SecREEts
Secure European Critical Rare Earth Elements

Analysing Critical Incidents for Rare Earth Elements Supply & Use in Europe

—SecREEts Policy Council

Berlin & ZOOM, 17 September 2021.

Prospex Institute
Authored by: Clara Boissenin, Prospex Institute.
Infographics by: Nina Cavz, Prospex Institute.
Reviewed by: Miro Prek, PhD, LL.M., Prospex Institute.

This project has received funding from the European Union's horizon 2020 Research and Innovation Programme under Grant Agreement No 776559

List of collaborators

Thank you to our workshop participants and collaborators for their contribution to this report:

- **Ana Maria Martinez** - Senior Research Scientist, SINTEF Industry
- **Andrew Hine** - Commercial Director, GreenSpur Wind Limited
- **Claudio Geyken** - CEO & Cofounder, RiDERgy
- **Giuseppe Giovanni Daquino, M.Sc., Ph.D., MBA** - Project Officer Materials & Structures Technologies, EDA Materials CapTech Chair, European Defence Agency
- **John Seaman** - Research Fellow, Centre for Asian Studies, French Institute of International Relations (IFRI)
- **Leonid Graf von Keyserlingk M.Sc.** - Bundeswehr Office for Defence Planning, Directorate I - Objectives and Innovation
- **Marie Gentzmann M.Sc.** - Bundesanstalt für Materialforschung und –prüfung (BAM), 4.4 Thermochemical Residues Treatment and Resource Recovery
- **Dr Shahid Riaz, CEng, CSci, FIMMM** - Technical & Development Manager, Less Common Metals Ltd

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 Heatmap Report

Prospex Institute, the partner leading SecREEts public engagement activities, organised a hybrid stakeholder workshop on 17th September 2021, engaging with participants joining in Berlin and online. The workshop was titled:

> *"Analysing Critical Incidents for Rare Earth Elements Use & Supply in Europe"*

Why this workshop?

SecREEts regularly organises European stakeholder workshops, called **Policy Councils**, to discuss ongoing issues and questions related to rare earth supply in Europe. These events gather a wide range of stakeholders covering the different industries using rare earths in Europe, as well as researchers, policymakers, non-profit organisations... For this 2021 edition, the workshop was set up as a **foresight** exercise, exploring with stakeholders possible **critical incidents** which could have an impact on **rare earth supply and use in Europe** over the **next 5 years**. This workshop was designed as a contribution to the ongoing debates & activities in the European critical raw materials sector, such as the recent publication of a European Call for Action to secure access to raw materials for the EU Green Deal, published by the European Raw Materials Alliance (ERMA).

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
- "REE use & supply in Europe: where are we now?" by Dr Roland Gauss, Senior Adviser Substitution and Recycling at EIT Raw Materials

After these scene-setter presentations, participants were guided by Prospex Institute's professional moderators to **co-create a heatmap of critical incidents for REE supply & use in Europe**.
Participants started by brainstorming to identify critical incidents in answer to the question:

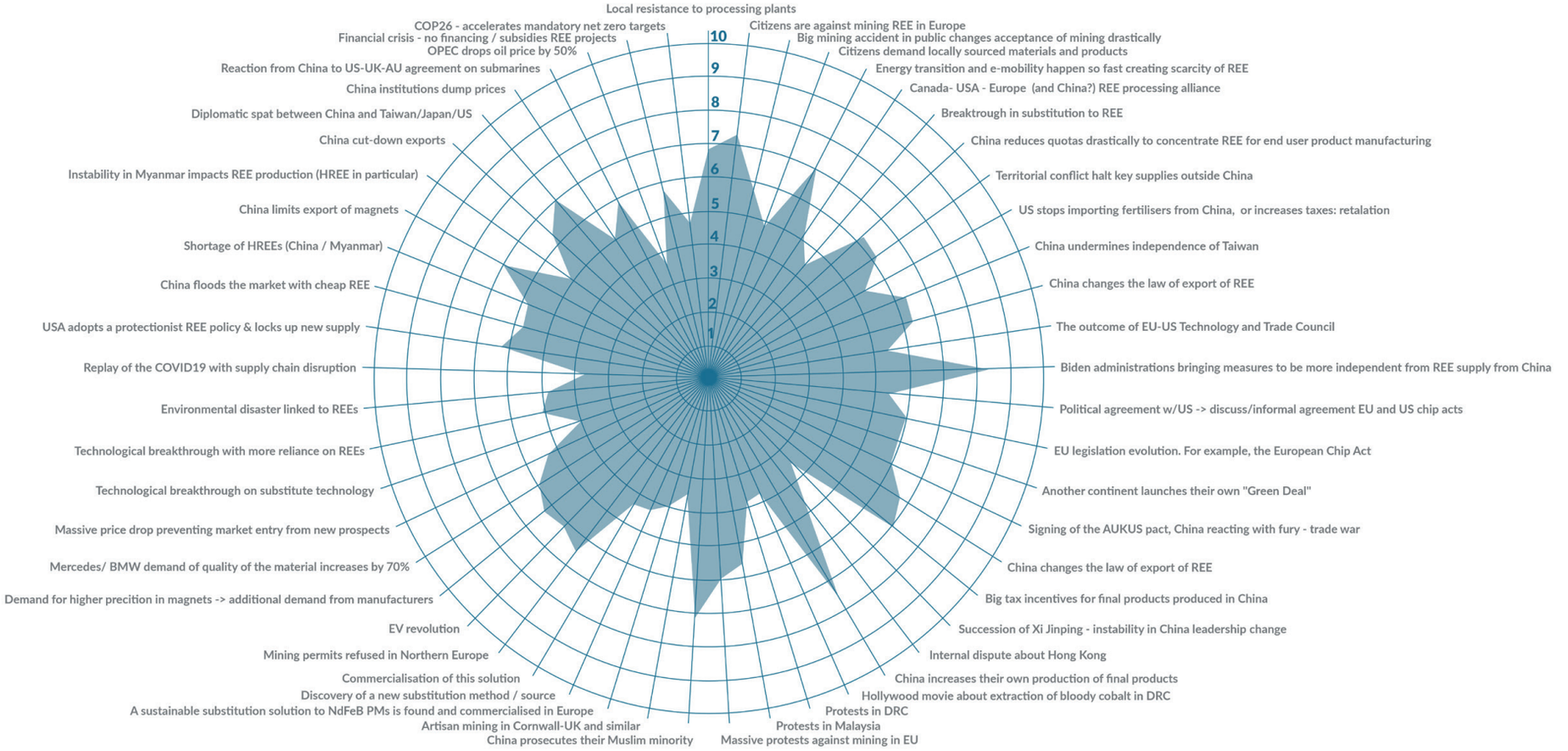
What could happen between now and 2026 that has an impact on REE supply and use in Europe?

The list of critical incidents identified was then further refined by an anonymous vote rating on a scale from 1 (low) to 10 (high) for each incident:
1. The **likelihood** of the incident happening in the next 5 years
2. The **impact** the incident would have on REE supply & use in Europe

The results of this co-creation and rating exercise resulted in the graphics below and show the richness of different views and inputs.

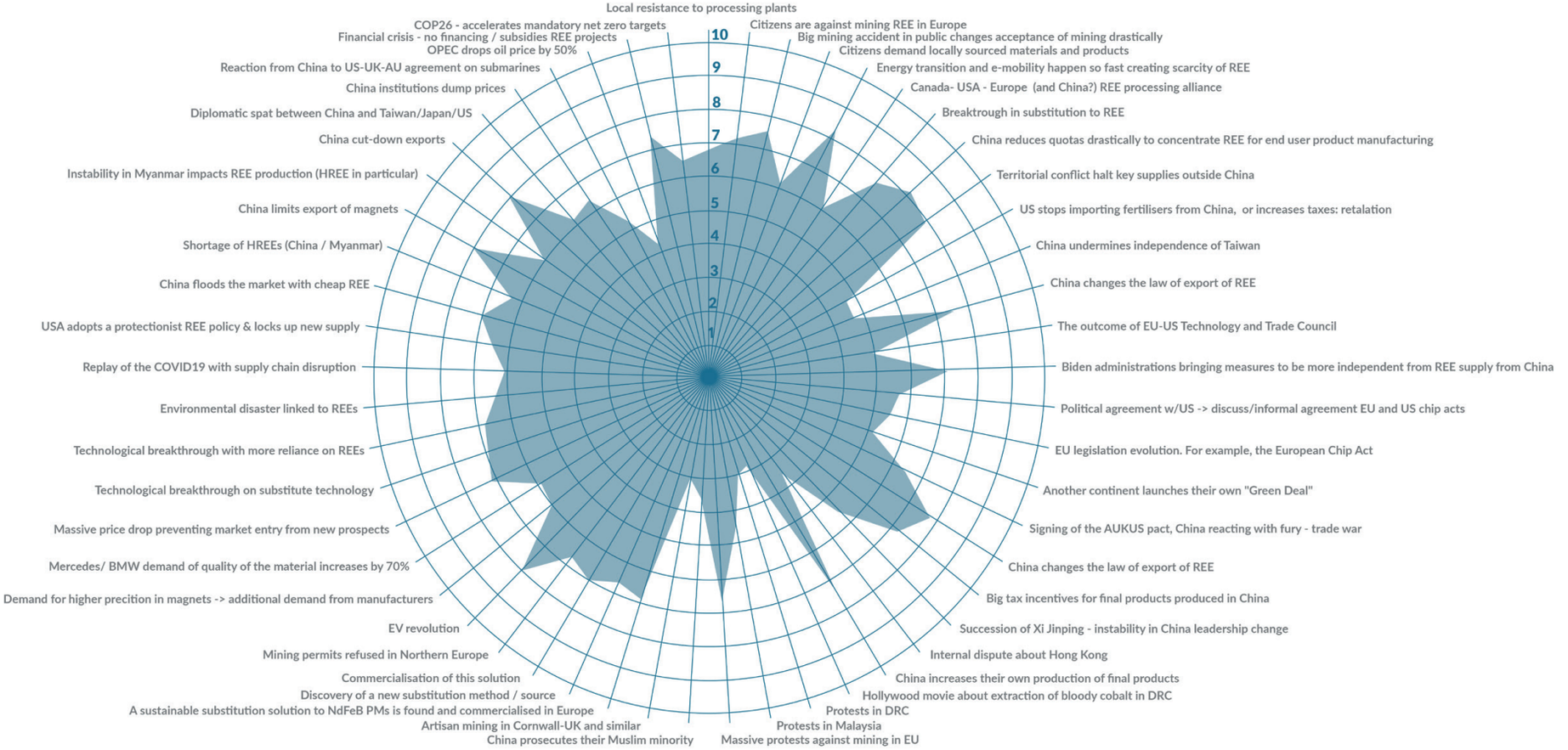
1st – Likelihood Spiderchart

This chart shows the results of the votes, in which participants were invited to rate the **likelihood** of each critical incident mentioned in the first part of the workshop, on a scale from 1 (low) to 10 (high).



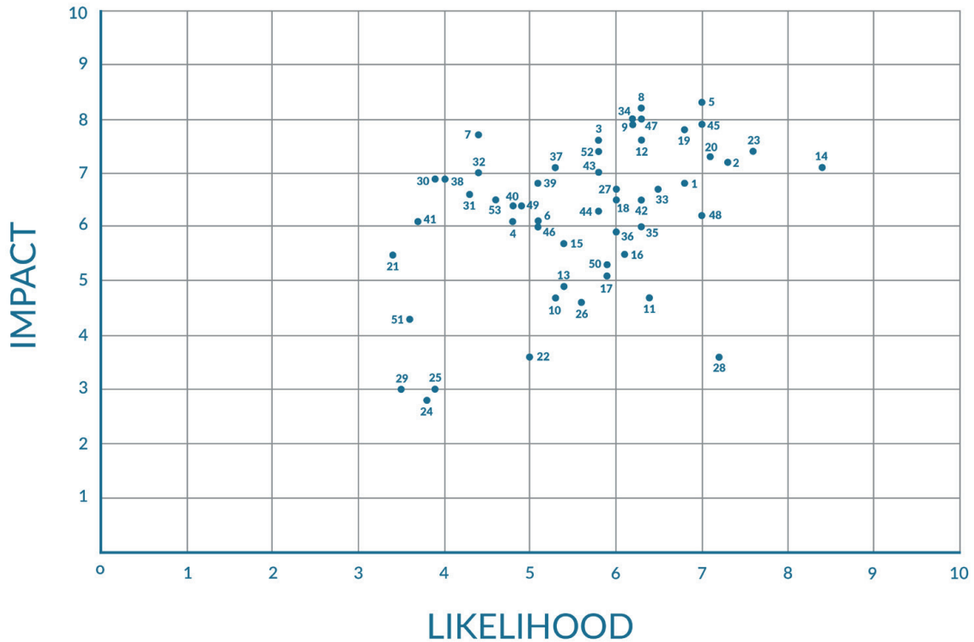
2nd – Impact Spiderchart

This chart shows the results of the votes, in which participants were invited to rate the impact of each critical incident mentioned in the first part of the workshop, on a scale from 1 (low) to 10 (high).



3rd – Heatmap in full

The overall results of the votes are compiled in this heatmap, highlighting the variety on critical incidents and their likelihood-impact ratio. This visualisation shows that, though some incidents might seem very likely, their impact is considered rather low and vice versa.

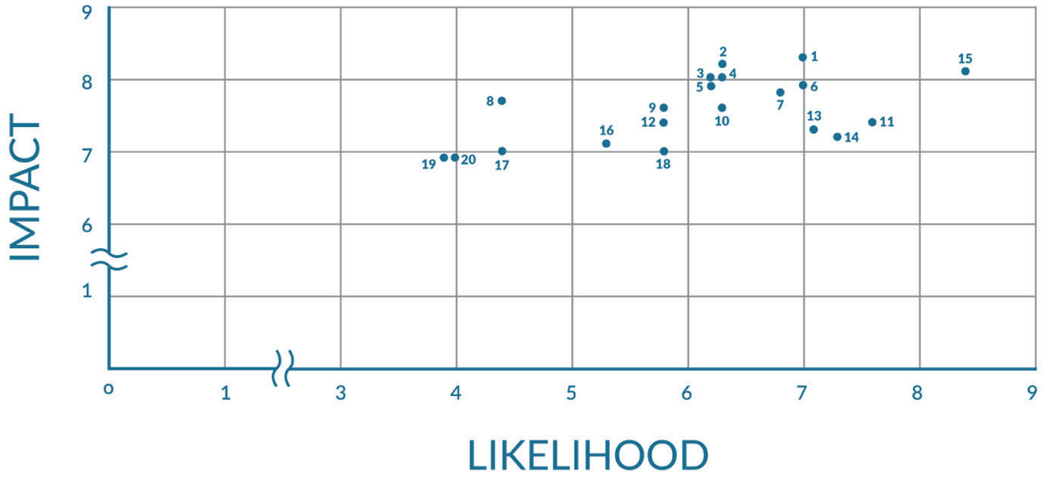


1 Local resistance to processing plants
2 Citizens are against mining REE in Europe
3 Big mining accident in public changes acceptance of mining drastically
4 Citizens demand locally sourced materials and products
5 Energy transition and e-mobility happen so fast creating scarcity of REE
6 Canada - USA - Europe (and China?) REE processing alliance
7 Breaktrough in substitution to REE
8 China reduces quotas drastically to concentrate REE for end user product manufacturing
9 Territorial conflict halt key supplies outside China
10 US stops importing fertilisers from China, or increases taxes: retalation
11 China undermines independence of Taiwan
12 China changes the law of export of REE
13 The outcome of EU-US Technology and Trade Council
14 Biden administrations bringing measures to be more independent from REE supply from China
15 Political agreement w/US -> discuss/informal agreement EU and US chip acts
16 EU legislation evolution. For example, the European Chip Act
17 Another continent launches their own "Green Deal"
18 Signing of the AUKUS pact, China reacting with fury - trade war
19 China changes the law of export of REE
20 Big tax incentives for final products produced in China
21 Succession of Xi Jiping - instability in China leadership change
22 Internal dispute about Hong Kong
23 China increases their own production of final products
24 Hollywood movie about extraction of bloody cobalt in DRC
25 Protests in DCR
26 Protests in Malaysia
27 Massive protests against mining in EU

28 China prosecutes their Muslim minority
29 Artisan mining in Cornwall-UK and similar.
30 A sustainable substitution solution to NdFeB PMs is found and commercialised in Europe
31 Discovery of a new substitution method/source
32 Commercialisation of this solution
33 Mining permits refused in Northern Europe
34 EV revolution
35 Demand for higher precition in magnets -> additional demand from manufacturers
36 Mercedes/BMW demand of quality of the material increases by 70%
37 Massive price drop preventing market entry from new prospects
38 Technological breakthrough on substitute technology
39 Technological breakthrough with more reliance on REEs
40 Environmental disaster linked to REEs
41 Replay of the COVID19 with supply chain disruption
42 USA adopts a protectionist REE policy & locks up new supply
43 China floods the market with cheap REE
44 Shortage of HREEs (China/Myanmar)
45 China limits export of magnets
46 Instability in Myanmar impacts REE production (HREE in particular)
47 China cut-down exports
48 Diplomatic spat between China and Taiwan/Japan/US
49 China institutions dump prices
50 Reaction from China to US-UK-AU agreement on submarines
51 OPEC drops oil price by 50%
52 Financial crisis - no financing/subsidies REE projects
53 COP26 - accelerates mandatory net zero targets

4th – Heatmap Top points

On this heatmap, you will see the critical incidents rated with the **highest likelihood-impact ratio**. Looking at the outcomes of the heatmap, participants were invited to select some critical incidents with high likelihood and high impact which they thought required further analysis and refining. These incidents were then further discussed, leading to the **four main critical incidents as detailed in the next pages**.



1 Energy transition and e-mobility happen so fast creating scarcity of REE
2 China reduces quotas drastically to concentrate REE for end user product manufacturing
3 EV revolution
4 China cut-down exports
5 Territorial conflict halt key supplies outside China
6 China limits export of magnets
7 China changes the law of export of REE
8 Breakthrough in substitution to REE
9 Big mining accident in public changes acceptance of mining drastically
10 China changes the law of export of REE
11 China increases their own production of final products
12 Financial crisis - no financing / subsidies REE projects
13 Big tax incentives for final products produced in China
14 Citizens are against mining REE in Europe
15 Biden administrations bringing measures to be more independent from REE supply from China
16 Massive price drop preventing market entry from new prospects
17 Commercialisation of this solution
18 China floods the market with cheap REE
19 A sustainable substitution solution to NdFeB PMs is found and commercialised in Europe
20 Technological breakthrough on substitute technology

Critical Incident 1

Transitioning to a carbon-neutral economy

Example 1: The energy transition and e-mobility happen so fast creating scarcity of REE

What does this look like?

The market is not able to deliver REEs for the energy transition and production of electric vehicles due to an **unexpectedly strong increase in demand**. In parallel, the global supply and production of REEs is ramping up too slowly to meet the demand.

What could lead to this?

Several events could lead to a stronger demand than anticipated:

- **Societal pressure:**
  - Rise in number of Green decision-makers in Europe, with more environmental regulations accelerating the transition to a carbon-neutral economy.
  - Rapid change in consumer behaviour, requesting more sustainably sourced products
- **Global warming** becomes an increasingly prominent narrative to act upon
- The energy and mobility transition is a promising **business case** for the European economy.

However, in parallel, adaptation to change could be difficult and slow, with difficulties to set up new manufacturing processes and getting permits (e.g. for mining), leading to resource scarcity.

Why is it so likely?

- There is **pressure for change** on all levels: social, economic trends but also natural forces.
- The attention on electromobility and the energy transition is much higher than attention on raw materials supply.
- **Establishing new mining capacities** is a complex and long process, which can take more than 5 years.
- The demand for REE in Europe is already rapidly growing right now.

Why is it so impactful?

- Scarcity leads to a need for **prioritisation** of some industries and applications over others. This could have a domino effect on other related services and industries.
- Risk of mass **redundancy** of existing strategic assets (e.g. in energy, defence, mobility) due to the lack of resources to replace them.
- This could also trigger increased efforts in **recycling and substituting.**
- Pressure to meet the demand could lead to **lower production standards** and **higher prices** (e.g. due to inflation or even social conflicts).
- There is a higher risk of **missing CO2 emission targets** of the EU Green Deal.

Example 2: The Electric Vehicle (EV) revolution

What does this look like?

Electric Vehicles (EVs) **turn into the norm**, becoming more **affordable** than combustion engines and eventually taking over the automotive market. Charging becomes as **easy** as filling in a fuel tank, with battery charges **lasting longer.** A threshold could be once the number of EVs sold reaches 50% of all new vehicles sales.

What could lead to this?

Many countries are already taking measures to ban combustion engines (UK 2030, NO 2025), and the EU Green Deal sets a target of 30 million EVs on European roads by 2030. Major car companies are progressively switching to EVs, **we are already at the start of the EV revolution**. Add to this the possibility of **differentiated taxation** between EVs and combustion engines, and the revolution would accelerate with EVs becoming cheaper.

Why is it so likely?

- There is a clear **political will** in Europe, with the EU Green Deal.
- Technological development and economy of scale, as well as incentives or simply economic viability pushes manufacturers in this direction. EVs are the future, **industries have to change to survive**.
- It is already becoming **easier and more convenient** for consumers to use EVs.
- The **car ownership model is changing** in general, with research on other aspects such as self-driving.

One development that could lower the likelihood of the EV revolution is the **hydrogen vehicle** alternative which is also gaining traction in parallel to EVs. It would be useful to evaluate the technological alternatives and their viability to avoid investing into something that may not function.

Why is it so impactful?

- EVs and generators require REEs: if the demand for EVs increases, so will the demand for REEs.
- EVs will require **green energy supply and infrastructure**, which also require REEs (e.g. wind turbines)
- REE-based technology currently makes electric cars more energy efficient.
- The transition will bring drastic changes to the economy, on a national/European but also individual level.

Critical Incident 2

Impact of Chinese export policies

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

What does this look like?

Two scenarios are foreseen:

- **Scenario 1** – China **deliberately** instructs its State-owned Enterprises to lower prices by a fixed percentage (for instance, with the China Northern Rare Earths Group setting a low price index).
- **Scenario 2** – China largely **overestimates the capacity of its domestic market** to absorb large amounts of REE-containing products, and processes much more REEs than their own internal market can integrate. This creates an overcapacity/overproduction in the country.

What could lead to this?

- The Chinese model is based on **fully integrated domestic value chains** "from cradle to grave". China is currently strengthening its magnet production capacities, with alloy and magnet production being particularly profitable. The value chains are led centrally, improving **capacity for control and leverage** in line with the 'Made in China 2025' strategy.
- China is moving **away from less environment-friendly practices** (for instance in mining) as a result of domestic pressures and lower profit at extraction stage. They are outsourcing extraction (for instance, heavy REEs in Myanmar) to focus on REE manufacturing.

Why is it so likely?

- Rare earths are a **diplomatic leverage** for China. The geopolitical situation increases the likelihood of a price drop as retaliation, with ongoing issues such as Taiwan or Hong Kong situations, treatment of Uyghur minority, 5G, the UK/US/AU submarine agreement…
- China has shown a high level of control over the years: the price of NdPr oxide has been historically very consistent, artificially maintained (40-45 USD per kg, though it recently rose to 100 USD per kg). Chinese companies would be able to survive such incidents, whether it is deliberately induced or not.

Why is it so impactful?

- European industries are already pressured by a severe "price risk", with Chinese products being highly competitive. In such situation, China's domestic industry would consolidate its monopoly but Western companies might not survive the competition. Market entry would be impossible for new prospects.
- Such incident would make European industries less profitable, comparatively less financed than their Chinese counterparts (if compared with export control), but also more dependent.

Example 2: China cuts down exports

What does this look like?

Chinese **economy and politics are deeply intertwined**, which means the government has a role to play on how companies are behaving. China could **limit exports** of either REEs or end-products containing REEs. The country could also choose to limit export for a particular industry (e.g. automotive industry). Another possibility could be to see China using **taxation** to protect their market: by increasing export taxes on REEs and limiting tax on finished products such as cars, they could increase the added value of products exported.

What could lead to this?

- Along the same lines as Europe, China requires an increasing amount of rare earths to meet the demand of industries such as energy, automobile or digital products. If a resource is becoming scarce, they will prioritise their industries and markets over exports.
- Many objects of tension between China and Europe could lead to worsening conflicts, encouraging China to make use of REE as a geopolitical leverage (see example 1).

Why is it so likely?

- China already used REE export as a **geopolitical tool** in the past, for instance in a diplomatic dispute with Japan after the 2010 Senkaku boat collision incident.
- China aims to develop or keep **control over full value chains**, from the mine to the final product.
- The “Made in China 2025” and “China Standards 2035” projects show a clear Chinese ambition to remain self-reliant and to prioritise their own needs over exports.

Why is it so impactful?

- REEs are omnipresent in European economy, including in strategic domains such as defence. Yet Europe is heavily relying on Chinese REEs (about **98% of REE needs in the EU is covered by Chinese imports**).
- European needs **for REEs will keep on increasing as the** transition to a carbon-neutral economy **is speeding up to reach the ambitions of the EU Green Deal. Europe also needs REEs as part of its** digitalisation strategy.

Critical Incident 3

Breakthrough in substitution of REE

What does this look like?

An alternative technology to rare earth direct drive machines could emerge: if its viability is showcased and independently verified, it could then rapidly arrive on the market through quick industrialisation programmes backed up by a market participant. Some alternative motor technologies could possibly become more competitive if the price implication of going REE-free proves beneficial.

In the longer run, less-price-sensitive industries (e.g. defence) could carry out large-scale awareness-raising campaigns for decision-makers on risks related to REE supply chains.

What could lead to this?

Some factors are enabling the occurrence of this critical incident, such as:

- the omnipresence of liberalism, especially in the West, which implies **open competition** on the market. This is a condition that cannot be centrally planned in a liberal economy, even on strategic markets.
- some **shorter-term policy perspectives** could also contribute to seek for a rapid alternative as developing domestic rare earths supplies can easily take more than 5 years.

In addition, some **geopolitical trigger events** could accelerate the development of substitute technologies by disrupting rare earths supply chain: for instance, unrest in Myanmar, flare-ups in the South China Sea, or potential trade war with China could rapidly increase the need for an alternative.

Why is it so likely? Why is it so impactful?

- The above-mentioned trigger events will have no impact on substitution technology if there is **no governmental support** for less price-sensitive sectors (e.g. defence).
- At the moment, there is still not enough evidence backing the technological performance of non-REE alternatives. But industries are facing raw materials constraints. With more evaluations and evidence, this critical incident could have a big impact.

Some actions suggested in the workshop:

- **Unified political decisions** are needed, possibly following some trigger events. This will require consensus-building among EU Member States, which could take time.
- Enabling alternatives requires **support**.
- There is a need for a **methodology and process** to evaluate and certify viability of substitute technology
- **Long-term planning** is needed for both EU governments and companies, to counter strategic disadvantages (e.g. compared to China)
- Some **short-term, tangible goals** can help **policymakers** move in the right direction.

Critical Incident 4

Citizens are against mining REE in Europe

What does this look like?

Mining is **perceived** negatively by the general public, with traditionally low willingness to accept mining project in their neighbourhood due to **assumed threats** (e.g. mining is loud, dirty, unhealthy, and leads to displacements). This is especially true if there are communities settled before the mine opens.

Some **real threats** such as environmental pollution (e.g. waterways) or radioactivity can also impact the public's opinion. Furthermore, REE are a "by-product" of mining: no mine opens for REE only so the main raw material mined (e.g. apatite) can induce other disturbances.

What could lead to this?

Many factors could explain an increasing need to find REEs in Europe:

- An increased demand of REE for the **energy transition** and **electrification of mobility** (see incident 1)
- Geopolitical context leading Europe to seek **more self-reliance and be less dependent on China** (see incident 2)
- **Fluctuation of prices** and **disturbances** on imported supplies of REEs

A soaring demand would mean trying to **(re)open mines in Europe**, leading to resistance partly due to **misinformation** or a **lack of knowledge** on the importance of critical raw materials. There could also be a **not-in-my-backyard effect**, with citizens wanting the benefits of end-products without the consequences of sourcing raw materials such as rare earths.

Why is it so likely?

- It happened in the past for other large infrastructure projects.
- Mass mobilisation of citizens and campaigning is easier in the digital era.
- Environmental regulations make it easier to stop new projects than a few decades ago.
- The general public is more environmentally aware but also more focused on their own quality of life than in the past.

Why is it so impactful?

- Resistance can stop operations and interrupt whole value chains.
- The price of REE would rise, and so would the price of end-products containing REEs.
- Alternatives or substitutes will need to be further researched, with no guarantee of being better options.
- All the expertise on REE mining would remain outside Europe, and so would the extraction activities.

Conclusion

Through discussion with fellow workshop participants, the exercise enabled stakeholders from different industries and background to share their vision for critical incidents which are likely to shape the future or European REE value chains in the short term. In this discussion, the incidents that were perceived as critical for the majority of participants were discussed, further refined and ranked, resulting in this Heatmap report.

According to this exercise, the main critical incidents that could influence European supply and use of REEs in the coming five years are mostly:

- Geopolitical
- Environmental
- Technological
- Social

Though it was not mentioned as clearly in top critical incidents of the heatmap, **the economic aspect** is also a common thread linking all four points above, influencing REE supply and use in the background.

SecREEts will make use of the last year of the project to explore these critical incidents further, contributing with other EU-funded projects and initiatives to **raising awareness** and discussing **needs and actions** to address points emerging from this workshop. The last Policy Council event of the SecREEts project is expected in spring 2022, with the objective to follow up on this foresight exercise, refine results as needed and explore **solutions** together.