but in a more indirect way, through governmental agencies with a legal mandate to manage the national stockpiling system. The pros and cons are explored in Table 4.

Table 4. Pros and cons of GOGO

GOGO: Governmentally Owned and Operated

Indicator	Pros	Cons
Alignment with public/private interests	• Full government control ensures alignment with national strategic and economic goals. • Clear public accountability and transparency.	• Potential for political interference or mismanagement.
Efficiency and flexibility	• The entire process is in the hands of one actor, so coordination times are reduced. • High efficiency in crisis scenarios.	• Potential lack of technical knowledge and expertise in the public sector. • Risk of bureaucratic inefficiency and slower response times. • Less agile in responding to market dynamics.
Costs	• Public funding ensures continuity and equity.	• High upfront and operational costs for government.

3.3.1.2. GOCO: Governmentally Owned and Company Operated

In this system, the government owns the stocks but leaves it to companies to operate the purchase and release of stocks. The pros and cons are explored in Table 5. An example of this is the U.S. Hawthorne Army Depot, an ammunition stockpile that is owned by the government and operated by the company Dyncorp.[61] In such ownership/operation constructions, often technical obligations are specified for private companies, such as the storage conditions, type of inventory goods and the minimum number of days of supply.[62]

Table 5. Pros and cons of GOCO

GOCO: Governmentally Owned and Company Operated

Indicator	Pros	Cons
Alignment with public/private interests	• It is inherently better at understanding and fulfilling private sector interests given that it is operated by the private sector.	• Requires accountability systems and decision-making protocols to ensure transparency and alignment with public goals rather than commercial competitive interests.
Efficiency and flexibility	• Leverages private sector expertise in market and industrial developments. • More agile in responding to market dynamics.	• Due to governmental ownership, all decisions still have to undergo governmental approvals, which may be bureaucratic and slow.
Costs	• Public funding ensures continuity and equity.	• High upfront and operational costs for government.

61 'Depot Signs 10-Year Deal with New Operator', *Mineral County Independent News*, 31 January 2022, https://mcindependentnews.com/2022/01/depot-signs-10-year-deal-with-new-operator/.

62 Department of Defense, *DOD Contractor's Safety Manual For Ammunition and Explosives* (2008), https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodm/414526m.pdf.
'The Supply of Personal Protective Equipment (PPE) during the COVID-19 Pandemic - NAO Report', *National Audit Office (NAO)*, 25 November 2020, https://www.nao.org.uk/reports/supplying-the-nhs-and-adult-social-care-sector-with-personal-protective-equipment-ppe/.

3.3.1.3. **COGO: Company Owned and Governmentally Operated**

This type of stockpiling system implies private sector ownership of the stocks combined with governmental control over deployment and release. Examples include the Dutch oil stock-holding obligation and the Swiss and Finnish compulsory stockpiling systems, whereby a part of the stock is held by companies under governmental obligation and supervision. Release is typically controlled through independent agencies or semi-public bodies. The pros and cons are explored in Table 6.

Table 6. Pros and cons COGO

COGO: Company Owned and Governmentally Operated

Indicator	Pros	Cons
Alignment with public/private interests	• Government maintains control over stock release to ensure alignment with public goals.	• If dialogue is poorly organized and not meaningful, mismatch in decision making and prioritization may lead to conflict and to a reduction in effectiveness of the stockpile system.
Efficiency and flexibility	• Can be scaled relatively quickly using existing company assets and infrastructure.	• Government may lack operational and market expertise. • Requires protocols in place to ensure that private sector expertise is included.
Costs	• Lower public capital investment; uses existing private infrastructure.	• Imposes additional costs on industries, which are supposed to be the ones benefitting from the economic stockpile. • Risk of underinvestment by companies if incentives are unclear.

3.3.1.4. **COCO: Company Owned and Operated**

Companies can choose to establish their own stockpiles by expanding their operational inventories from just-in-time to just-in-case. The Glencore cobalt stockpile mentioned in section 2.1.2. is an example. Pros and cons are explored in Table 7.

Table 7. Pros and cons of COCO

COCO: Company Owned and Operated

Indicator	Pros	Cons
Alignment with public/private interests	• Full alignment with the company's economic goals.	• No guarantee of alignment with national strategic and industrial goals. • No or limited transparency and public oversight.
Efficiency and flexibility	• High operational efficiency. • Can adapt the stockpile according to the company's needs and market dynamics.	• Additional burden on company operations due to new responsibility of owning and operating the stockpile.
Costs	• No public funding required; fully market-driven.	• Small and medium enterprises likely unable to create a large stock. • Risk of underinvestment or hoarding during crises.

Box 3: Public-private stockpiling systems in Finland and Switzerland

Finland and Switzerland have relatively long histories (post-WW2) of maintaining large stockpiles of key supplies in the context of the Cold War and their armed neutrality policies. For Switzerland, a law introducing compulsory reserves for the private sector came out in 1955, while the Finish policy was developed shortly after, largely based on the Swiss system.[63] Both are notable for their unique public-private compulsory stockholding and the breadth and quantity of products covered by their stockpiling mandates.

In each country, not only fuel and certain industrial precursors are stockpiled against economic disruption but also civilian goods such as foodstuffs, medicines, seeds and animal feed (though information about the exact products stored in Finland is confidential).[64] Switzerland stores enough of each product to last three to four months of food-stuffs and medicine and four and a half months for fuel (kerosene is an exception at three months).[65] In Finland data on supply is less readily available but indications are that stockpiles may be for up to nine months. For example, Finland increased its grain stockpile in 2021 from six to eight and a half months in response to a harvest failure.[66]

In Switzerland an arm of the federal government called FONES operates the stockpile, i.e. is responsible for deciding when to release goods from stockpiles and determining which goods and in what amounts are to be held.[67] Beneath this body are the compulsory stock organisations, which are semi-private bodies that act as an intermediary between the federal government and private companies. There are five such organisations covering foodstuffs, medicines, fuels, fertilisers, and natural gas. Their management is primarily composed of the leadership of the companies that hold stocks. Compulsory stock organisations are also responsible for monitoring the efficiency of held stocks.[68]

Every company that imports or produces goods that are to be stockpiled above a certain value is required by law to hold a commensurate amount of stocks. There are about 280 companies subject to these requirements.[69] The companies can draw on bank loans guaranteed by the federal government to fund these stocks. They are also able to claim higher tax write-offs for compulsory stocks. The stocks remain the property of the companies and are circulated through normal business operations.

Finland is quite similar in its organisation, given that its model was inspired by the Swiss one. As in Switzerland there is a single state body that is responsible for supervising and to some degree managing emergency/strategic stockpiles called the National Emergency Supply Agency (NESA).[70] The Finnish system also draws on semi-private organisations called "pools" which serve advisory and supervisory roles over stockpile management divided by stockpile sector and involving membership of private companies.[71] There is however, a greater diversity of stockpiling methods. There are national emergency stockpiles which are the sole responsibility of NESA, compulsory stockpiling (similar to the Swiss system), and security stockpiling, which involves both relevant companies and NESA. Some companies are required to undertake stockpiling, while others do so on a voluntary basis. The NESA does not own its own stockpiles but rather agrees amounts to be stockpiled with relevant companies.

63 Samuel Jaberg, 'Why Switzerland Stockpiles for Possible Emergencies', *SWI Swissinfo.Ch*, 24 April 2019, https://www.swissinfo.ch/eng/business/mandatory-reserves_why-switzerland-stockpiles-for-possible-emergencies/44917424; Kahkonen and Forsberg, *Preparing for a Rainy Day*.

64 'Strategic Stockpiling', Federal Office for National Economic Supply (Switzerland), accessed 5 June 2025, https://www.bwl.admin.ch/en/strategic-stockpiling.

65 Theodora Peter, 'Switzerland's Emergency Stocks', *Swiss Community*, March 2024, https://www.swisscommunity.org/en/news-media/swiss-revue/article/switzerlands-emergency-stocks.

66 'National Emergency Supply Agency Boosting Finland's Emergency Grain Stockpiles', Huoltovarmuuskeskus, accessed 12 June 2025, https://www.huoltovarmuuskeskus.fi/en/a/national-emergency-supply-agency-boosting-finlands-emergency-grain-stockpiles.

67 Federal Office for National Economic Supply (Switzerland), 'Strategic Stockpiling'.

68 Federal Office for National Economic Supply (Switzerland), 'Strategic Stockpiling'.

69 *Report on Strategic Stockpiling 2023* (Federal Office for National Economic Supply FONES (Switzerland), 2023), https://backend.bwl.admin.ch/fileservice/sdweb-docs-prod-bwladminch-files/files/2025/02/12/d73ed122-0d38-4196-92fa-3c69247f81ec.pdf.

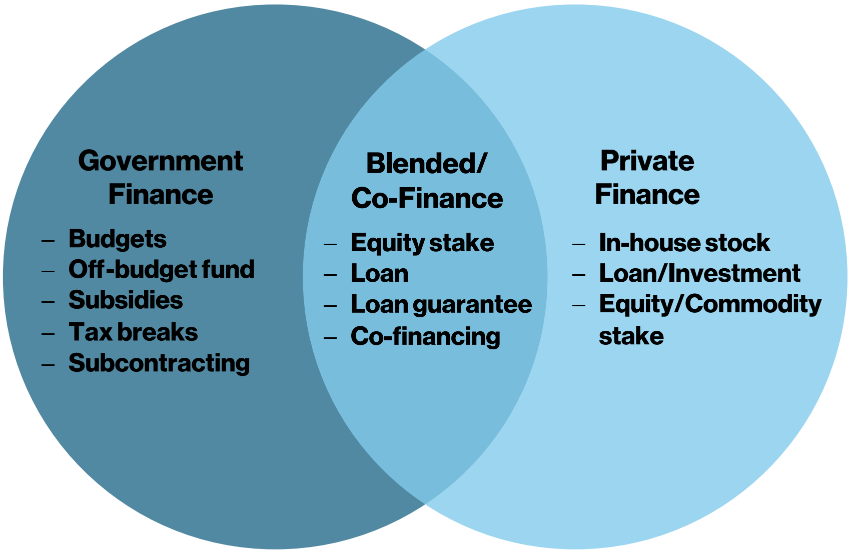
70 'Security of Supply in Finland', National Emergency Supply Agency (Finland), accessed 11 June 2025, https://www.huoltovarmuuskeskus.fi/en/security-of-supply/public-private-partnership.

71 National Emergency Supply Agency (Finland), 'Security of Supply in Finland'.

3.3.2. **Financing structure**

Stockpiles can be financed in various ways: government financed, privately financed and 'blended finance' stockpiles (Figure 3). The selected financing structure is strongly related to the management system, as discussed above. The sections below discuss these three financing structures in more detail, current practices in stockpiling finance, and the pros and cons of each of the financing options.

Figure 3. Government-, blended- and private financing options for a CRM stockpile



3.3.2.1. **Government financed**

National stockpiles of critical raw materials are primarily funded through direct government budget allocations. In other words, the assets are on the government's balance sheet. These stockpiles are built for national security purposes, making governmental ownership an effective option. Governmental funding allows the public institutions to retain a high degree of control over the management of the stockpile and the decision making surrounding their release. As a governmentally funded mechanism, it ensures that public interests – such as national security, but also sustainability standards – are central to its purpose, rather than economic profit as in the case of a private entity. The downside is that the government becomes subject to increased financial risk from having the CRM on its balance sheet, and is prevented from spending public funding on other sectors of public interest.

The CRM stockpiles in China, Russia, South Korea, and Japan are governmentally funded. These budgets are determined by national legislation. In the United States, the system is slightly different: the NDS receives funding from the National Defense Stockpile Transaction Fund. This fund is filled through the sale of current inventory, and occasional injections of funding from the US Congress.[72] Finland finances strategic stockpiling off-budget through a levy system on imported energy products, protecting it from budgetary volatility.[73]

[72] 'Emergency Access to Strategic and Critical Materials'.

[73] 'Finances - Huoltovarmuuskeskus', accessed 25 September 2025, https://www.huoltovarmuuskeskus.fi/en/organisation/funding-and-legislation/finances.

Government financing can also be indirect, by offering subsidies, grants, tax breaks or loan guarantees to companies that want to build a stockpile. This is the case in Switzerland, for instance, where companies are legally required to have stockpiles, but the financing is partly offered by the government.

3.3.2.2. **Privately financed**

Private financing offers a range of possibilities. The most straightforward option is that a company invests in its own stockpile, which is then added to its balance sheet. This means that the company has full ownership of stocks and full control over when these can be used. In case this is financially difficult for the company, but it is a strategic priority, a private investor can take an equity stake in the company and give it the cash flow to build the inventory. If the company already holds operational inventories, this would be an extension of existing stocks, which makes it a relatively simple albeit expensive operation. If the company does not have pre-existing operational inventories, whether due to financial costs or simply its small market share, establishing stockpiles can be a more complex task.

Stockpiles can also be privately funded through equity finance, whereby a private investor takes a financial stake in a company that has or wants to build a CRM stockpile. This is especially attractive for companies that are specialised in holding assets and selling it to industrial actors that need it. An example from the financial commodity world is the Sprott Physical Copper Trust, a fund that holds physical copper assets in which private investors can take an equity stake. The Trust is open to both retail and institutional investors. This kind of investment allows companies to overcome market volatility and financial risk when building a stockpile, and provides the necessary funding for buying a stockpile. However, to offer returns on investment, it might have to involve a degree of trade and use of financial instruments in relation to that physical stockpile.

Blended finance combines the upsides of governmental funding, translated into a focus on public interests, with those of private financing.

Another channel through which private finance can be mobilized is through loans to companies. These loans can be designed based on the strategic objectives of the financing entity. Especially for CRM investments, the gestation period towards profitability could be several years. This would imply that a loan would be given for a longer time to allow time for the company to become profitable.

Private financing has some benefits compared to public financing, including higher efficiency and market responsiveness, and avoiding the use of taxpayer funds. However, a private stockpile is more likely to follow returns on investments and profits rather than public interests like sustainability and economic security.

3.3.2.3. **Blended/Co-finance**

Blended finance is the strategic use of public or philanthropic capital to attract and mobilise larger volumes of private investment, often towards broader societal goals such as the energy transition, or in this case, (open) strategic autonomy.[74] Co-financing is the umbrella term for finance that include governmental and non-governmental investors.

An example of blended finance could be an (governmental) institute that supports private companies that are looking to build a stockpile through giving subsidies, loan guarantees

[74] 'Blended Finance', OECD, accessed 22 August 2025, https://www.oecd.org/en/topics/sub-issues/leveraging-private-finance-for-development/blended-finance.html.

or other forms of financial support. This could help 'de-risk' the investment for other private investors, and decrease the operational costs of the stockpiling company through lower interest rates. Other options include taking a minority stake in a private company, alongside other private investors. Another example could be to provide a co-financed loan to a CRM stockpiling company.

Blended finance combines the upsides of governmental funding, translated into a focus on public interests, with those of private financing, which include market agility, flexibility and rapid decision making.

3.4. **Deploying: Considerations for the physical stockpile of materials**

Storing minerals for an extended period of time involves a wide range of material and non-material requirements.

The technical requirements are related to the physical storage and transportation of the materials. Materials vary in their shelf life and the complexity – those needed for clean tech tend to be highly specialized chemical compounds that have already undergone several processing stages. These specialised high purity materials come in different forms (liquid, powder, solid) that are more or less vulnerable to external conditions (temperature, humidity, fragility, etc.) for optimal storage. They require storage units with highly controlled environments to prevent degradation. For instance, high purity germanium crystal is much more fragile to shattering than germanium oxide.[75] Especially if there are no available processing facilities to refine the material into the highly specialized one, it makes sense to investigate stockpiling compounds.

Apart from the physical storage and transportation, a stockpile has non-material requirements too. These include skilled human capital that can manage logistics but also ensure compliance with trade, environmental and safety regulations. This also relates to securing governmental permits and licenses, as well as quality assurance for the clients. Security arrangements are necessary to protect against theft or even cyber attacks given the strategic importance of such a stockpile. Insurance coverage mitigates risks from fire, accidents or natural hazards, which can be costly in the case of highly flammable or toxic materials.

There are specialised logistics and warehousing companies that offer complete packages of services to a wide variety of clients, which can be essential partners in the establishment of a stockpile for economic security and sustainability.

[75] Moerenhout et al., *Five Key Decisions to Revitalize US Critical Mineral Stockpiles*.

4. Stockpiling for the Dutch clean tech industry

After defining the main characteristics of the stockpile in section 2, and detailing the four phases needed to build such a stockpile in section 3, this fourth section introduces the first case study: a stockpile for the Dutch clean tech industry.

As a first step of the planning phase, the Dutch clean tech sector has been analysed through a sector analysis, presented below. Based on its results, the purchasing, managing and deployment phases are further elaborated upon.

4.1. Sector analysis

Thirteen Dutch companies that are present in the clean tech supply chain have been surveyed or interviewed. The type of companies queried range from black mass recyclers and specialty materials producers to manufacturers that use forms of CRM as input materials. In this survey, a combination of small, moderate and large CRM users across the country have been asked about their CRM use, their stockpiling practices and their view on possible future public-private stockpiling initiatives. The survey results and additional interviews show a generally positive, but nuanced perspective on the usefulness of public-private stockpiling, explored in the following paragraphs.

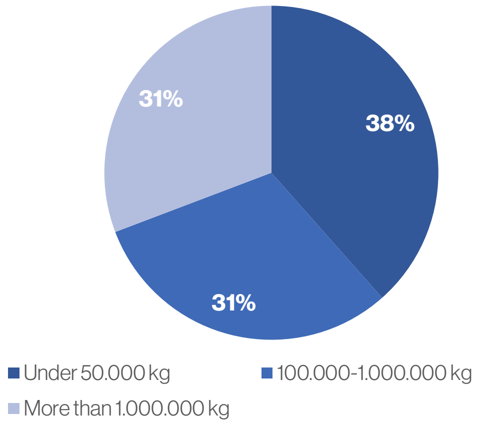
4.1.1. CRM consumption in the Dutch clean tech sector

In the survey, a distinction has been made between small, moderate and large CRM users, all with differing use patterns (Figure 4).

Small CRM users (annual use under 50.000 kg) report a highly diverse use of critical raw materials. These companies are often involved in early-stage technologies and niche products. Materials mentioned in the survey include lithium, graphite, cobalt, nickel, platinum group metals (PGM),[76] silicon, and iridium. These are used in activities ranging from battery recycling and production to the manufacturing of anodes for electrolysers. Quantities used are generally modest, but for specialised industrial consumers purity and reliability are crucial.

[76] Platinum group metals (PGMs) are a set of six precious metallic elements—platinum, palladium, rhodium, ruthenium, iridium, and osmium.

Figure 4. Yearly consumption of CRM by the companies interviewed and surveyed



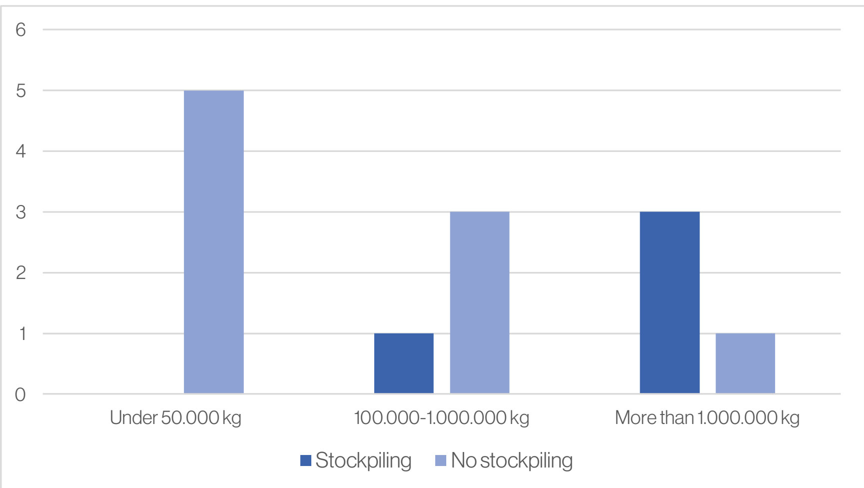
Moderate CRM users (annual use above 50.000 but below 1.000.000 kg) relied on a narrower set of critical raw materials. These include graphite, cobalt, nickel, manganese, and two different forms of platinum group metals (PGM), platinum and iridium. Most of these companies were active in the recycling or refining industries of CRM. All moderate CRM users expected that their CRM use will grow in the future.

Large CRM users (annual use above 1.000.000 kg) generally use CRMs in large, standardised forms, often in infrastructure or heavy industry. The materials used include iron, vanadium, copper, aluminium, palladium and a few other specialty metals. These materials are generally used for (bulk) manufacturing, electricity grids and wired infrastructure.

4.1.2. **Existing Stockpiling Practices**

Overall, stockpiling is not a common practice for clean tech companies in the Netherlands. Figure 5 shows which of the different CRM users have stockpiles.

Figure 5. Stockpiling practices of companies interviewed and surveyed, categorised by yearly CRM consumption



None of the small CRM users reported having any stockpiles, which is not surprising considering their position as startups or scaleups. Only one company mentioned changing their CRM strategy in the last 2-3 years, and is planning to build a stockpile in the future.

For moderate CRM users, stockpiling is a bit more common than with small CRM users. Moreover, a larger share of these users have changed their CRM strategy in the last 2-3 years, highlighting changing attitudes as a result of more frequent supply chain disruptions.

Large CRM users report a higher share of stockpiling. One of the companies indicated that the stockpile was not located in the Netherlands but elsewhere in the EU. Another interviewed company noted that they had a stockpile in the US, at another business unit. A large CRM user that was interviewed divulged that their company already maintains (limited) CRM reserves. These reserves were generally geared towards manufacturing continuity in business-as-usual scenario, and less equipped to deal with geopolitical shocks that could have a longer time horizon.

Several companies highlight that stockpiling is not enough on its own. It must be part of a larger industrial strategy that involves the entire clean tech supply chain and potentially other sectors too.

4.1.3. Company views on future stockpiling strategies

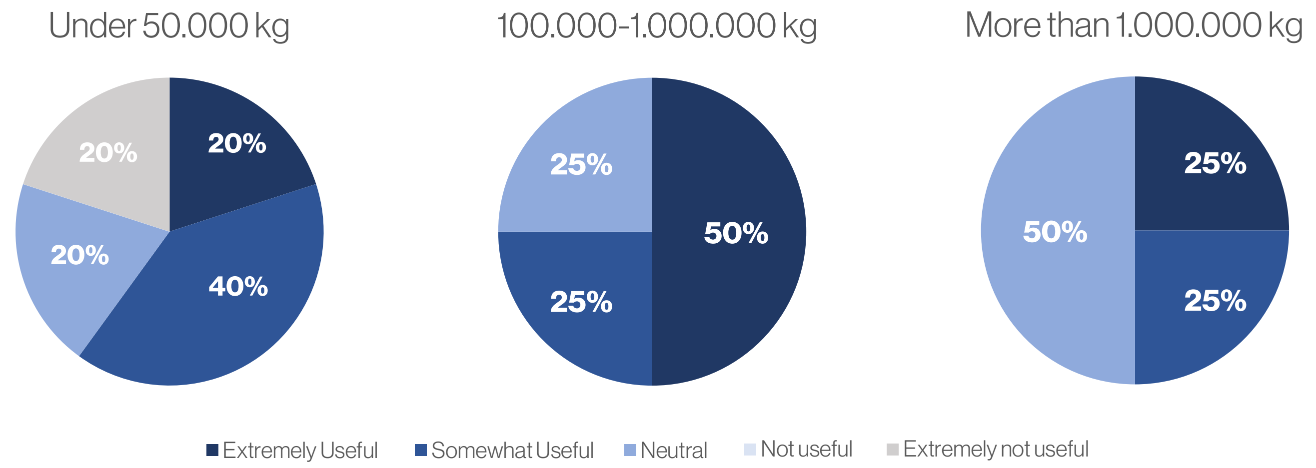
Overall, a majority of companies see strategic value in the establishment of a public-private stockpile, given certain key conditions are met. These conditions centre around proper market design for such a stockpile to succeed. A repeated argument in favour of stockpiling is the fact that it could improve price stability, which could lead to more security for companies and investors. Some companies suggest that coordination at the EU level would be essential.

Surveyed companies indicate they would like to have clear insight into which material will be stored and in which quantities. Materials must be available in the right form, at the right quality and at acceptable cost. Some companies propose clear agreements about access and product specifications.

Several companies highlight that stockpiling is not enough on its own. It must be part of a larger industrial strategy that involves the entire clean tech supply chain and potentially other sectors too. For example, battery producers need downstream infrastructure to turn materials into usable products. There is concern that stockpiles will not be useful unless supported by processing capacity and downstream uses. A few companies thus called for a broader definition of stockpiling. This would include storage and processing capabilities, not just raw materials.

Moreover, there were differences between small, moderate and large CRM users in other domains, as seen in Figure 6.

Figure 6. Views on the usefulness of a public-private stockpile, categorised by yearly CRM consumption



Small CRM users

Perceptions of a (public and/or private) stockpile's usefulness among small CRM users were varied. Some companies saw it as extremely useful, for example for securing specialised refined materials. One company cited difficulties sourcing feedstock (specifically lithium chloride) as a key barrier to advancing its refinery plans. Other respondents perceived it as somewhat useful, or sometimes as not useful at all. One company indicated that its low annual consumption volume (~100–500g) makes participation in a stockpile system impractical or unnecessary. Stockpiling is perceived to be useful if it could help mitigate price fluctuations. Also, it was suggested that the usefulness of any stockpile would depend on the demand for each CRM, the cost, the purity of supply and the country of origin of the stockpiled material.

Moderate CRM users

Moderate CRM users largely view a public-private stockpile as valuable. Several respondents rated stockpiling as 'extremely useful,' citing its potential to enhance security of supply and reduce vulnerability to global market volatility. Other companies were a bit more hesitant or critical of creating stockpiles, emphasising that without the right approach a stockpile could be limited in impact or not suited to their specific needs.

One company suggested it is not enough to stock materials alone. A more holistic approach should be used, incorporating supply chain stages, end-of-life management, and reuse of CRM. One company added that stockpiles would only be valuable if also supported by an industrial ecosystem that can use them and has capacity to manage end-of-life and recycling. Without an integrated approach, stockpiles could be ineffective or simply deplete too quickly to make a difference. Others stressed the need for competitive pricing, offtake agreements, and clearly defined product specifications, particularly for refining operations. A company working with platinum group metals (PGMs) perceived cross-border coordination (ideally at the European level) as crucial.

One company suggested expanding the definition of stockpiling beyond raw materials: domestic capacity in refining and processing should also be part of a stockpiling strategy. Among the companies surveyed there were also companies that expressed willingness to be part of the stockpiling solutions. Ways in which this can materialise still need to be defined, but a few specific examples were recovering vanadium from (steel) waste sources and being part of a circular battery materials supply chain.

Large CRM users

Large CRM users generally support the idea of a public-private stockpile, seeing it as an extremely useful tool under the right conditions. For instance, the stockpiling system must be designed to take into account market dynamics, and without this any projects or subsidies would inevitably fail due to misalignment and misinvestment. Another company also highlighted that even though stockpiling can add resilience, the most important question is who will bear the cost of stockpiling. If the cost of stockpiling is too high, it could result in Dutch companies becoming uncompetitive if the cost falls upon them.

Generally, companies emphasise that next to emergency supplies, stockpiling can increase market liquidity and price transparency. This could help large CRM users in their strategic planning and manufacturing operations.

The insights from this section are taken on board for the design of different CRM stockpiling options for the Dutch clean tech industry in the next paragraphs.

A stockpile for the Dutch clean tech industry could start by focusing on small and medium enterprises that are trying to expand operations but that are too small to be able to stockpile their own materials

4.2. Designing a stockpile for the Dutch clean tech industry

Based on the sector analysis presented in the previous section, the paragraphs below explore the four phases of stockpiling for the Dutch clean tech industry in the Netherlands.

4.2.1. Planning

Platinum and iridium, lithium, and vanadium came up several times in the sector analysis as used by Dutch clean tech companies. While this is not a comprehensive view of all national Dutch consumption, they can be used as case studies to calculate what a stockpile could look like. Platinum and iridium are used for metal anodes that are used both in electrolysers for green hydrogen and broader electrochemical industry. Lithium is used in the manufacturing of battery cells. Vanadium is used in the recovery of CRM from industrial waste, and also in steel alloys. This is in line with the two clean tech sectors mentioned in the Dutch National Technology Strategy, battery storage and electrolysers. It is also intuitive considering the presence of Tata Steel in the Netherlands as the largest consumer of metals in the country.

A stockpile for the Dutch clean tech industry could start by focusing on companies in the middle category, which use between 50.000 kg – 1.000.000 kg annually. These tend to be small and medium enterprises (SMEs) that are trying to expand operations but that are too small to be able to stockpile their own materials. This also makes them very vulnerable to global supply chain disruptions.

Companies that use larger amounts of metals should also be included in a stockpiling programme. These companies already have sufficiently large industrial inventories to mitigate their own risks. Because of this, they may not be as vulnerable as the SMEs. Still, they may benefit from more cost-effective ways of storing their materials and from more attractive costs by pooling demand with other companies. They are also essential partners given their established market position, infrastructure and knowledge.

Finally, companies that use under 50.000 kg per year are innovative start-ups that are in the early stages of business operations at scale. Given that their focus is placed more on the technological development rather than scale, and they use very specialized materials and compounds, they may be left out in the early stages of the stockpile, with the possibility of joining when they reach the scale-up phase. This can be determined in the management stage of the stockpile.

4.2.2. **Purchasing**

4.2.2.1. **Sustainable sourcing of lithium, vanadium, platinum, iridium**

As sustainability is central to the stockpile objectives, the needs of Dutch clean tech companies should be fulfilled through procurement agreements for circular and/or sustainably sourced materials.

Establishing a stockpile can be an impetus for a CRM recovery facility from e-waste to be established in the Netherlands.

The Netherlands has a well-established e-waste collection and sorting system, with an emerging recycling ecosystem. There are several companies of different sizes in the Netherlands working on the recycling of batteries and recovery of lithium, including startups like Back to Battery or large-scale facilities like SK TES in the Port of Rotterdam. There is also research being done by TATA Steel into the recovery of vanadium. Often, however, the waste is either exported outside of the country, or it is melted and mixed with other types of metals. As such, establishing a stockpile can be an impetus for a CRM recovery facility from e-waste to be established in the Netherlands.

When it comes to the purchase of platinum and iridium, Dutch recycling capabilities are quite undeveloped. This is applicable to the wider European market as well, although there are companies in other countries that supply PGMs, like Heraeus in Germany.[77] Apart from directly sourcing from EU facilities, arranging responsibly platinum and iridium might have to come from South Africa, the world's largest producer, but also Zimbabwe, the US, or Canada.[78]

4.2.2.2. **Estimated quantities and costs**

Based on the estimated quantities of company consumption in the sector analysis, estimations for a 60 day, 100 day and 180 day stockpile were calculated for five different types of materials (Table 8).

The upfront costs of purchasing materials for the stockpile depend on the procurement agreements. If the procurement is solely focused on secondary and responsibly sourced materials, including residue streams of the mining industry, the costs will be significantly

77 'Heraeus Precious Metals', accessed 4 September 2025, https://www.heraeus-group.com/en/heraeus-businesses/heraeus-precious-metals/.

78 Ed Crooks, 'Why Iridium Could Put a Damper on the Green Hydrogen Boom', Wood Mackenzie, 15 July 2022, https://www.woodmac.com/blogs/energy-pulse/why-iridium-could-put-a-damper-on-the-green-hydrogen-boom/.

higher than those of primary materials. While the prices of recycled base metals (steel, aluminium, copper) tend to be comparable or even lower than primary ones, the prices of recycled minor and precious metals (PGM, lithium, vanadium) remain significantly higher due to low recycling rates. A calculation was made based on the market prices of primary materials in Table 8, explained in Annex 1. This should be considered as a minimum price of the stockpile, with realistic estimates reaching significantly higher numbers.

Of course it makes sense to time the purchase of the material when the prices are relatively low, or at least to create a purchasing schedule when product is bought in different stages. Moreover, not all materials have to be bought at the same time. For the early stages, it makes sense to start with a small group and, if relevant, expand further in time. For a stockpile, long-term contracts are preferred to ensure stability.

Table 8. Material costs for a stockpile of platinum, iridium, lithium and vanadium for Dutch clean tech industry

Material	Est. yearly consumption (kg)	Price (EUR/kg)	Stockpile 60 days (kg)	Price 60 days (EUR)	Stockpile 100 days (kg)	Price 100 days (EUR)	Stockpile 180 days (kg)	Price 180 days (EUR)
Platinum	275,000	36,810	45,205	1,664,180,050	75,342	2,771,302,020	136,616	5,028,612,960
Iridium	275,000	122,839	45,205	5,552,350,695	75,342	9,254,007,738	136,616	16,780,392,424
Lithium carbonate	775,000	7.23	127,380	920,507.40	212,300	1,534,629.00	382,140	2,761,892.20
Ferro-vanadium	500,000	19.9	82,140	1,634,586	136,900	2,724,310	246,420	4,903,758
Vanadium pentoxide	500,000	9.19	82,140	754,866.60	136,900	1,258,111	246,420	2,264,599.80

4.2.3. Managing

This section explores the opportunities and challenges of employing the different types of management systems and financial structures introduced in section 3.3 for a stockpile in the Netherlands.

There are three preconditions to this stockpile for clean tech in the Netherlands. First, the stockpile does not involve direct governmental ownership or operation given the absence of a regulatory framework. A GOGO / GOCO / COGO approach with a governmentally allocated yearly budget could be more applicable for a stockpile for national security purposes, which is out of the scope of this report. Second, the stockpile cannot be enforced on private actors. These are both due to the lack of governmental legislation as of September 2025, given that the stockpile does not primarily serve national security and defence. Third, the stockpile should have a public function, i.e., help the clean tech sector's competitiveness and sustainable sourcing.

These three preconditions lead to the shortlisting of two different options for the management of the stockpile, each with different financial considerations. The two options and their pros and cons are summarised in Table 9 below.

The first option is a voluntary company owned and operated stockpile (COCO). Companies build and hold individual stocks, and manage them according to their needs. As discussed in section 3.3., this kind of stockpile is advantageous as it fully aligns with the company's economic goals, and it has high operational efficiency and flexibility to respond to market dynamics.

There are two different financing structures for such a stockpile. First, the company finances its own inventories. This is in line with economic security goals as it may make the company more resilient to disruptions, but there is no guarantee of alignment with national strategic goals, no transparency, and there is a risk that smaller companies cannot afford to do this. The second option mitigates some of these risks by involving Invest-NL as a co-financer, which could ensure that some of the public interests are fulfilled. Blending finance options could be considered, where Invest-NL helps the company attract other private investments too. The funding would come with considerations around sustainable procurement. Each company uses the stockpiled material when it needs to.

In the second option, Invest-NL in collaboration with private actors could consider co-financing a newly established company whose mandate is stockpiling materials. Like in the Finish and Swiss systems (see Box 3), company and Invest-NL representatives could be appointed to a 'decision making council' where they meet, debate and decide on when the stockpile should be released and under what circumstances (based on clearly set protocols and regulations). An independent public agency like COVA (see Box 1) could be established to coordinate the system, handle the day-to-day operations including contracting, monitoring and provide technical support.

This option combines the pros of a public-private collaboration and mitigates the negative impacts. As such, the efficiency, expertise and flexibility of the private sector would be maintained, while the overall objectives would be aligned with public interests and not solely commercial (see section 3.3).

Table 9. Options for the management system and financial structure of a stockpile for Dutch industry and pros and cons

<table>
<tr><th>Management system</th><th>Financial structure</th><th>Pros</th><th>Cons</th></tr>
<tr><td rowspan="2">Owned and operated by an industrial actor</td><td>Financed by said industrial actor (COCO)</td><td>• Full alignment with the company's economic goals.
• High operational efficiency.
• Can adapt the stockpile according to the company's needs and market dynamics.
• No public funding required; fully market-driven.</td><td>• No guarantee of alignment with national strategic and industrial goals.
• No or limited transparency and public oversight.
• Additional burden on company operations due to new responsibility of owning and operating the stockpile.
• Small and medium enterprises likely unable to create a large stock.
• Risk of underinvestment or hoarding during crises.</td></tr>
<tr><td>Blended finance including Invest-NL and other private investors</td><td>• Full alignment with the company's economic goals.
• High operational efficiency.
• Can adapt the stockpile according to the company's needs and market dynamics.
• Alignment with national strategic and industrial goals.
• Small and medium enterprises able to create a large stock.
• Lower risk of underinvestment or hoarding during crises.</td><td>• No or limited transparency and public oversight.
• Additional burden on company operations due to new responsibility of owning and operating the stockpile.</td></tr>
<tr><td>Owned and operated by a new company specialising in owning stocks</td><td>Investment from Invest-NL and industrial actors</td><td>• Alignment with both public and private interests.
• Can adapt the stockpile according to the company's needs and market dynamics.
• Alignment with national strategic and industrial goals.
• Small and medium enterprises able to create a large stock.
• Lower risk of underinvestment or hoarding during crises.</td><td>• Lower alignment with individual company's economic goals.
• Reduced operational efficiency.
• Less agile in responding to market dynamics.
• Requires accountability systems and decision-making protocols to ensure transparency and alignment with public goals rather than commercial competitive interests.</td></tr>
</table>

4.2.4. Deploying

Storing materials involves several considerations, as discussed in section 3.4. Depending on the management system of the stockpile, the physical conditions would be provided by different actors. Some industrial actors that already have their operational inventories may choose to make all the arrangements in-house. Others, especially smaller actors, may lean on the services of specialised logistics providers. There are different companies in the Netherlands, like EuroRijn, AccessWorld or Hudig & Verder, that are specialised in the logistics and transportation of commodities for their clients. Using the services of such companies would be the most effective way of arranging the physical conditions of the stockpile given that they have the infrastructure, expertise and human capital to arrange this in the most effective way.

5. Stockpiling for the EU clean tech industry

Instead of designing 27 separate CRM stockpiling systems across every EU member state, a European approach could be highly beneficial for two reasons. First, the CRM demand of individual EU members like the Netherlands is relatively low, so the costs of setting up a stockpiling system could be reduced when coordinating with other countries. Through demand aggregation, multiple buyers across the Union pool demand to strengthen their bargaining power and benefit from reduced costs through economies of scale.

Second, the clean tech manufacturing objectives under the Net Zero Industry Act (NZIA) are set at the European level to promote specialization in different member states and avoid duplication of efforts. Stockpiling rare earths, for instance, should be done in relation to emerging manufacturing facilities for permanent magnets, otherwise their utility is highly limited.

Through demand aggregation, multiple buyers across the Union pool demand to strengthen their bargaining power and benefit from reduced costs through economies of scale.

These considerations are acknowledged in the EU's 2025 Stockpiling Strategy and form the rationale for this section of the research.[79] Below, the four stages of planning, purchasing, managing and deployment are explored in turn, discussing what a stockpile for the EU clean tech industry could look like in the Netherlands.

5.1. Planning

In the planning phase, the clean tech sector in Europe and the role of the Netherlands within this sector are analysed to determine what kind of materials and in which quantities should be included in the stockpile.

As a proxy for the material needs of the EU's clean tech industry in 2030, the benchmarks provided in the 2024 Net Zero Industry Act (NZIA) are used, supplemented by additional documents where the Act does not provide sufficient detail.[80]

[79] European Commission, *EU Stockpiling Strategy: Boosting the EU's Material Preparedness for Crises*.

[80] European Commission, 'The Net-Zero Industry Act'.

According to the NZIA, at least 40% of EU deployment needs for net-zero technologies should be met domestically including components. The EU should aim to have 15% of the global net-zero technology market share by value by 2040. The NZIA sets the following sector-specific benchmarks for EU annual production by 2030:[81]

- 30GW of solar PV manufacturing capacity
- 36GW of wind turbine manufacturing capacity
- 31GW of heat pump manufacturing capacity
- 550GW/h of battery manufacturing capacity
- 100GW of installed electrolyser capacity, equivalent to 10 million tonnes of green hydrogen.

These benchmarks were matched with data about the material usage for each type of technology, from a variety of sources, including Liang et al. for wind and solar PV, Eikeng et al. for electrolysers, Naumann et al. for heat pumps, and the Visual Capitalist for batteries.[82]

The annual material needs for the EU clean tech industry in 2030 are shown in Table 10 and Figure 7. Steel stands out as the largest needed material by far, especially in the wind sector. Out of the CRM, copper is needed in the highest amount and across all five technologies. Less than half of the amount of copper is needed for nickel, which is also used for four of the technologies, excluding heat pumps. Graphite represents the second largest amount, with the bulk of the material needed for batteries, both in the nickel-manganese-cobalt and lithium-iron-phosphate chemistries. So are cobalt, manganese and lithium, though in much lower amounts than graphite. When it comes to rare earth elements, they are only needed for wind turbines, with praseodymium required in the highest amount.

81 European Commission, 'The Net-Zero Industry Act'.

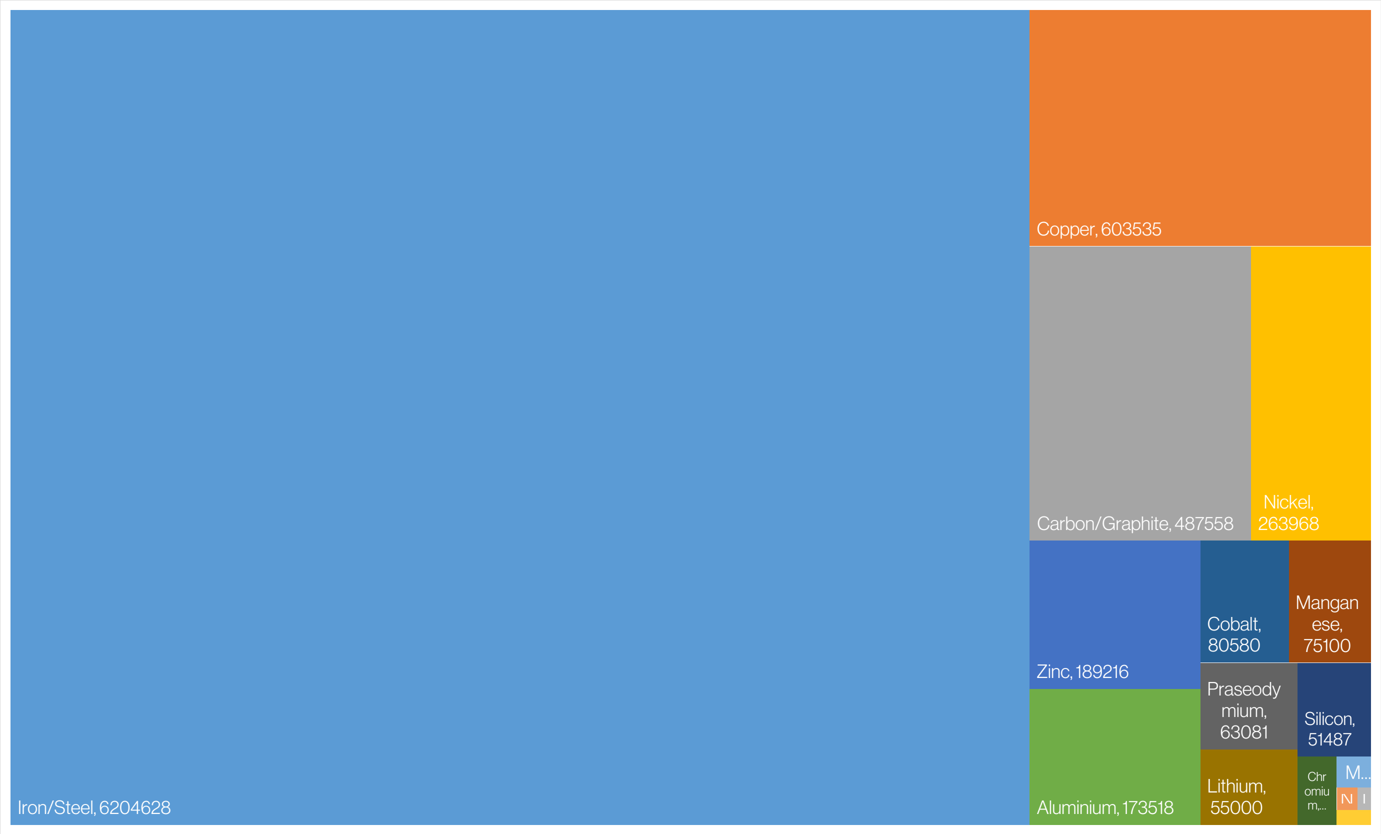
82 Yanan Liang et al., 'Material Requirements for Low-Carbon Energy Technologies: A Quantitative Review', *Renewable and Sustainable Energy Reviews* 161 (June 2022): 112334, https://doi.org/10.1016/j.rser.2022.112334; Erik Eikeng et al., 'Critical and Strategic Raw Materials for Electrolysers, Fuel Cells, Metal Hydrides and Hydrogen Separation Technologies', *International Journal of Hydrogen Energy* 71 (June 2024): 433–64, https://doi.org/10.1016/j.ijhydene.2024.05.096; Gabriel Naumann et al., 'Life Cycle Assessment of an Air-Source Heat Pump and a Condensing Gas Boiler Using an Attributional and a Consequential Approach', *Procedia CIRP*, The 29th CIRP Conference on Life Cycle Engineering, April 4 – 6, 2022, Leuven, Belgium., vol. 105 (January 2022): 351–56, https://doi.org/10.1016/j.procir.2022.02.058; 'The Key Minerals in an EV Battery', *Elements by Visual Capitalist*, 2 May 2022, https://elements.visualcapitalist.com/the-key-minerals-in-an-ev-battery/.

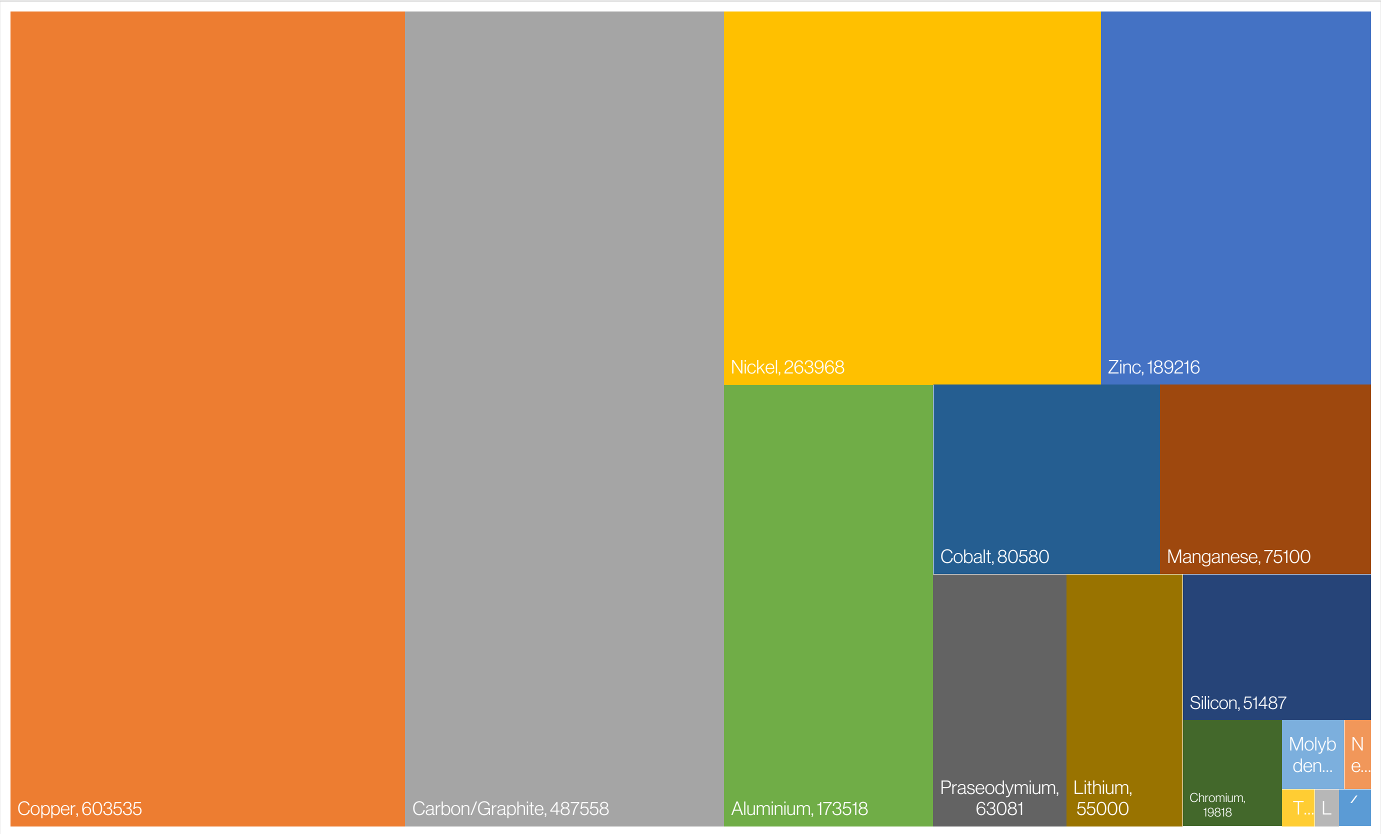
Table 10. Expected material needs for wind turbine manufacturing in the EU in 2030 (tonnes). Critical raw materials are shown in bold.

EU Clean Tech Industry

Material	Expected amount in 2030 (tonnes)					
	Solar PV (30 GW)	Wind (36 GW)	Heat pumps (31 GW)	Batteries (550 GWh)	Electrolysers (100 GW)	Total
Iron/Steel	-	5,952,808.5	-	131,390	120,430	**6,204,628.5**
Copper	20,925	168,561	226,920	187,110	19.35	**603,535.35**
Carbon/ Graphite	-	-	-	487,520	38.7	**487,558.7**
Nickel	30	19,818	-	234,520	9,600	**263,968**
Zinc	-	189,216	-	-	-	**189,216**
Aluminium	-	72,252	-	95,150	6,116.1	**173,518.1**
Cobalt	-	-	-	80,520	60	**80,580**
Manganese	-	1,620	-	73,480	-	**75,100**
Praseodymium (REE)	-	63,081	-	-	-	**63,081**
Lithium	-	-	-	55,000	-	**55,000**
Silicon	51,487.5	-	-	-	-	**51,487.5**
Chromium	-	19,818	-	-	-	**19,818**
Molybdenum	-	8,118	-	-	-	**8,118**
Neodymium (REE)	-	3,479.76	-	-	-	**3,479.76**
Titanium	-	-	-	-	2,270.4	**2,270.4**
Lead	1,665	-	-	-	-	**1,665**
Zirconium	-	-	-	-	1,200	**1,200**
Silver	540	-	-	-	-	**540**
Dysprosium (REE)	-	303.5	-	-	-	**303.5**
Boron	-	90	-	-	-	**90**
Terbium (REE)	-	90	-	-	-	**90**
Iridium	-	-	-	-	3.225	**3.225**
Platinum	-	-	-	-	3.225	**3.225**
Total	**74,647.5**	**6,499,255.76**	**226,920**	**1,344,690**	**139,741**	**8,285,254.26**

Figure 7. Expected material needs for clean technology manufacturing in the EU in 2030 (tonnes), with and without steel





The role of the Netherlands within the European clean tech sector could be focused on electrolysers and batteries, as noted in the National Technology Strategy (see section 2.2). These are two of the five sectors for which the NZIA sets benchmarks for domestic production, as discussed above. As such, in addition to platinum and iridium which are necessary for the development of Dutch industry, stockpiles of copper, graphite, nickel, aluminium, cobalt and titanium could also be considered for electrolysers. While copper and nickel are base metals with large global markets, priority could be given to the other minerals. Some of these overlap with the materials needed for batteries, notably copper, graphite, nickel, aluminium, cobalt. Other materials that are specifically needed for batteries are lithium, which is also in line with the Dutch sector analysis in 4.1, and manganese.

5.2. **Purchasing**

The needed quantities and purchasing agreements depend on whether the stockpile serves the entire EU clean tech industry or a region like Northwestern Europe. From a purchasing perspective, the advantage of a stockpile for the entire EU as opposed to one region is the scale. A stockpile of EU-wide proportions would benefit from economies of scale and have the capability to create advantageous offtake agreements with emerging producers of both primary and secondary materials in the EU. This would further the EU Critical Raw Material Act's goals of boosting domestic production capabilities and support the NZIA's goals of expanding manufacturing capabilities. At the same time, storing all materials for two different pan-European supply chains in the Netherlands might be effective due to this scale, but it would also require significant space from a very densely populated country with severe limitations.

Contrastingly, the advantages of purchasing fewer materials and serving a smaller group of European states could be the targeted procurement from fewer emerging companies. This might increase the speed of action given that there are less companies competing with each other for offtake agreements with the stockpile.

5.3. **Managing**

The geographical scope has significant implications for the stockpile's management system and financial structure.

Generally, a cross-European initiative would be best supported through governmental involvement. This could follow the model implemented through the rescEU programme in Finland.[83] In 2023 and 2024 the EU established two large stockpiles of Chemical, Biological, Radiological, and Nuclear (CBRN) and medical supplies on the basis of EU funding/ownership and Finnish management.[84] A total of €304 million was dedicated to this stockpile, or around

83 'RescEU Stockpiling in Finland', Sisäministeriö, accessed 12 June 2025, https://intermin.fi/en/project/resceu-stockpiling.

84 'RescEU Stockpiling in Finland', Sisäministeriö, accessed 12 June 2025, https://intermin.fi/en/project/resceu-stockpiling.

1/6th of the total funding for rescEU (despite there being 22 member states participating).[85] Finland was likely chosen both due to its existing expertise and its relative proximity to the ongoing conflict in Ukraine and Russia generally. Were a CRM stockpile to be set up on an EU-wide basis, the Netherlands could be a prime location for a larger portion of said stockpile especially in the battery and electrolysers sectors, given its domestic industrial priorities, its status as Europe's largest maritime trade hub, and its positioning on the Rhine River.

Without a governmental mandate, the stockpile becomes voluntary for companies, with the offer of financial assistance from national promotional investment institutions like Invest-NL in the Netherlands, Kreditanstalt für Wiederaufbau (KfW) in Germany, Cassa Depositi e Prestiti in Italy, or Banque Publique d'Investissement in France. If companies from other countries wanted to be involved in a stockpile in the Netherlands, this would (1) have to include Dutch companies; and (2) require the involvement of Invest-NL's counterparts in those countries. Otherwise, the Netherlands becomes simply a location for other countries' stockpiles, and the stockpile becomes unable to contribute to Dutch / European public interests. As such, out of the two management options discussed in 4.2.3. – the stockpile owned and operated by the industrial actor; and the stockpile owned and operated by a new public-private company – the latter option becomes the most attractive for a multinational stockpile. Each participating country would provide a public sector agency that can support with funding; and a selection of companies that would be interested to participate, on a voluntary basis.

This arrangement could start with a smaller group of countries to pilot the idea and ensure relative speed of action, and, if successful, expand toward other regions in the EU, potentially with governmental and EU-level involvement to manage the complexity as well as ensure a Europe-wide approach. In first instance, it could start with the countries with which the Netherlands already has close industrial ties with, Germany, Belgium and France.

5.4. **Deployment**

As it would support the wider European clean tech industry, the stockpile would gain strategic importance and potentially become a bigger security target. As such, it might require more advanced security protocols and insurance coverage, increasing the costs. This would also impact the logistics companies that will provide the service, who might incur higher geopolitical risk due to their role in physically managing the stockpile.

85 'RescEU', European Commission, February 2025, https://civil-protection-humanitarian-aid.ec.europa.eu/what/civil-protection/resceu_en.

6. Conclusions and recommendations

This report analysed the potential of public instruments to support private CRM stockpiles, with a twofold role: (1) the business continuity of companies in the clean tech sector; and (2) sustainable material sourcing. Assuming that a private industrial actor and a public financing institution agreed to jointly pursue such a collaboration, this report also developed a step-by-step approach to designing this stockpile. It involves planning the type and quantity of materials to be stockpiled; developing purchasing agreements for sustainable sourcing; selecting a fitting management system and financing structure; and deploying the stockpile, taking into account material and non-material considerations for a physical stockpile.

The analysis leads to seven key conclusions, detailed below.

1. **Stockpiling systems specifically designed for industrial business continuity and sustainable sourcing do not yet exist but they could be an effective instrument to pair private interests with broader public strategic goals.** Such a stockpile would provide support to the private sector, on a voluntary basis, to overcome potential supply chain disruptions. It would also promote two strategic priorities in the Netherlands and the EU. On the one hand, it would enhance the strategic autonomy of the clean tech sector, supporting a secure energy transition in the EU. On the other hand, it would act as an offtaker for more sustainable sourcing.

2. **Both Dutch and European clean tech companies could benefit from private stockpiling, but the scale of the Dutch industry is too small for an industry-wide stockpile.** Building a stockpile of materials that is (partially) externally funded could be an attractive supply chain management strategy for individual companies in the Dutch and European clean tech sectors, considering their exposure to disruptions. A cross-industrial stockpile that serves more than one company would be ineffective if only planned for Dutch industry, considering the low number of companies that use the same type of materials, as well as other supply chain capabilities available in the Netherlands.

3. **Within clean tech, a focus on materials for batteries and electrolysers for a stockpile in the Netherlands could be interesting from both a national and European perspective.** The Dutch National Technology Strategy focuses on energy materials as one of its ten priorities, especially in relation to battery storage and electrolyzers for green hydrogen.[86] The Net Zero Industry Act (NZIA) was developed in support of the EU's efforts to mitigate climate change and maintain industrial competitiveness, which require the expansion of its domestic manufacturing capabilities for clean tech.[87] Two of the five sectors that have benchmarked ambitions for 2030 are batteries and electrolysers.

[86] Ministerie van Economische Zaken en Klimaat, *De Nationale Technologiestrategie*.

[87] European Commission, 'The Net-Zero Industry Act'.

4. **Many companies that are starting up sustainable primary production (mining and refining) and recycling could significantly benefit by the scale of a stockpile for offtake.** Companies aiming to produce materials in a sustainable way are suffering from an uneven playing field given that the prices they can offer are significantly higher than materials produced elsewhere with more lax standards. Stockpiling, especially one that is publicly funded and able to tolerate higher prices, can be an essential offtaker. Within this context, the importance of comprehensive and EU-approved certification schemes cannot be overstated.

5. **The Netherlands is an attractive location for a Northwestern European or pan-European stockpile for three reasons:** (1) knowledge of and infrastructure for metal warehousing; (2) advanced logistics and customs system supporting its function as a trade hub; and (3) advantageous location at the North Sea Coast and with good connections with the rest of Europe.

6. **Without a government mandate, the options for a stockpile in the Netherlands are strongly dependent on company willingness to participate.** The first option is a voluntary company owned and operated stockpile. Companies build and hold individual stocks, and manage them according to their needs. To ensure that the stockpile fulfils societal goals, it needs to have some public support – this is where national financing institutions like Invest-NL could play a role. In the second option, Invest-NL in collaboration with private actors could co-finance a newly established company whose mandate is stockpiling materials.

7. **In the European context, supporting public-private partnerships for stockpiles is difficult to arrange without a governmental mandate.** If companies from other countries wanted to be involved in a stockpile in the Netherlands, this would (1) have to include Dutch companies; and (2) require the involvement of national promotional institutes in those countries. Otherwise, the Netherlands becomes simply a location for other countries' stockpiles, and the stockpile becomes unable to contribute to Dutch / European public interests.

Based on these main conclusions, five recommendations are developed for Invest-NL to consider:

1. **Support the scale-up of small and medium-sized enterprises in the clean tech sector through stockpiling.** Invest-NL can support Dutch companies in the clean tech sector to establish voluntary stockpiling through co-financing arrangements with other public and private actors. The starting point should be on SMEs that are trying to expand operations but that are too small to be able to stockpile their own materials. This is in line with Invest-NL's ambition of supporting the development of innovative companies in the clean tech sector.

2. **Link the support for voluntary stockpiling to ESG goals.** By supporting voluntary stockpiling, Invest-NL can incentivize companies to adopt sustainable and responsible sourcing practices. As a financer, Invest-NL could reward companies that build their stockpiles in line with ESG standards and responsible supply chain principles. This would reinforce alignment with the Dutch National Raw Material Strategy and broader public sustainability objectives.

3. **Complement national efforts for a national security stockpile.** Invest-NL's role as a public impact investor with a mandate to accelerate societal transitions could be leveraged to support private stockpiles in strategic sectors. This voluntary industry-driven mechanism should complement efforts by the Dutch government to develop a stockpile program for national security purposes, which would potentially involve mandatory reserves and public financing.

4. **Explore regional cooperation for enhanced effectiveness.** The Dutch clean tech sector is too small to require a sector-wide stockpile, so a wider geographical focus would be more effective. A decentralised approach to European stockpile could be pursued. This arrangement could start with a smaller group of countries to pilot the idea and ensure relative speed of action, and, if successful, expand toward other regions in the EU. In first instance, it could start with the countries with which the Netherlands already has close industrial ties with: Germany, Belgium and France. Coordination with the Dutch government and the European Commission would be essential to manage cross-border complexity and ensure coherence with the European Stockpiling Strategy.

5. **Expand approach beyond clean tech.** Invest-NL can extend its support to other sectors of strategic importance in addition to clean tech, following the four stage approach presented in this report. Clean tech can be a pilot, which can later be expanded to other sectors too. Companies in the digital technologies, life sciences and healthcare sectors are part of the Dutch National Technology Strategy may also be interested in public-private arrangements for stockpiling. These initiatives can also be pursued in a European context to maximise impact.

Annex 1. Choices and calculations for material stockpiles

Estimated yearly consumption in NL was calculated by taking the average amounts of each company answer that referred to the said material, and adding up the averages for all companies that mentioned it. Each material was mentioned 2-3 times.

Platinum

1. Price average from CME Group (1339 $/troy oz) and Johnson Matthey (1343 $/troy oz) on 6 August, amounting to 1341 $/troy oz.[88] Converted to 43,039 $/kg.

Iridium

2. Price from Johnson Matthey, average of the last 30 days (4471,74 $/troy oz) on 6 August.[89] Converted to 143,781 $/kg.

Lithium carbonate

3. Chosen as it is widely perceived to be relatively easy to store and applicable to several end users[90]
4. Price is from Asian Metal, taken on 6 August as the average of the last 28 days. Price curve for lithium carbonate 99.5%min Delivered EU.

Vanadium

5. Both ferrovanadium and vanadium pentoxide were shown for comparison.
6. The prices are from Asian Metal, taken on 6 August as the average of the previous 28 days.
7. Price curves:
    a. Ferro-vanadium 80%min in warehouse Rotterdam
    b. Vanadium pentoxide flake 98%min in warehouse Rotterdam: 4.9 USD / lb, converted into 10.8 USD/kg.

After the calculations were made, all prices were converted into EUR on 5 Sept 2025 and inserted into the table in 4.2.2.

88 'Platinum Overview', CME Group, accessed 3 October 2025, https://www.cmegroup.com/markets/metals/precious/platinum.html; 'PGM Prices and Trading', Johnson Matthey, accessed 3 October 2025, https://matthey.com/products-and-markets/pgms-and-circularity/pgm-management.

89 Johnson Matthey, 'PGM Prices and Trading'.

90 Moerenhout et al., *Five Key Decisions to Revitalize US Critical Mineral Stockpiles*.

Annex 2.
Calculations of EU clean tech industry needs

Solar PV

Material needs for solar PV are based on Liang et al. The mean was considered across technologies. These were multiplied by 30 GW, which is the NZIA manufacturing goal for 2030, in order to get to the final numbers (Table 11).

Table 11. Material needs for solar PV (tonnes/ GW) and expected amount for manufacturing in the EU in 2030 (tonnes)

SOLAR PV

Material	Mean amount in tonnes/GW for c-Si	Expected amount in 2030 (tonnes)
Copper	**697.5**	**20,925**
Silicon	1,716.25	51,487.5
Nickel	**1**	**30**
Silver	18.00703125	540
Lead	55.5	1,665

Heat pumps

Material needs for heat pumps based on Naumann et al. for a 5 kW heat pump. These were multiplied by 200 in order to reach the amount per 1 GW, and then by 31 to reach the amount needed for 31 GW (Table 12).

Table 12. Material needs for heat pumps (kg/ 5 kW) and expected amount for manufacturing in the EU in 2030. Data for material needs from Naumann et al.[91]

HEAT PUMPS

Material	Amount (kg/ 5 kW)	Expected amount in 2030 (tonnes)
Copper	**36.6**	**226,920**
Elastomer	16	99,200
HDPE	0.5	3,100
Low-Alloy Steel	32	198,400
PVC	1.6	9,920
R-134a	4.9	30,380

Wind turbines

The EU NZIA aims to achieve 36 GW of manufacturing capacity for wind turbines, without specifying a distinction between onshore and offshore turbines. The calculation takes into account 27 GW of manufacturing capacity for onshore (75% of total capacity) and 9 GW for offshore (25% of total capacity) for the following reasons. First, onshore wind is dominant in the EU as of 2024 (210 GW of installed capacity onshore vs 21 GW offshore).[92] Second, the voluntary targets for offshore wind in the EU is 88 GW by 2030 (so an additional 67 GW compared to 2024).[93] Third, Wind Europe expects the growth in installed wind capacity to 2030 to be in proportion of 75% onshore and 25% offshore.[94]

The material needs for wind turbines are derived from Liang et al, where the materials are divided into offshore and onshore turbine needs (Table 13). The average amount was taken for either offshore and onshore. The average amount was taken in the case of 'not defined' categories as well (the only one being zinc). The results are shown in Table 14.

91 Gabriel Naumann et al., 'Life Cycle Assessment of an Air-Source Heat Pump and a Condensing Gas Boiler Using an Attributional and a Consequential Approach', *Procedia CIRP*, The 29th CIRP Conference on Life Cycle Engineering, April 4 – 6, 2022, Leuven, Belgium., vol. 105 (January 2022): 351–56, https://doi.org/10.1016/j.procir.2022.02.058. Pg. 353

92 'Wind Energy in Europe: 2024 Statistics and the Outlook for 2025-2030', *WindEurope*, 2025, https://windeurope.org/data/products/wind-energy-in-europe-2024-statistics-and-the-outlook-for-2025-2030/.

93 'Member States Agree New Ambition for Expanding Offshore Renewable Energy', European Commission, 18 December 2024, https://energy.ec.europa.eu/news/member-states-agree-new-ambition-expanding-offshore-renewable-energy-2024-12-18_en.

94 'Wind Energy in Europe'.

Table 13. Material needs for offshore and onshore wind turbines (tonnes/ GW). Data from Liang et al.

Wind turbines			
Material	**Amount in Tonnes/GW Range & Average**		
	Offshore	**Onshore**	**Not Defined**
Aluminium	300-9400, 3060	260-5300, 1656	-
Boron	7-7, 7	1, 1	-
Chromium	372-372, 372	359-789, 610	-
Copper	1800- 22,200, 8187	1400-7000, 3514	1143-1143, 1143
Dysprosium	4.86-25, 13.38222	0.9-14.58, 6.78	4,026
Manganese	33-57, 45	33-57, 45	33-57, 45
Molybdenum	116-335, 225.5	116-335, 225.5	116-335, 225
Neodymium	27-200, 136.77	6.2-182.75, 83.29	28-244, 128.43
Nickel	372, 372	359-789, 610	427-557, 492
Praseodymium	33-35, 34	1-4, 2.325	26-26, 26
Steel	125,000-400,000, 257,696.667	54,000-204,000, 134,575.5	-
Terbium	7-7, 7	1-1, 1	1.003-1.003, 1.003
Zinc			5150-5450, 5256

Table 14. Expected material needs for wind turbine manufacturing in the EU in 2030 (tonnes)

WIND TURBINES			
Material	**Expected amount in 2030 (tonnes)**		
	Offshore (9 GW)	**Onshore (27 GW)**	**Total (36 GW)**
Aluminium	27,540	44,712	72,252
Boron	63	27	90
Chromium	3,348	16,470	19,818
Copper	73,683	94,878	168,561
Dysprosium	120.44	183.06	303.5
Manganese	405	1,215	1,620
Molybdenum	2,029.5	6,088.5	8,118
Neodymium	1,230.93	2,248.83	3,479.76
Nickel	3,348	16,470	19,818
Praseodymium	306	62,775	63,081
Steel	2,319,270	3,633,538.5	5,952,808.5
Terbium	63	27	90
Zinc	47,304	141,912	189,216

Batteries

The NZIA sets the target of achieving at least 550 GWh of battery manufacturing capacity in 2030, covering at least 80% of the EU's domestic demand. In 2024, factories worth 1,725 GWh had been announced across Europe, which is a significantly higher capacity than the expected 1,000 GWh of expected demand for lithium-ion batteries in 2030.[95] Still, about half of these projects are at risk of being delayed, scaled down or cancelled.[96] For this reason, the conservative estimate of 550 GWh in 2030 is considered.

Even though the NZIA does not specify the target in terms of different battery technologies, both chemistries accounted for in the calculation are lithium-ion batteries given their market dominance.[97] Specifically, two chemistries are considered: Nickel-Manganese-Cobalt (NMC), the dominant chemistry for EVs; and Lithium-Iron-Phosphate (LFP), dominant for stationary storage.[98] NMC622 is considered compared to other variants like NMC811 or NMC532 given its relative growth in popularity since 2015 due to lower material demand. Moreover, NMC622 represents a 'middle ground' between other NMC chemistries in terms of material consumption, making it a useful reference point. Nickel-Cobalt-Aluminium (NCA) batteries have a notable market share too, but since the materials are relatively similar to NMC, it is not included in the calculation. While other types of batteries like sodium-iron or solid state are also rapidly gaining market share, they are left out of this analysis as they likely will become more important after 2030, and even then, it is unclear whether the EU will be a key player in their manufacturing compared to e.g. China.

The 550 GWh goal is divided into 80% NMC and 20% LFP. This is a middle ground between accounts that project NMC chemistries at 90% and those more conservative estimates that place it at about 60%.[99] This translates into 440 GWh NMC and 110 GWh LFP.

Material needs for a 60 kWh battery are shown in Table 15. The expected amount of materials needed in 2030 are shown in Table 16.

95 Transport & Environment, *An Industrial Blueprint for Batteries in Europe* (2024), https://www.transportenvironment.org/uploads/files/An-industrial-blueprint-for-batteries-in-Europe-How-Europe-can-successfully-build-a-sustainable-battery-value-chain.pdf.

96 Transport & Environment, *An Industrial Blueprint for Batteries in Europe*.

97 International Energy Agency, *Batteries and Secure Energy Transitions* (2024), https://www.iea.org/reports/batteries-and-secure-energy-transitions.

98 Aude Marjolin, 'Lithium-Ion Battery Capacity to Grow Steadily to 2030', S&P Global, 2023, https://www.spglobal.com/market-intelligence/en/news-insights/research/lithium-ion-battery-capacity-to-grow-steadily-to-2030?; International Energy Agency, *Batteries and Secure Energy Transitions*.

99 Ines Rosellon Inclan and Tim Wicke, 'Analysis of Global Battery Production: Production Locations and Quantities of Cells with LFP and NMC/NCA Cathode Material', Fraunhofer Institute for Systems and Innovation Research ISI, 2023, https://www.isi.fraunhofer.de/en/blog/themen/batterie-update/globale-batterieproduktion-analyse-standorte-mengen-zellen-lfp-nmc-nca-kathoden.html; Marjolin, 'Lithium-Ion Battery Capacity to Grow Steadily to 2030'.

Table 15. Material needs for batteries (kg/ 60 kWh). Data from the Visual Capitalist[100]

Batteries

Material	Amount for 60 kWh NMC622 (kg)	Amount for 60 kWh LFP (kg)
Lithium	6	6
Cobalt	11	0
Nickel	32	0
Manganese	10	0
Graphite	50	66
Aluminium	33	44
Copper	19	26
Steel	19	26
Iron	0	41

Table 16. Expected material needs for battery manufacturing in the EU in 2030 (tonnes)

Batteries

Material	Expected amount NMC622 (tonnes)	Expected amount LFP (tonnes)	Total
Lithium	44,000	11,000	55,000
Cobalt	80,520	0	80,520
Nickel	234,520	0	234,520
Manganese	73,480	0	73,480
Graphite	366,520	121,000	487,520
Aluminium	14,520	80,630	95,150
Copper	139,480	47,630	187,110
Steel	8,360	47,630	56,260
Iron	0	75,130	75,130

Electrolysers

The NZIA set the target of European manufacturers scaling production capacity to reach 100 GW of installed electrolyser capacity by 2030, without setting clear capacity goals. To calculate an estimate of what this capacity will be, this paper assumes that the growth will be linear to 2030. Considering that the installed capacity as of 2025 is 380 MW, almost the entire 100 GW will have to be installed from 2025 onwards.[101] Divided by five years, this means 20 GW per year of electrolyser capacity.

100 Govind Bhutada, 'The Key Minerals in an EV Battery', *Elements by Visual Capitalist*, 2 May 2022, https://elements.visualcapitalist.com/the-key-minerals-in-an-ev-battery/.

101 'Hydrogen Production and Consumption Projects', European Hydrogen Observatory, December 2024, https://observatory.clean-hydrogen.europa.eu/hydrogen-landscape/projects-and-valleys/hydrogen-production-and-consumption-projects.

Alkaline and Proton Exchange Membrane (PEM) electrolysers are the only mature technologies as of 2025, even though others are rapidly expanding too. For this reason, alkaline and PEM technologies are considered, in their 2024 global proportion of deployment of about 60% alkaline and 21.5% PEM.[102]

As such, we calculate the material needs for 12 GW of alkaline electrolyser manufacturing and 4.3 GW of PEM. The amount of materials in kg per MW is taken from Eikeng et al., as shown in Table 17.[103] The final results are displayed in Table 18.

Table 17. Material needs for alkaline and PEM electrolyzers (kg/ MW or tonne/GW). Data from Eikeng et al.

Material	Amount for Alkaline electrolysers (kg/MW or tonne/GW)	Amount for PEM electrolysers (kg/MW or tonne/GW)
Aluminium	500	27
Carbon	-	9
Cobalt	5	-
Copper	-	4.5
Iridium	-	0.75
Nickel	800	-
Platinum		0.5
Steel	10,000	100
Titanium	-	528
Zirconium	100	-

Table 18. Expected material needs for electrolyser manufacturing in the EU in 2030 (tonnes)

Material	Expected amount for Alkaline electrolysers (12GW)	Expected amount for PEM electrolysers (4.3 GW)	Total
Aluminium	6,000	116.1	6,116.1
Carbon	-	38.7	38.7
Cobalt	60	-	60
Copper	-	19.35	19.35
Iridium	-	3.225	3.225
Nickel	9,600	-	9,600
Platinum	-	3.225	3.225
Steel	120,000	430	120,430
Titanium	-	2,270.4	2,270.4
Zirconium	1,200	-	1,200

102 'Electrolysers', IEA, accessed 3 October 2025, https://www.iea.org/energy-system/low-emission-fuels/electrolysers.

103 Erik Eikeng et al., 'Critical and Strategic Raw Materials for Electrolysers, Fuel Cells, Metal Hydrides and Hydrogen Separation Technologies', *International Journal of Hydrogen Energy* 71 (June 2024): 433–64, https://doi.org/10.1016/j.ijhydene.2024.05.096.

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