SecREEts Citizen Lab – Questions & Answers

Ellesmere Port, 14th January 2019

1. SecREEts Technology

- ***Is there a possibility to use other sources than phosphate? Can REEs be extracted and used for other goals?***

REEtec is a partner in SecREEts based at the Herøya Industrial Park, in Porsgrunn, Norway. They have developed a new extraction process of high purity Rare Earth Elements (REE). In the context of SecREEts, their pilot is used to extract Praseodymium, Neodymium and Dyprosimium, from a nitrophosphate solution, and turn them into high purity oxides for LCM to manufacture. However, their separation process can, in principle, use all types of REE raw materials, also from recycled materials, for different areas of application which is one of the strengths of REEtec's technology.

- ***Is the project happening all in one place and how is it different from China?***

The SecREEts project gathers a consortium of European partners, with industrial pilot sites located in Norway, the UK, and Germany. This European extraction process is different from traditional Chinese REE extraction and manufacturing process under many aspects. Most extractions of minerals are based on the following (major) steps: Mining – ore dressing – separation – manufacturing.

Mining and ore dressing:
The Chinese production of Rare Earth Elements is based on mining rare earth rich mineral resources while the SecREEts project is based on established mining of phosphate rocks for fertilisers. As in most mining, there is the rich ore and the gangue (the worthless materials) removed during ore dressing (processing of the ores). The ore dressing usually involves crushing and separation (often floatation using solutions with adequate density), normally producing a wet slime or slurry that is deposited. Environmental regulations may dictate how well this residue is handled. In general, the gangue fraction is higher in mining of rare earth deposits than phosphate for fertilisers, and, on a general basis, **the environmental standards in the western countries are much stricter than in China**. Severe pollution has been reported in Chinese mining sites (see e.g.: http://www.bbc.com/future/story/20150402-the-worst-place-on-earth).

Separation:
The traditional separation method for Rare Earth Elements is made through a process called solvent-solvent extraction. In short, this means that the mineral is digested (dissolved) in an acid (aqueous solution). This acid solution is mixed with an organic solution (almost similar to diesel fuel used in cars) mixed with an organic extractant that binds to the REE(s). After settling (separation of the water and the organic phase), the organic phase is remixed with a new acid phase to strip the rare earth element out of the organic solution. Hence, an extraction plant consists of several extraction tanks were the aqueous phase and the organic phase are flowing counter current through several tanks to effectively extract the valuable elements out of the aqueous solution. The same is the case with the stripping part, except now the valuable

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elements are extracted to a new aqueous phase. Since REEs are difficult to separate due to their inherent chemical similarities, a solvent extraction plant consist of many extraction-stripping units, often comprising several hundred tanks. Solvent extraction plants generate hazardous organic sludge as well as diesel vapours to the environment. Again, environmental standards are not necessarily the same in all countries. In the SecREEts process, REEs are extracted from an existing phosphate fertiliser process. The intermediate step for extracting REEs from the fertiliser process uses the same chemicals adopted for precipitating the digested (dissolved) phosphate rock. **This means that there is no pollution related to the extraction and no discharge of harmful chemicals**. Instead of using solvent-solvent extraction, the rare earth concentrate coming from the fertiliser is separated into individual elements in a novel chromatographic method. The rare earths in the aqueous solution from the fertiliser are separated in one pass without producing any side streams or harmful discharges.

Manufacturing:
REEs are mainly produced by two routes, electrowinning or calciothermic reduction. Calciothermic reduction uses calcium metal to react with the rare earth oxide, producing a rare earth metal and calcium oxide. This is mainly used for the heavy REEs with melting points well above 1000 °C and is not relevant for the extraction of the magnet elements in the SecREEts project. All electrowinning of rare earth metals are fundamentally the same; the rare earth oxide is dissolved in a fluoride melt at around 1000 – 1100 °C and a direct current is passed through the melt (electrolyte) from an anode to a cathode causing a cathode reaction that produce the metal and an anode reaction producing CO gas (the anode is made of carbon that is consumed in the anode reaction). In principle, CO is the only gas released in the production of REEs. However, depending on process control and operations, secondary reactions may take place. HF (hydrogen fluoride), formed from contact between the fluoride electrolyte and moisture or humidity in the oxide feed, is also well known from aluminium production. HF is quite easy to capture and the release to the environment is minimal. CF_4 (carbon tetrafluoride) can be produced on the anode if the electrolyte is depleted in oxide. CF_4 is a gas with a high global warming potential and is hard to capture or destroy. Good control of the oxide feed to the electrolysis cell is essential to avoid the formation of CF_4. Much of the Chinese production is in cells with no monitoring or capture of harmful gases. Process control measures are also very limited, usually only by visual control. SecREEts aim at establishing electrolysis technology that by far surpass most production cells in China. This is also necessary since European environmental standards are very strict. In addition, European standards for staff safety and exposure limits are much stricter than in China, in spite of gradually improving Chinese standards.

In conclusion, the SecREEts concept is cost-effective and, by far, more environmentally friendly in all production steps compared to most of the rare earth production globally. To be fair, it is, however, necessary to point out that there are some other production of REEs that are operated according to high environmental and production standards.

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2. Environmental impact, Health & Safety

- ***What is the plan for environmental impact assessment? Does it include transport? Have there been planning applications, particularly for materials?***

Within the framework of the SecREEts project, our partner Quantis will perform a Life Cycle Assessment (LCA) in order to determine LCM's pilot environmental impact. The LCA method quantifies the environmental impact across the whole supply chain of a product or a service on a broad variety of indicators. Climate change is one of them but LCA also accounts for various other impacts:

· on the environment (such as freshwater and marine eutrophication, ecotoxicity, acidification, land occupation etc.),
· on human health (human toxicity, particulate matters, ozone layer depletion etc.) and,
· on resources depletion (mineral extraction, non-renewable energy etc.).

The environmental impact assessment methods Quantis uses in SecREEts are in line with EU requirements.

The supply chain of LCM's pilot will be considered as far as data availability allows it. The data which will be gathered concern: any raw material (chemicals, water, packaging), capital equipment, transports, energy consumption (heat and electricity), emissions to air, water and soils and finally any sort of waste which requires treatment.

The official goal and scope will be defined in Quantis SecREEts deliverable 1 (Framework of the sustainability and risk assessment), which they are working on at the moment by starting to understand each partner's supply chain and data availability. Once this is defined and all intellectual property issues are solved, they will start with a data collection, followed by the modelling using an LCA software which will give the results of the impact assessment.

Goal and scope definition together with data collection are the most important and delicate part of Quantis' work. Many factors can influence what is considered in their study and they will discover that as well as any other challenges all along discussions with the partners.

- ***Is the project adding to the local traffic? Are we getting notification locally? Is it necessary to or has it been planned to have a limit on road planning?***

Considering that the SecREEts project is at a demonstration pilot phase, LCM does not expect the project to have any impact on the local traffic as the quantity of material transported will be minimal. After the end of the project, in the event of an upscaling, LCM will be required to make plans accordingly should there be a significant increase in the quantity of material transported.

- ***Health & Safety – what are the steps needed with these new processes? Are LCM's manufacturing processes having an impact on the everyday life of the local community?***

When developing a new pilot or a new technology, there is a number of European and national rules industries must follow to ensure safety for workers and for the local environment (including local residents). Within the framework of the SecREEts project, our partner INERIS

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(French Institut National de l'Environnement Industriel et des Risques) will independently control safety compliance of the SecREEts pilots developed in the different locations of the project, including in Ellesmere Port with Less Common Metals.

Firstly, LCM, just like every other SecREEts industrial partners, must prepare a risk assessment of the new pilot taking into account all aspects of the functioning of the pilot from material storage to manipulation. In the meantime, INERIS will conduct a review of relevant regulations. On this basis, they will assess the compliance of the pilot at LCM and evaluate their risk assessment. If INERIS notices a breach, they will provide recommendations based on BATs (Best Available Technologies) approved by legislators.

In the event of a post-SecREEts upscaling of the pilot, further safety studies will have to be conducted to comply with regulations, and a building permit might be necessary, along with local consultations.

INERIS and Quantis will work together to answer this question by defining the impact of LCM's manufacturing processes on the local environment, and the local community. It is however difficult to provide an answer now as they are currently working on the pilots of our partners Yara and REEtec in Norway, who are placed before LCM in the SecREEts value chain (Yara and REEtec work on REE extraction whereas LCM will work on REE manufacturing).

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3. Public Engagement

- ***Who have you tried to engage with so far? What do you hope to achieve through consultation? What is your communications & engagement plan?***

Prospex Institute is responsible for public engagement as part of the SecREEts project. Their goal is to bring industrial partners, public authorities and members of the civil society together to ensure each stakeholder is given the opportunity to play an active role in the development of SecREEts.

SecREEts stakeholder engagement consists of two strategies. The first strategic elements are known as **Citizen Labs**. These are interactive consultations designed to identify relevant organisations, media, or public actors locally and enable communication with SecREEts industrial partners. Citizen Labs are an opportunity for the local community to raise concerns or highlight opportunities. Prospex Institute uses them as a basis for co-creation by implementing local stakeholders' feedback into follow-up engagement activities. In other words, what was suggested and discussed by participants in the first Ellesmere Port Citizen Lab will help LCM and Prospex Institute design next steps for public engagement in the Cheshire area, by contacting relevant stakeholders and organising other activities along with yearly Citizen Labs to keep the local community involved in the discussions throughout the project. A similar process will be implemented in Porsgrunn, Norway, with local industrial partners.

The second engagement strategy is the **Policy Council**, a yearly forum gathering business representatives and policy experts at a European level to discuss issues relevant to SecREEts, such as social acceptance, security and sustainability of supply, environmental standards… This event will also imply a number of side activities, including engagement with other EU-funded projects in the field of European REE extraction and manufacturing, or participation in related conferences and high-level panels. By proactively engaging with these stakeholders, SecREEts partners will be able to share knowledge, experience and insights to best move forward with the project.

- ***Ellesmere Port is a town that strongly relates to the industries, there are programmes of education with local schools (STEM) – is there a plan to engage with the kids and keep schools in the loop?***

As explained in the above response, Prospex Institute and LCM design SecREEts local public engagement strategy in Ellesmere Port based on feedback received through the Citizen Lab and follow-up comments. During the Citizen Lab on 14th of January 2019, it was suggested several times that youth education was an important engagement factor for the local community. As a response, Prospex Institute has started contacting STEM education organisations in Chester to follow-up on this suggestion. The Cheshire West and Chester Council has also shown interest in organising activities with schools and industries locally.

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