SecREEts Citizen Lab

SecREEts

Secure European Critical Rare Earth Elements

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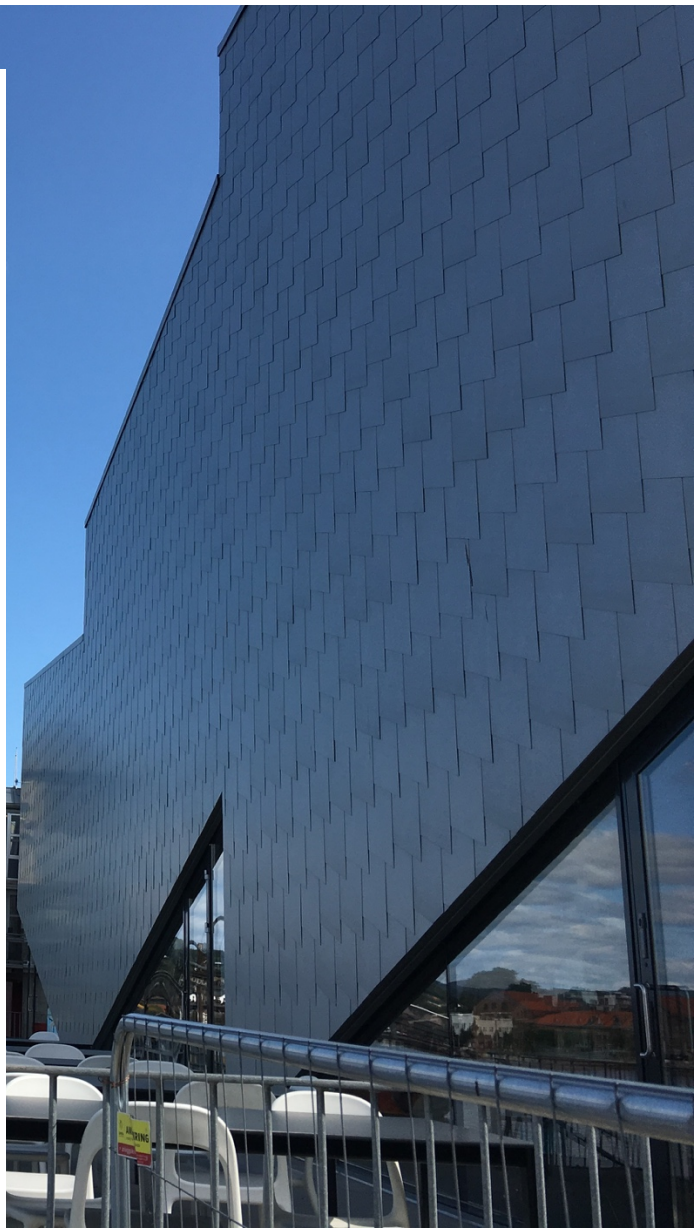

Porsgrunn, 21. August 2019.

Led by Prospex Institute
With REEtec, SINTEF, Vekst i Grenland, Yara.

Questions and Answers

How much REE is there in phosphorus stone? Is it expensive to do this process on phosphorus apatite compared to other deposits with higher concentration?

Yara's phosphate rock contains up to 1% REE which is not utilized today but ends up as part of the fertilizer. Here it has no function but does not do any harm, either. By extracting REE concentrate from a feedstock that has already been mined, prepared and shipped to Yara, the potential benefits are obvious. One of the objectives of SecREEts is to determine if Yara could extract the REE concentrate in a cost competitive way without any negative impacts on the fertilizer production.

What will be the by-products of SecREEts if any?

SecREEts will be utilizing the REE content in Yara's feedstock. This is a source that is not utilized today and the REE content is part of the fertilizer product. In SecREEts, a concentrate containing the REE will be extracted by Yara and sent to REEtec for separation. Excess material from the concentrate will be returned to Yara and will go back into their fertilizer production.

Is the project open for input from others, for example Fensfeltet?

In SecREEts, the idea is to separate the REE content from Yara's phosphate rock feedstock. But other raw materials will also be tested as part of the project. Material from Fensfeltet could then in principle be tested within the frames of the project.

Will equipment from the project be available for others after the project is finished?

REEtec has built and equipped an industrial scale demo-facility as part of the SecREEts project. The equipment is planned to be used as R&D test facility also after the SecREEts project is completed.

What's the economic potential of the new method developed in the SecREEts value chain?

There are some vulnerability in the pricing of rare earth elements and compounds so the numbers are not necessarily representing current trading prices, but the following numbers give a rough indication of the economic potential (https://price.metal.com/Rare-Earth). For the Nd/Pr mix, which goes directly to magnet production, the price is comparable to the Nd price (although Pr is priced higher, if separated from Nd). In the calculations, I have used 3000 tonnes of rare earths extracted at Yara, although this may vary depending on rare earth content in the phosphate rock. Using 15 % Nd and 5 % Dy in the mix (see numbers in next question), Yara has the potential to extract 600 tonnes of Nd/Pr. Using the prices in the price.metal.com, the value is about clos to 300 MNOK per year (30 M€). In addition, the value of 0.9 wt% Dy is in the range of 80 MNOK. Also, some RE can be offered as oxides, e.g. Gd oxide, accounting for about 2 wt% of the rare earth mix, or 60 tonnes at a market value in the range of 14 MNOK. Overall, the economic potential can be estimated to be in the range of 420 MNOK per year, based on the concentrate from Yara alone. In addition, both REEtec and LCM have the potential to add other sources.

What will be the market share of the SecREEts value chain if the project is successful?

Global production of rare earth elements is about 115 000 to 120 000 tonnes, although the real number may be somewhat higher since the illegal production in China is not readily quantified. If only the Yara plant in Porsgrunn is considered (neglecting the potential of other plants using the nitrophosphate route), the estimated production will be in the range of 3 000 tonnes depending on the average content of rare earth elements in the 650 000 tonnes of phosphate rock (apatite) converted. For igneous apatite the typical REE level is between 0.3 to 0.9 %, but we do not expect to be able to reach the higher value in average. Cerium, the most common rare earth element may not be extracted from the fertiliser production due to the low value caused by a market surplus.

If imported consumer products manufactured outside Europe (mainly in Asia) is excluded, the total import of rare earth metals to Europe is about 4 % of the global production, i.e. between 4 and 5 000 tonnes, while the total import including chemical compounds are closer to 11 – 12 000 tonnes. Since the major metal elements imported are Nd and Pr, and these typically represents about 11-17 % and 4-7 %, respectively, of the total rare earth content in apatite, Yara has the potential to extract around 600 tonnes of these metals, representing a European market share around 15 %.

Why not focus on recycling in the project? Could re-circulation of the product be considered in the future?

One of the major European projects focusing on recycling of rare earth elements is REE4EU. This project ends in the fall of 2019. This project has demonstrated recovery of rare earth elements from several European end of life products. Currently, no industrial recycling has been established as a result of this project, but SecREEts will benefit from several of the activities done in that project. Both REEtec and LCM can add recycled products to their processes. REEtec can separate RE concentrates, while LCM can take Nd/Pr and Dy oxides, either purified at REEtec or sourced from others. Recycling in the Yara process is believed to be less attractive due to feed restriction in the fertiliser process.

Why is the ore in Norway so interesting? Is Norway especially rich/effective in processing REE?

Currently, Norway has no phosphate mining suited for fertiliser production. All sourced phosphate rock (apatite) comes from other sources, the Yara mine in Finland being the only European source if Russia is excluded. Norway, have, however, sources high in rare earth elements and has a potential for future mining of rare earth elements. The reason Norway is very attractive in the current project is that Yara has previous competence from extracting rare earth concentrate from their phosphate fertiliser production. In addition, the nitrophosphate route at Yara is much better suited for rare earth recovery than the mixed acid route used in most other plants (about 85 % of the phosphate fertiliser production).

Have there been any negative effects (eg. on equipment, environment etc) of the SecREEts process, especially in Porsgrunn?

The SecREEts consortium counts among its members two partners studying industrial risks, economic and environmental impact of the whole SecREEts value chain. Quantis, based in Switzerland, is in charge of conducting a full Life Cycle Assessment (LCA) of the SecREEts process, including the pilots at Yara and REEtec. The LCA method quantifies the impact of SecREEts taking into account various indicators related to:

- The environment (freshwater and marine impact, ecotoxicity, air quality, land occupation…)
- Human health (toxicity, particulate matters…)
- Resource depletion (energy use, material extraction…)

Quantis is gathering data related to raw materials, capital equipment, transport, energy consumption, emissions to air/water/soil, waste etc… Data collection, along with the

definition of the goals and scope of the LCA, are the most important and delicate part of Quantis' work in SecREEts.

In addition, the French Institute National de l'Environnement Industriel et des Risques (INERIS) is independently controlling safety compliance of all the SecREEts pilots developed in the different locations of the project, including in Herøya. Industrial partners are required to prepare risk assessment of their pilots, taking into account all steps of its functioning cycle (including material storage, equipment and manipulation). INERIS also reviews relevant national and international regulations to assess the compliance of all pilots and evaluate their risk assessment. Should INERIS notice a breach, they will direct the relevant industrial partner to Best Available Technologies (BATs) recommendations approved by legislators.

Quantis and INERIS are working together to assess the full impact of SecREEts' manufacturing processes on the local environment and local communities at the pilot sites. However, these studies are ongoing and results are not available yet as the project is still at an early stage.