SecREEts
Secure European Critical Rare Earth Elements

Obstacles, Impacts and Recommendations for the future of the European rare earth elements value chain

—SecREEts Fourth Policy Council

Brussels, 3 June 2022

Prospex Institute
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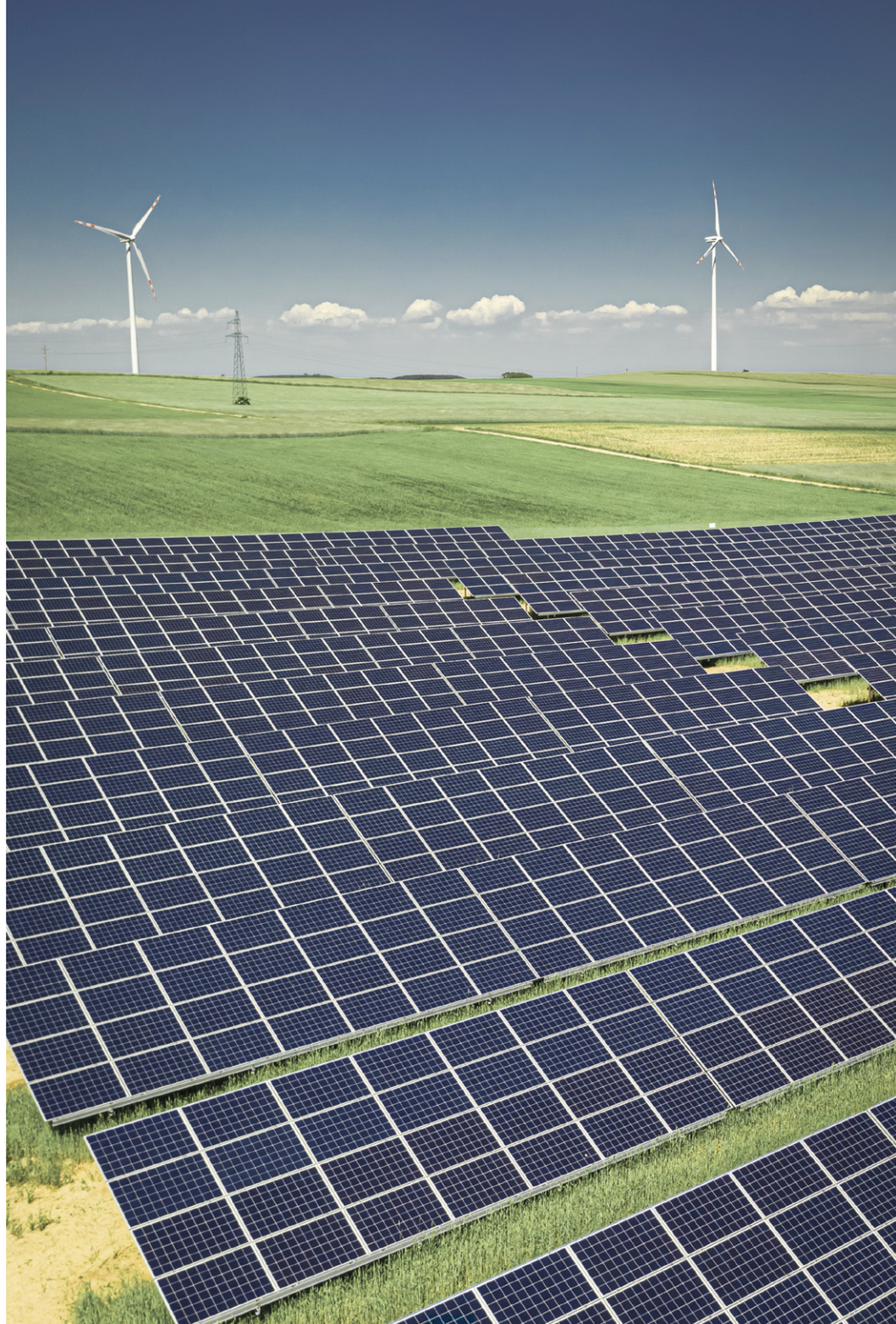

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Please note that this workshop followed safe-house rules, meaning that some collaborator's names do not appear in this list.

About SecREEts

SecREEts is a project receiving funding from the European Commission Horizon 2020 programme for research & innovation. It aims to establish a secure and stable supply of Rare Earth Elements (REEs) in Europe, using sustainable extraction methods from European apatite sources used in the production of NPK fertilisers. SecREEts partners are developing pilot processes for a sustainable extraction, separation and manufacturing of REEs to create permanent magnets for application to areas such as electric vehicles, industrial motors, wind turbines, with replication potential in consumer products or medical equipment. The main objective of SecREEts is to set up a new integrated European value chain for extraction, refining and production of REEs.

SecREEts partners are:
SINTEF AS – Norway – Coordinator
Yara International ASA – Norway – Industrial pilot
REEtec AS – Norway – Industrial Pilot
Less Common Metals Ltd – UK – Industrial Pilot
Vacuumschmelze GmbH & Co KG – Germany
Quantis – Switzerland
Institut National de l'Environnement et des Risques INERIS – France
Prospex Institute vzw – Belgium

Please find all relevant information and latest updates on the project website:
www.secreets.eu

Twitter - @Secreets_H2020
LinkedIn page - SecREEts

About the Report

This report gives a summary of the activities and results of the 4th SecREEts Policy Council. Prospex Institute, the partner leading SecREEts public engagement activities, organised the 4th Policy Council in form of a stakeholder workshop on 03 June 2022 in Brussels. The workshop was titled:

> *"Obstacles, Impacts and Recommendations for the future of the European REE value chain"*

Why this workshop?

SecREEts regularly organises European stakeholder workshops, called Policy Councils, to discuss ongoing issues and questions related to REE supply in Europe. These events gather a wide range of stakeholders covering the different industries using REE in Europe, as well as researchers, policymakers, non-profit organisations, schools, citizens... For this 2022 edition, following up on the previous Policy Council in September 2021, stakeholders discussed solutions and policy recommendations for impact mitigation of the critical incidents for REE use & supply in Europe that had been identified in 2019.

What happened at the workshop?

Stakeholders were first introduced to the topic through two presentations:

- An introduction to SecREEts by Dr Arne Petter Ratvik, Senior Scientist at SINTEF and SecREEts project coordinator
- An overview of what happened during the previous Policy Council by Stefan Haenen from Prospex Institute. During this introduction, the process that led to the co-creation of the heatmap of critical incidents for REE supply and use in Europe was presented to participants.

After this scene-setter presentations, participants were then guided by Prospex Institute's professional moderators in a brainstorming exercise to examine existing or identify additional events (Critical incidents) that could impact the supply and use of REE in Europe in answer to the question:

What critical incidents affecting REE supply and use in Europe have happened since the last Policy Council? Which critical incidents do you think have further materialised?

The collective brainstorming started already during a networking dinner before the event and resulted in the timeline (next page).

JULY 2021

EU - Ukraine sign 'strategic partnership' on raw materials

- EU-Ukraine partnership has wider global relevance.
- Ukraine becoming heart of a European value chain – strategic importance also in a geopolitical context
- The alliance aims to strengthen the EU's "strategic autonomy" on raw materials

NOVEMBER 2021

Greenland bans uranium mining, blocking vast rare earths project

Launch of DiscoveREEs

Neo Performance Materials planned magnet factory in Estonia

A joint effort between the Estonian Ministry of Economic Affairs and Communications and Neo Performance Materials has been launched to explore a possible expansion of Neo's current production of advanced rare earth element products in Estonia, and well as to potentially launch new manufacturing of REE-based metals, alloys, and magnetic materials for use in electric vehicles and other green technologies.

FEBRUARY 2022

Russian Invasion of Ukraine

- Impacts on global commodity markets – rises in several metal and mineral prices
- Current crisis brings to the fore bottlenecks and risks in the fragile critical minerals supply chain
- Western countries sanctions may disrupt US-Europe rare earths supply chain setting back Europe's attempts to reduce reliance on China for the critical materials.

Biden-Harris Administration announces major investments in domestic production of key critical minerals and material

US Companies Announce Major Investments to Expand Domestic Critical Minerals Supply Chain Breaking Dependence on China and Boosting Sustainable Practices

Proposal for a Directive on regulation on due diligence

Bigger responsibilities on companies for their supply chain - including waste management

APRIL 2022

EIT Raw Materials launches circular System for Assessing RE sustainability- CSyARES

- The project aims to help strengthen the transition to a CE through tracking and traceability of CM
- The scheme will help companies improve the transparency and sustainability of their supply chain and provide the handling of RM is not linked to poor ESG standards
- Improving transparency will also pave the way to increase consumer confidence
- This Blockchain based scheme will also make standards more reliable and consistent

MAY 2022

China about to tighten exports

- In December of 2020, China joined many other countries in passing an Export Control Law
- New export proposal - when it becomes law, it will empower the Chinese Government to carry out a "risk assessment" and require exporters of products that can have military applications to provide documentation of the intended use by the buyers in an effort to halt the militarization of sensitive technology
- Potentially in line with critical incident n°2 identified in the 3rd PC

Scandium under the lens of REACH leading to issues for the Ti alloy supply chain

Studies showing that scandium can produce hazardous gases – if categorised as dangerous metal, need to find alternative solutions which will take time

N9ve Project (Portugal) 2019

Main goal is to use nature's own systems to respond to our needs, maintaining its balance. Present subjects are REE and/or Lithium recover, Lithium obtention, and nutrients incorporation.

REPOWER-EU - accelerate RE transition (mention of CRM supply chain)

- Plan aims to increase the 2030 target for EU renewable energy from 40% to 45% of total supplies, via a significant stepping up of both solar and windpower installations
- Scale up of wind power may put considerable pressure on critical rare earths supplies and permanent magnets
- Accelerate RE transition (mention of CRM Supply Chain)

30 SEPTEMBER 2021

European Raw Materials Alliance (ERMA) releases Action Plan to secure access to REE for European industry

- Report outlines current and projected EU demand for REE and steps which should be taken to secure their supply
- ERMA ran a stakeholder consultation process to understand regulatory bottle- necks.
- 12 actions, 4 key recommendations
  - Creation of a level playing field
  - European OEMs (original equipment providers) will need to consider potential commitments to buying a significant percentage share of REM from European producers.
  - Ensure that end-of-life products and waste materials containing RE stay in Europe, facilitating their reprocessing and recycling.
  - Financial contribution by EU & Member Stater financial levers including state aid, to trigger large private investments in the emerging European rare earths value chain

JANUARY 2022

China merges key rare earth producers

The new mining giant will be formed of three government-owned companies, strengthening China's control over the rare earth industry

30 MARCH 2022

EU Proposal Ecodesign for Sustainable Products

- The proposal establishes a framework to set Ecodesign requirements for specific product groups to improve their circularity, energy performance and other environmental sustainability aspects
- A new "Digital Product Passport" will provide information about products' environmental sustainability and help consumers and businesses make informed choices
- The product passport should also help public authorities to better perform checks and controls

New EU regulationon Batteries -Battery - publication, regulation to replace the 2006 directive

- To replace 2006 directive
- Regulation is intended to ensure more sustainable use of batteries along the entire value chain throughout the EU
- A carbon footprint will be introduced for electric vehicle batteries and the replaceability of portable batteries improved

19 APRIL 2022

Schaeffler & REEtec: 1st European Rare Earth deal

- General Motors previously reached an agreement to source REE magnets in the US
- 1st deal in European auto sector to source domestic Rare Elements
- EU is trying to innovate and boost domestic production of REE and strong magnets to cut dependence on China
- According to analysts, EU sourced REE may come at higher costs, but can be marketed as more sustainable and thus justify higher prices to customers

ONGOING

Citizens against mining across Europe: protests in Portugal, Serbia, Romania

- Highlights environmental and economic trade-offs in the transition to cleaner energy
- In line with critical incident identified in the last Policy Council
- Citizens protesting in Cáceres (Spain), UN World Heritage. The proposed project has set off strong local opposition
- Jan 2021: Plan for lithium mine in Serbia cancelled following weeks of major protests
- Portugal October 2021

Gazprom – cutting ties, diversifying energy supplies

Increase in transport prices /availability

Escalations China - Taiwan

Expansion / Reduction of Russian War

Economic impact on Permanent Magnet production if energy prices increase

The Russian invasion of Ukraine was added to the initial four critical incidents identified during the previous Policy Council, as most of the participants agreed on the fact that it could be qualified as critical for REE supply and use in Europe.

1. Transition to a Carbon Neutral Economy
2. Impact of Chinese export policies
3. Breakthrough in substitution of REE
4. Citizens are against mining REE in Europe
5. *Russian invasion of Ukraine*

Looking at the Critical incidents, participants were invited to select two of the critical incidents to further discuss in small groups and identify **potential solutions to mitigate OR maximise the impact and/or likelihood of selected critical incidents for REE supply and use in Europe.**

The results of the discussions are presented on the pages that follow.

Critical Incident 1

Transitioning to a carbon-neutral economy

Within the Critical Incident 1: Transitioning to a carbon-neutral economy, two situations were examined:

1. *The energy transition and e-mobility happen so fast that this creates scarcity for REE,*
2. *The Electric Vehicle (EV) revolution.*

Overview of current state of play

There are currently two main drivers in the transition towards carbon neutrality: Electric Vehicles (EVs) and Wind Industry.
For the wind industry, REE are mostly needed for offshore wind turbines, as onshore is efficient enough with the magnets that are currently being used. In addition, RE magnets are a relatively new technology for offshore.
The likelihood of one of those industries driving the change or being impacted by REE supply challenges in Europe is higher with EVs, with a strong expected increase of REE demand in the automotive sector.
As opposed to wind turbines that are an industrial product, EVs are a *consumer product*.

Discussion: Solutions explored & bottlenecks

To mitigate the likelihood of this risk, Policy Council participants identified the following recommendations:

/ Support recycling and substitution schemes

a) REE recycling *(technologies already exist and are mature enough for upscaling, but there are difficulties around the value chain)*

To make this solution viable there is a need for:

- more efficient waste and end-of-life collection schemes and policies in Europe, to avoid products are sent abroad,
- standardisation in magnet production & design for recycling,
- development of recycling chains – the technology is there and needs to be scaled up,
- ensuring proper communication among players,
- subsidising recycling facilities.

As Europe lacks its own sources of REE, recycling will be crucial to tackle the REE criticality in Europe. However, the recycling solution will become viable several years from now as there is still not enough recycling material available: the installations are still being used, not near their end of life yet. If there is a fast increase in demand, and if we consider the lifetime of products (e.g., 15 years), recycling is too slow compared to current needs.

b) Substitution technologies

There is a public interest in finding alternative technologies. For EVs, one solution that has been explored by participants is REE-free permanent magnets. It was highlighted that more efficient batteries are needed: more

efficient batteries allow more REE-free permanent magnets.

/ *Innovation and R&D to deploy non-REE magnets should be fostered*

This would require a joint public and private effort, ideally in this decade. However, at the moment, some bottlenecks impeding the substitution have been identified:

- REE-free magnets are not as performant as the REE magnets,
- the substitution technologies exist, but they are not completely mature or certified,
- within Europe, there is a lack of production capacities and gaps in the process, especially a lack of expertise to scale up magnet production.

Strong support from policy actors is needed to spur change in the industry.

/ *Optimize the material cycles (flows and stocks) on a system level instead of optimization of individual technologies*

This requires:

- quantified data on material flow and stock, including future scenarios,
- national and international regulation on circular economy strategies and policies,
- include the whole R-ladder, not only recycling:
  - product design guidelines;
  - product substitution;
  - product standardization.

/ *Encourage vertical integration of OEMs with upstream stages: encourage private companies to enter the mining sector*

- This could foster long-term agreements for supply.
- This could reduce the financial exposure of mining activities with downstream support (investments) & reduce the timescale to come to market.
- From a policy perspective, private companies need to have a clear signal from policy makers on their commitment to EV adoption and related regulation.

/ *Provide demand-side solutions*

Attempting to reduce demand of EVs has been identified as critical in alleviating bottlenecks caused by faster-than-expected demand.

In the case of EVs, to reduce the expected high demand, the encouragement of less personal vehicle use by citizens has been recognized as high priority. To achieve the goal of demand reduction, identified solutions include:

- increase of investments in public transport infrastructure,
- taxation of personal vehicle use and subsidies to public transport.

Critical Incident 2

Impact of Chinese export policies

Within the Critical Incident 2: Impact of Chinese export policies, two situations were examined:

1. *Example 1: China floods the market with cheap REE products and magnets, and*
2. *Example 2: China cuts down exports.*

Example 1: China floods the market with cheap REE products and magnets

Overview of current state of play

Within this first example, two starting points were made

a. it is possible that China could exert control over the exporters of REE:
   - the structure of the market is such that it is easy for the State to control the extraction and marketing (export of the REE);

b. it is impossible for China to exert control over the export of magnets:
   - the structure of the market is such that it does not allow for State intervention.

China is a member of the WTO. Statistics in China are generally not considered to be very reliable, making it difficult to analyse and predict developments. Sanctioning of companies selling at overly low prices (as perceived by the State) happened in the past.

Downstream production in China is subsidised in many forms, meaning that already lower-cost operations are able to maintain competitive positions European or other non-Chinese assets are unable to reach. Lower prices as a result of a flooded market would, therefore, impact European producers more significantly.

Recently, at least one Chinese company tried to enter the EU market by establishing a company in Poland, but the Russian invasion in Ukraine blocked that plan.

However, the likelihood of this incident materialising has been classified by some participants as low.

Discussion: Solutions explored & bottlenecks

/ Further integration of the value chain

It could take the form of cross-ownership of companies from the same value chain that are at the various levels up- and downstream of the REE/magnets value chain.

/ Develop strategic alliances and treaty frameworks to secure the regular supply of REE/magnets.

To develop this, action is needed at the level of institutions and policymakers as well as at the level of businesses (companies) and trade associations.

/ Include OEMs in the value chain

OEMs need to be made responsible for the sustainability and resilience of the value chain. Their motivation lies in the strategic dependence on regular uninterrupted supply.

/ Enabling Chinese companies to establish themselves in the EU should be facilitated.

Long-term incentives are indispensable for the development of an integrated value chain, ideally complemented by regulations and ESG (due diligence/sustainability) monitoring and action.

/ Revert technological flows that used to be directed toward China…

… so as to flow back to the EU (and the US) who seem to have lost the technological expertise that cannot be created in a short period of time.

/ Respect for basic design rules (technical regulations, standards) in magnets development/production…

… which is already at a very early stage.

/ Strong value chain from mining through production of magnets to recycling.

/ "Domestication" of the Chinese companies

in the sense of their incorporation (alone or in joint venture) would be a must.

/ Support to economies so that EU projects become interesting for investors:

- incentives (subsidies) need to be provided over a longer term so as to develop a real capacity to operate on the market on a lasting basis,
- stockpiling should be encouraged in the short-term and hedging mechanisms developed.

/ Investment in human capital should be encouraged…

…especially concerning the refining and end-product-making in Europe.

/ Investment with other (strategic) allies should be prioritised:

Possibilities of actions within the WTO should be examined and used to the advantage of the value chains.

/ Incentivise through government subsidies:

In order to incentivise new capacity addition (and to maintain current assets), government subsidies could go a long way to ensure asset level economics are feasible (see for example bi-partisan bill in the US).

Example 2: China cuts down exports

Overview of current state of play

The entire value chain is currently dominated by China. In addition, the market is witnessing an expansion abroad, especially in its mining phase, and sees increasing levels of control over the companies active in that industry. Further consolidation is taking place. In December 2020, a regulation was adopted that provides a legal basis for the adoption of measures regarding REE (among others, export control).
Compared to the previous incident of China flooding the market, a cut in Chinese export has been considered more likely to manifest and can thus be considered as a higher risk incident.

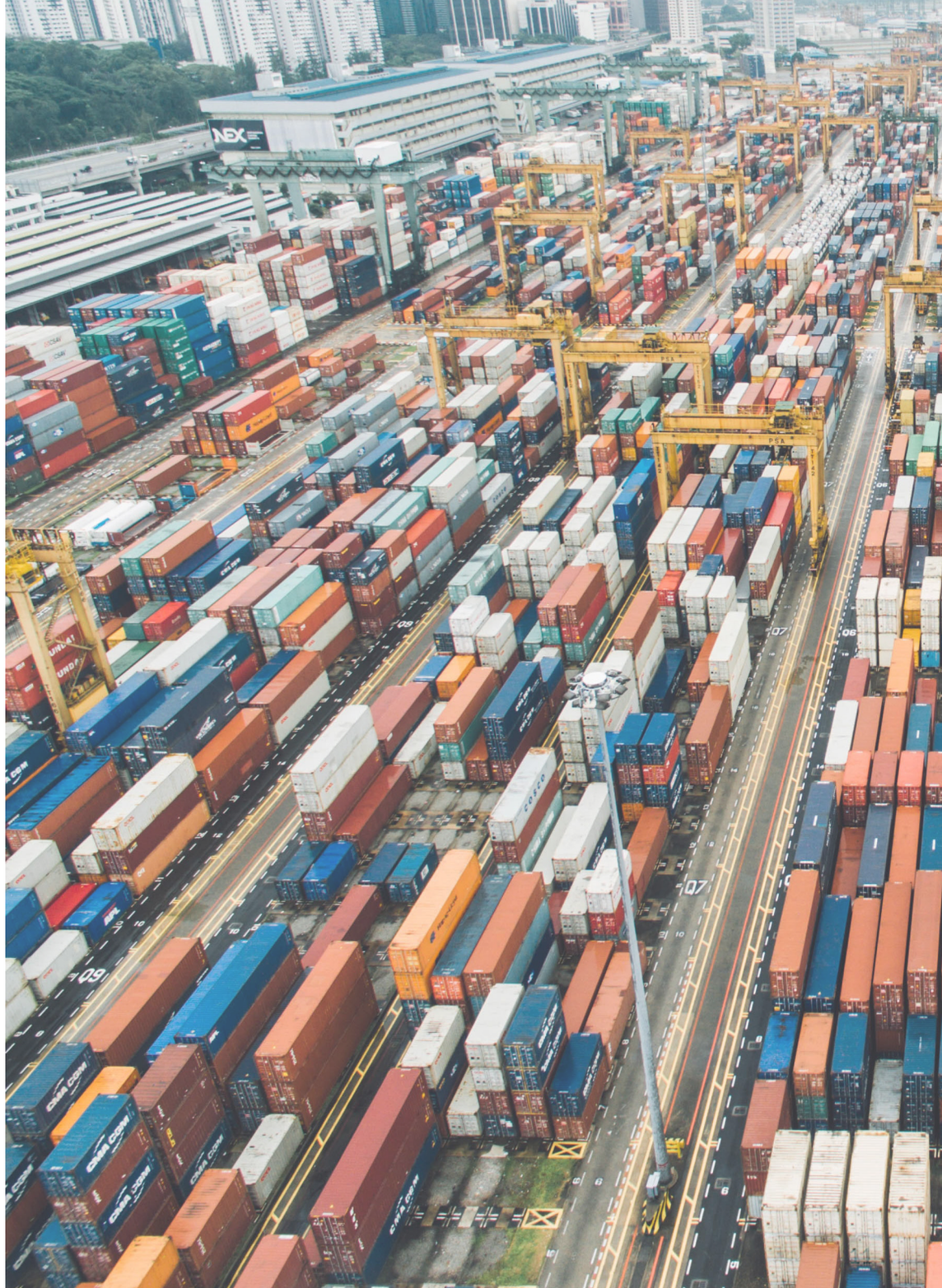
If conceived as a geopolitical tool, with some degree of miscalculation, a Chinese export ban might target value added products that could severely impact existing industrial activities (EU magnets consumers) or by deterring new actors from entering the market, exposing them to more uncertainty.

Discussion: Solutions explored & bottlenecks

There is no response to a sudden halt in exports from China: the EU industry cannot provide an immediate solution, which means that only mid- and long-term solutions can be examined. Recommendations that follow are applicable in the medium- and long runs:

/ Better use of EU's own resources and their development

From existing raw materials to the not-yet-existing technical and technological expertise.



/ Development and use of EU's competitive advantages…

…where they exist, and invest in becoming a stronger negotiating partner.

/ Investment in human capital should be encouraged.

/ Investment with other (strategic) allies should be prioritized.

/ Targeting available substitute end-user applications…

…such as induction motors over permanent magnet motors for EVs to safeguard industrial operations over consumer preferences.

/ Engage with China more closely to address market distortion measures…

- …bilaterally (the USA have launched a Commerce Department investigation under Section 232 of the Trade Expansion Act for national security reasons)
- or multilaterally recurring to WTO measures, with the former being considered harmful by the European Union

/ Speed up the development of magnet production capacity in the EU…

…making China aware of the consequences of the decision to block exports geopolitically, as a means of modern warfare. The solution could be to organise multilateral talks and eventually place certain questions (extraction of the REEs and production of magnets – basic questions) under common tutelage: it is probably not realistic to expect that resources could be managed collectively, but it might be envisaged to establish some forms of predictability over their quantities and timing so as to ensure more appropriate planning.

In the particular context of this scenario, **China is and will remain an inevitable interlocutor**, meaning that ways of communicating with it successfully need to be explored, developed and secured.

Critical Incident 3

Breakthrough in substitution of REE

Overview of current state of play

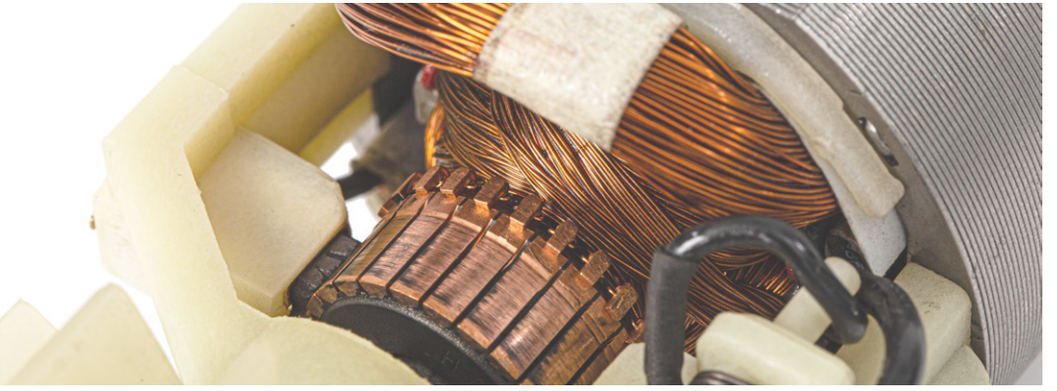
We are seeing a surge in the demand for REEs in Europe. Offshore wind farms for example are a significant driver in this, with the next generation of turbines requiring over 15 tons of REEs each. The need for permanent magnets was perceived as a critical driver, pushing REE volume in different sectors. All this implies a massive competition within Europe for these resources, between different REE-based applications, which in turn will drive the need for viable substitution technology.

The discussion explored the state of play of different options to match this increasing demand with supply, including:

- alternative / substitution technology, e.g., induction motors. Overall, it was suggested that substitution tech currently lacks evidence of its efficacy, and that there is currently no viable substitute for REE permanent magnets;
- hybrid magnets in the same vein could be a promising alternative technology, but their performance is still unclear;
- lower-performance substitutes such as ferrite-based permanent magnets are an alternative technology, depending on the kind of performance needed from the end-user;
- recycling might not be a "magic bullet" presently, but can be effective if combined with re-thinking the design of REE-applications (more efficient / more second-life design), increasing own EU supply through domestic mines.

A few important transversal points regarding future substitution technology were raised:

- more R&D in rare-earth permanent magnet substitutes would be crucial. An existing example is the EU PASSENGER project focusing on substituting NdFeB permanent magnets. This could include R&D into batteries, however this would require the use of other critical raw materials;
- neodymium is considered a "divine material", i.e. it has excellent properties – it is therefore extremely difficult to match the performance it can generate through alternative materials;
- perhaps there is a need for a consideration of alternatives at a different or higher level, i.e. for our energy needs;
- similarly, there needs to be a technology-neutral approach in the energy transition overall: e.g., push also fuel-cell vehicles, not just EVs;



- price for REEs is both an enabler and disabler for substitution technology. Considering future price fluctuations, it is crucial to have substitution contingencies in place, in case REE prices surge;
- similarly, substitution costs are often underestimated;
- the size of a product affects the substitution potential: for example, for a large product such as an MRI scanner, there is less of a need to be extremely compact with the magnets required, and therefore alternatives can be more easily used;
- the performance requirements of an application will determine the specifications of the product. These, in turn, need to be assessed in light of the cost of different options (e.g., a more costly high-performance REE permanent magnets vs. a less-costly yet (currently) lower-performing alternative).
- there is no one-permanent-magnet-fits-all — an application's requirements, size, cost of different options..., all need to be integrated into decision-making regarding to go for REE-technology or a substitute.

Discussion: Solutions explored & bottlenecks

/ Evaluate / benchmark / categorise

- perform proper evaluation of substitutes, including their performance, comparative cost and environmental footprint;
- categorise and create an overview of different options: hybrid magnets, iron-nitride magnets, manganese-aluminium magnets;
- develop REE-free e-motors, wind turbines etc., assess cost and perform Life Cycle Assessment (LCA).

/ Policies and institutions

- substitution is technologically feasible but will not be automatically streamlined in the right direction. Public policies are necessary to help with that;
- replacement or substitution-related policies must be harmonised with other constraints (e.g., REACH), including environmental aspects;
- REE replacement or substitution policies are strongly related to other critical raw materials supply chains – coordination is necessary;
- mainstream long-term strategic thinking with civil servants. Thinking should not only be expert-based;
- short-term and long-term public investments and incentives.

/ R&D

- more R&D support for alternative technologies at EU level, e.g., through innovation funds;
- invest in R&D: improve the efficiency of magnet technology, as well as expansion of frontiers of material sciences;
- at what level is R&D? Basic science and / or permanent magnets?
- apply Rare Earth R&D to ferrite-based applications (potential for breakthroughs);
- understand and map REE bottlenecks. Direct where R&D is needed;
- SnNb for land-based applications.

/ Recycling / second-life / circularity

- mixture of recycling and replacement / substitution – Europe also needs to be more efficient in the way it uses REE (cf. above);
- circularity implies a change of mindset: conduct awareness-raising campaigns to create grass-roots support and social pressure towards the right policies.

/ Build a European closed loop supply chain; create more permanent magnets producers in Europe and encourage collaboration

Critical Incident 4

Citizens are against mining REE in Europe

Overview of current state of play

This critical incident is already materialising. In the past years, certain events showing citizens disapproval of mining have happened. The most recent example was, as per the timeline above, with Serbia having to interrupt a $2.4 billion lithium mining project in the face of protests – the Serbian government revoked mining licences to the group Rio Tinto which was planning lithium mining. This project would have been sufficient to bring lithium for the production of about one million electric vehicles, though protesters showed concern over water pollution. A similar case occurred in November 2021 in Greenland, where the parliament passed a bill to ban a uranium mining project, upon which a large-scale project intended to extract rare earth as a by-product. Among different reasons, a concern about radioactivity of the product was at the heart of the decision.

Discussion: Solutions explored & bottlenecks

In order to mitigate the likelihood of this risk, participants identified a number of recommendations upon which national and European policymakers as well as industry players in the mining sector but also rare-earth-using industries can act.

/ Moving from perception to fact – awareness-raising on a social level

With a rise in extremist movements and a general skepticism towards politics or the European Union, the right narrative is key to avoiding perception bypassing facts in discussions.

- adopt a long-term, full lifecycle narrative to improve understanding of the reasons for mining (e.g., what the materials are used for, how they contribute to our daily life and society…),
- take into account the emotional aspect of these discussions and work with professionals from social science and humanities. This can help avoid misinformation and disinformation.

/ Engage with the local community

Mining projects have a big impact from a financial and economic perspective and a project being shut down has a massive impact. However, even if a project is very important, it is essential to acknowledge and respect communities' disagreements.
Some steps that can be implemented to finetune mining projects to local realities include:

- implement from the start inclusive democratic decision-making processes on the ground, that go beyond consultation (citizen assemblies, referendums etc., at municipality level),

- ensure the issues (why, why is this important, where, impacts, externalities) are understood,
- go to a sufficient level of granularity when explaining these facts – communities living closer to where the mining is happening are differently impacted compared to those living further away and thus will have different perceptions and understandings. This is also valid for other demographic data, with the impact being potentially different based on gender or ethnic background, for instance,
- identify a local neutral intermediary to speak for the community and to inform and explain what the mining project is about,
- ensure the local community benefits from some trade-off: different options can be explored for mining projects to offer compensation such as:
  - direct financial incentives – dividends that mining companies would give to local communities,
  - indirect compensation - de-taxation of landownership where mining will happen, job creation & re-skilling programmes, improved local everyday life infrastructure.

/ *Improving mining capabilities to increase chances of social acceptability*

- Keep on innovating to make mining technologies more environment-friendly and decrease issues and risks which can arise from mining and affect the local community (e.g., concerns around radioactivity). This implies support for innovation through national and European funding or education (e.g., Horizon programme, Erasmus +).
- Provide education opportunities for jobs in the mining sector, especially with the local community so they can get involved in the project and benefit from it.
- Pick up on pre-existing experience to address issues and build upon Best Available Technologies (BAT).

/ *Think about the full lifecycle of the mine*

Opening a mine implies that, at some point, resources will run out and the mine will have to close. What happens to the local community which has built its economy on the mine?

- Start identifying early on end-of-lifecycle plans in terms of economic transition of the area. Lessons can be drawn from other European areas where mines have closed (e.g., former coal mines).

/ *Keep in mind that Rare Earths are always a mining by-product*

This means there are other options than opening new mines. This includes valorizing tailings of existing mining or industrial processes that contain REE, recycling end-of-life products that contain REE, exploring urban mining…

/ *Explore options to diminish REE needs*

- Projections of REE demand in Europe are not necessarily going to represent the exact reality of the market. It could possibly mean that less REE than expected will be needed, lowering the need for domestic mining.
- Other supply options can also be explored such as recycling but also substitution (see critical incident 3).
- Means of decreasing the need for REE can be explored all the way down the value chain. There is a need for a full lifecycle approach to identify possible areas of resource efficiency (e.g., substitution of REE earth, longer-lasting end-products, less need for the end-product in itself…).

Russia's invasion of Ukraine

As mentioned above, one group also discussed on the impacts that that the Russian invasion of Ukraine might have on REE.
The energy impact is very important as Europe gets large amounts of energy from Russia – we are already experiencing higher energy prices and higher living costs; this has put a lot of pressure on Europe and the responses are not easy to find.
REE could be one of the catalysts, with a "Cascading effect" on many other products used in high-tech.

Discussion: Solutions explored & bottlenecks:

- More focus on EU production
- Diversifying supply chain
- More focus on Recycling in EU
- Better interactions between EU/US

Conclusion

Through discussion with workshop participants, the exercise enabled stakeholders from different industries and backgrounds to share their vision and jointly explore and identify solutions and policy recommendations on the future of REE supply and use in Europe.

During the exercise, each participant took part in examining two different critical incidents; every group discussed a different critical incident, identified solutions and shortcomings, and formulated the specific policy responses that seem appropriate in the area.

The carousel setting provided space for interaction and contributed to raising the level of awareness of the problems, at the same time contributing to increased creativity in problem-solving.

Some of the policy recommendations were the same across several critical incidents (e.g., substitution and recycling, better use of existing resources; need for an adequate policy response and for an action at the strategic level; supply chain integration and resilience), as they are reflecting the need for a coordinated general approach and a global solution, while the other policy recommendations only relate to a specific critical incident and to its special nature.

Flowing from this exercise, the main recommendations for the future of the European REE value chain are:

- on the supply side, focus on substitution and recycling technologies (technical solutions),
- on the demand side, give priority to solutions that foster taming the demand in order to avoid overheating of the sectors,
- better coordination between EU/US, coordinated approach towards China and Russia,
- diversification of supply chain, its integration and reinforced resilience,
- awareness raising and proper consultation in decision-making processes (social impact).