

SecREEs Workshop



SecREEs

Secure European Critical Rare Earth Elements



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



CITIZEN LAB – BUSINESS COMMUNITY

Online, 16 June 2021 - Morning

Led by Prospex Institute
With Vacuumschmelze



About SecREEs

SecREEs 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. SecREEs 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 SecREEs is to set up a new integrated European value chain for extraction, refining and production of REEs.

SecREEs 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 asbl – Belgium

Please find all relevant information and latest updates on the project website:

www.secreets.eu

Citizen Engagement in SecREEs

As part of the SecREEs Public Engagement strategy, Prospex Institute organises regular Citizen Labs, to engage local communities in areas where industrial partners are established. However, considering that Vacuumschmelze (VAC) has established a magnet production in Hanau for many years, it has been decided to use this opportunity to engage directly with the business community instead. VAC has therefore identified and invited business partners, as well as current, potential and past customers to introduce SecREEs and discuss the business community's views on the project's value chain.

Together with LCM, REEtec and Quantis, Prospex Institute and VAC introduced the latest updates on SecREEs to a group of business stakeholders. The project team used presentations, interviews, polls and Q&A to help participants understand activities carried out in the project and discuss the potential for the new value chain to address some of the current challenges of the permanent magnet market in Europe.

In accordance with the EU General Data Protection Regulation, participants were requested to fill in a registration form online ahead of the event, with personal information and consent for the processing of their personal data as part of the organisation and reporting of the activity. A recording of the meeting was performed for internal purposes only. To protect participants, the meeting applied safe-house rules and gave participants the possibility to interact anonymously with the panellists, using the dedicated function in ZOOM Webinar.

Discussions

1 – Welcome and introductions

After welcoming participants to the session, Marc Gramberger from Prospex Institute (PI), and lead moderator of the session, provided an overview of the house rules for this session, as well as the agenda. To protect the anonymity of the participants in a business context, Marc Gramberger invited everyone in the meeting to apply safe-house rules (no statement can be publicly linked to a person or organisation on any public platform). Participants were also given the option to ask questions anonymously.

Bernd Schleede, Head of Permanent Magnets at Vacuumschmelze (VAC), welcomed participants and gave a brief introduction to VAC and the question of raw material supply in permanent magnet production. Miro Prek from Prospex Institute, and second moderator for the session, proceeded to an ice-breaker exercise, with two word cloud questions on the anonymous polling tool Wooclap. Here were the outcomes:

In 1 or 2 words, what advantages do you think a European supply of rare earth elements would have for your industry compared to existing non-European supply (all else equal)?



In 1 or 2 words, what do you think could be challenges for your industry to adopt a European supply of rare earth elements?



2 – Learning about the SecREEs project – *with Clara Boissenin, Propsex Institute*

Clara Boissenin from Propsex Institute, and in charge of public engagement in SecREEs, introduced participants to the SecREEs project on behalf of the project coordinator, Dr. Arne Petter Ratvik from SINTEF. The slides from her presentation are available below:

Participants



-  **SINTEF** ■ SINTEF AS – Norway. Coordinator
-  **YARA** ■ Yara International ASA – Norway
-  **LCM** ■ LESS COMMON METALS LIMITED - United Kingdom
less common metals
-  **REEtEC** ■ REETEC AS - Norway
-  **Quantis** ■ QUANTIS - Switzerland
-  **VAC** ■ VACUUMSCHMELZE GMBH & CO KG - Germany
VACUUMSCHMELZE
-  **PROSPEX** ■ PROSPEX INSTITUTE - Belgium
PROSPEX
-  **INERIS** ■ INSTITUT NATIONAL DE L'ENVIRONNEMENT ET DES RISQUES (INERIS) - France



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Secure European Critical Rare Earth Elements



- Rare earths are critical elements with high importance for European industries
- 100 % import dependency in EU
- Cessation in EU supply will jeopardise production of advanced products, with a negative impact on jobs, society and the well-being of citizens



- SecREEs provides part of the solution

http://ec.europa.eu/growth/sectors/raw-materials/specific-interest/critical_nl
Average 2010-2014



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Secure European Critical Rare Earth Elements - Goal and Objectives



- Establish stable and secure supply of critical REEs
- Based on sustainable extraction from apatite used in fertiliser production
- Pilot processes based on innovative extraction, separation and transformation of REEs
 - Focus on Pr, Nd and Dy metals used in permanent magnets
 - Replication potentials of other REEs - medical diagnostics, fluid catalytic cracking (FCC) and consumer products (LCD and LED screens)



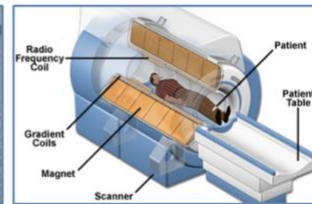
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Rare Earth Magnets – Why Important?



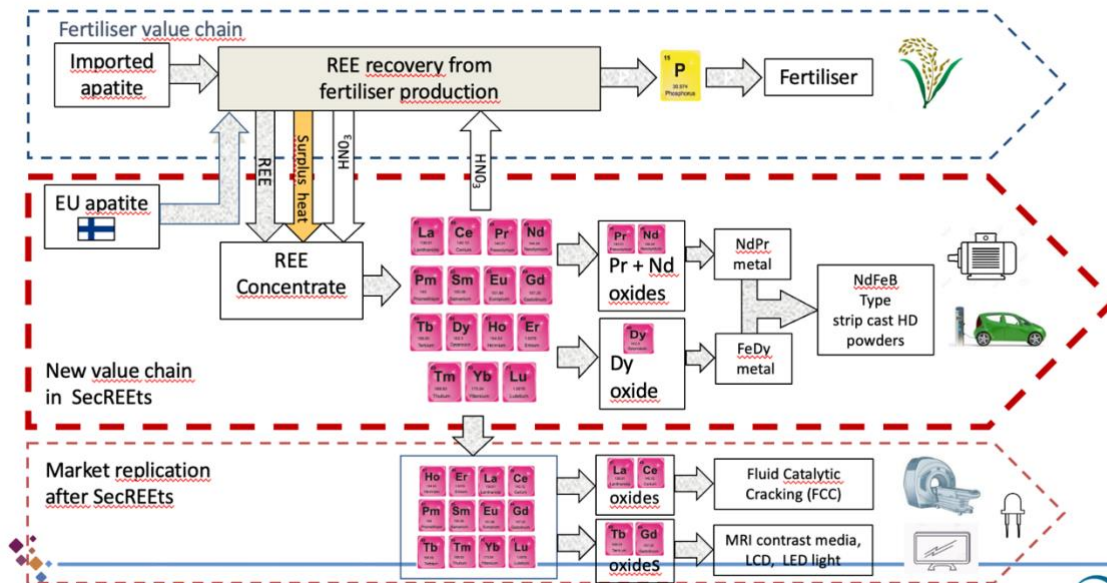
- Big Motors/Generators – Wind turbines, Ship and Train, Paper Machines, Elevators
- Automotive - Solenoids/Valves, Sensors (ESP), Power Steering, Hybrid/E-drive Motor Generator, Electrical Auxiliary Motors (water pump, van, fuel pump, etc)
- Industrial Motors/Generators - Servo drives/Torque motors, Linear drives, Micro motors
- Medical and Science - MRI assemblies, Special Motors (dental, surgery, ...), NMR, Mass Spectrometers, Precision Balances



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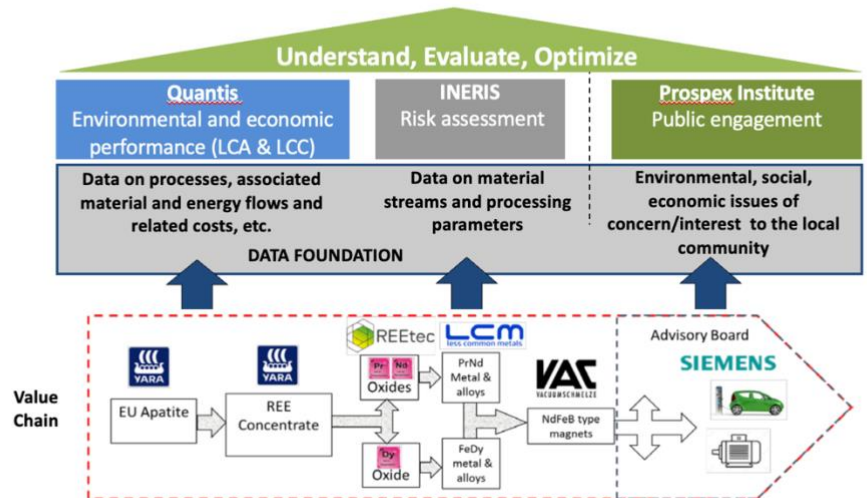
Our Concept



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Sustainability and Risk, and Public Engagement



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3 – Presentation of VAC's role and interest in SecREEs – with Christoph Brombacher from Vacuumschmelze

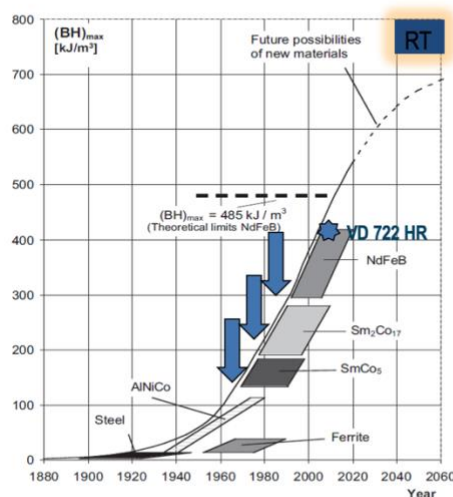
Christoph Brombacher from Vacuumschmelze (VAC) gave a presentation on their interest role in the SecREEs project. His presentation is available below:

History of Permanent Magnets

- 1966: SmCo_5 *
- 1970s: $\text{Sm}_2\text{Co}_{17}$ *
- 1984: $\text{Nd}_2\text{Fe}_{14}\text{B}$ **
- Rapid industrialization
- RE – magnets with $(BH)_{\text{max}} = 415 \text{ kJ/m}^3$
- $(BH)_{\text{max}}$ four times larger than AlNiCo

* K.J. Strnat, *Ferromagnetic Materials* 4, 131 (1988)

** M. Sagawa et al., *JAP* 55, 2083 (1984)



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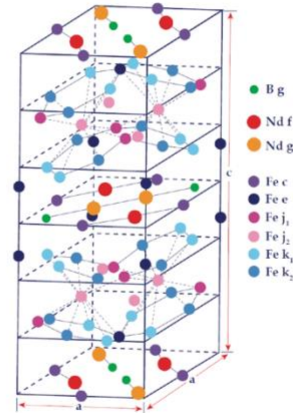
VACODYM



- VACODYM consists of a $\text{RE}_2\text{-Fe}_{14}\text{-B}$ main phase



- RE elements for magnetic anisotropy
- Fe for high remanent magnetization
- VAC has a stable supply chain for raw materials
- Diversified supply chain with better ecological footprint



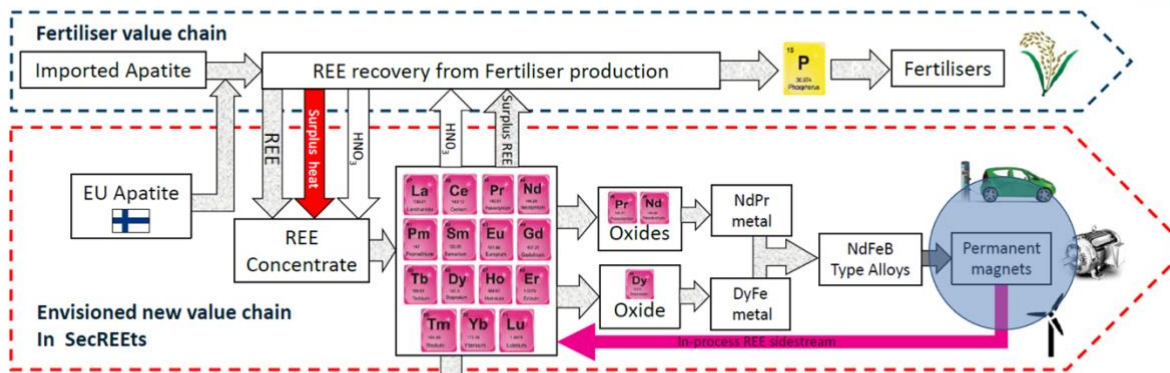
J.F. Herbst et al. Phys. Rev. B **29** 4176-4178 (1984)



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Role of VAC within SecREEs



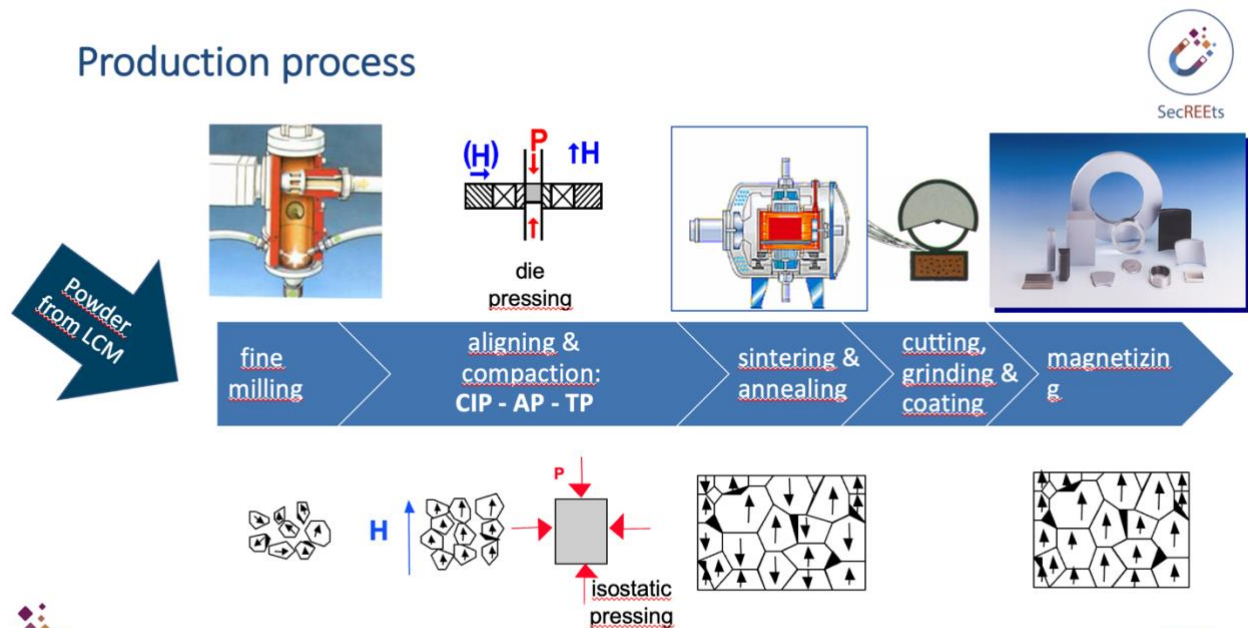
- VAC uses the alloy from LCM to manufacture VACODYM magnets
- VAC provides grinding sludge for recycling



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Production process



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Qualification of LCM material

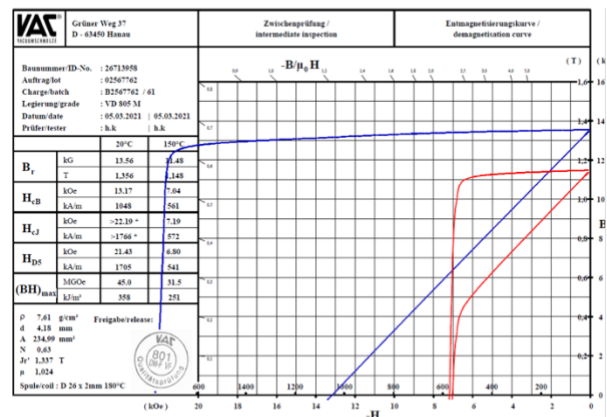


Conventional production process

Qualification of HD powder from LCM

- ✓ $B_{r,min} = 1,35 \text{ T}$
- ✓ $H_{cJ,min} = 21 \text{ kOe}$

Properties of VD 805 TP achieved

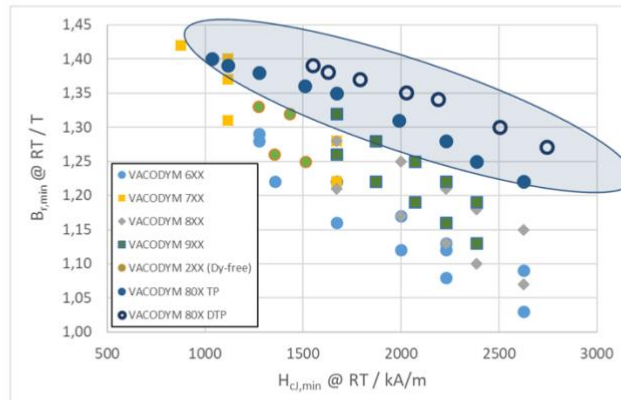


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VD 80X TP from European alloy production

VD 80X TP/DTP
fine grain size
Oxygen free process
European alloy production



- New VD 80X alloy family designed for European based supply chain



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Recycling



- Grinding sludge contains precious elements such as Nd, Dy, Tb, Sm and Co



- RE-Oxide from upcycled grinding sludge has been transferred to REEtec for separation



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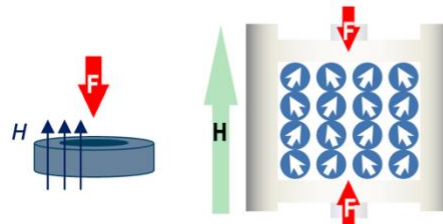


Recycling



- Near net shape production

- ✓ small near net shape magnets
- ✓ pressing with high stroke rates
- ✓ degree of alignment: 91% - 96%
- ✓ high reproducibility
- ✓ **yield > 90%**



- VAC has a raw material efficient production process of VACODYM and VACOMAX
- Recycling of grinding sludge further minimizes waste



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Summary



- Stable supply of RE elements is important for high performance magnet production
- SecREEs project has the potential to establish an eco-friendly supply of RE elements from all European partners
- VAC has introduced VD 80X TP magnet grades especially designed for a European alloy production
- Recycling of grinding sludge will further enhance the raw material efficiency



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The presentation was followed by a Q&A session. The exchange is transcribed below:

Q – What will make a customer like myself change my mind about the transition from cheap magnets or cheap parts in my car, knowing that they come from China to something that is more expensive but is more sustainable?

A – An electric vehicle with an average electric motor, would have a maximum of 2 kg of NdFeb magnets in it and the price gap in sourcing these magnets is in the range of 30 to 40 Euro/kg, hence less than 100 Euros in purchasing price to change over from the Chinese magnets towards sustainable magnets. If we display it in this way, it should be easy for the end-user to decide. However, each part of the car needs to be evaluated in this way. We have to do a lot of promotion in this direction and to try to get the end-users involved, to know that they are willing to pay, for example 200 Euros more for a car using European raw material.

Q – You have explained that the supply or the raw materials come from YARA and the scalability. Could you please say something more about that?

A – The amount of powder we have foreseen from LCM is significant and already in the production scale, hence there will be no problem with scalability with our process. However, this powder that we have received from LCM is not completely from European RE material, because the plants in Norway are not yet ready to provide this significant amount, but hopefully by the end of 2021 we will have sufficient supply of RE to prove that the European RE could work on production volume.

Q – Is there any calendar for this project?

A – Yes, the project will go for another one and a half year and if we manage to build up a business case that we can build a pilot plant by the end of project, then we have done a good job.

Q – What about Cobalt? Is that something that it could be included?

A – Cobalt is not of any concern right now, much of it comes from Central African sources, and it is not rare, it is easily accessible in the public markets in Europe. Cobalt occurs in some Iron Boron alloys in relatively small amounts. All the alloys which LCM supplies use Cobalt from fully sustainable sources and LCM is a signed-up member to CIRAF which is the Cobalt institute responsible assessment framework, ensuring that

all the unacceptable aspects associated with Cobalt, particularly from the Democratic Republic of Congo are addressed. LCM uses exclusively ethically sourced Cobalt.

4 – Upstream SecREEs value chain – *with David O’Brock (REEttec) and Ian Higgins (LCM)*

Marc Gramberger introduced David O’Brock, Commercial Director of REEttec and Ian Higgins, Managing Director of Less Common Metals (LCM). They were both interviewed by Marc Gramberger:

Q– Could you please shortly introduce REEttec and LCM, and their role in SecREEs?

A– REEttec is a company in Norway that started in 2008 and came up with an innovative technology to separate the RE from each other. To get a mixed RE is not extremely difficult but it is challenging to take the different 15 elements and separate them from each other efficiently to get a pure elemental oxide. Currently around the world the common method to do this is solvent extraction and it is quite efficient, but it is not economically and ecologically friendly, and we came up with our own method. We are not looking only at one feed stock but also from the circular economy, for instance what VAC considers waste we would consider raw material for raw, pure virgin element for them to use again. We also see end-of-life magnets as a good opportunity.

A– LCM was founded in 1992. However, rare earth processing in Northwest England dates back to the 1960s with Johnson Matthey Rare Earth Products. Several members of staff, together with expertise and equipment transferred to LCM following the closure of Johnson Matthey Rare Earth Products in 2001. We do the two stages between REEttec and VAC. We take the separated oxides and convert to metals and then we take those metals and do the alloy. The metal making process is the same technology as it is used globally for making aluminium, but the technology is applied to RE. For the RE the process has been developed almost exclusively in China with the exception of LCM. A lot of the processing in China has been traditionally carried out with less than acceptable regards to the environmental health and safety stewardship and this is one of the main aspects of the process we do at LCM, not just to comply to the local health and safety and environmental requirements but to improve this process as far it is possible. We have great focus on instrumentation, on automation, measurement, and control of emissions. Regarding the alloys’ side of life, the four important characteristics of the raw material are: the chemical composition must be very precise, low levels of impurities, good reproducibility, and specific microstructures.

The floor was then open for questions:

Q – In SecREEs, LCM delivers the alloys to VAC and needs to observe certain standards. Have there been any quality issues that you came across and, if yes, how did you solve that?

A – So far there have been very few issues. We are operating through a Robust Qualitative Assurance system, which means we are controlling all our raw materials for specifications, we also control our processes through a detailed operating instruction, procedures, training of personnel and our partner VAC has put very detailed specifications on us regarding the properties which are important for them to make magnets. Everything is specified, from the chemical composition to the levels of impurity we are permitted to have in the alloys and specific requirements on the microstructure.

Q- How does LCM tests the quality of the material in practice? Personnel, hardware, infrastructure?

A – Because what we do is so specialised it is very difficult to get an external analysis which will meet our requirements, hence we have our own in-house dedicated laboratory, which is very well equipped, we have two ICP optical emissions spectroscopy instruments, an optical microscopy, X-ray diffraction among others, as well as long standing experienced analysts, and it all seats in our documented quality system, working to standard procedures.

Q – To VAC: How do you see the upstream value chain in SecREEs presented through REEtec and LCM?

A – It is already a well-established value chain, we have a long relationship with LCM and an excellent record with their supply to us, most of the Samarium-Cobalt supply runs through them and we would like to increase the NdFeB share that we run via LCM within the scope of this project, and it all depends on the market acceptance. There is a sensitivity on the cost but there are already some customers who insist to have materials at least melted outside China. Hence it is still ok to have metals from China but up the value chain, now they ask for materials to be melted outside China and in next step might want the materials to be originated in different locations. With the help of LCM we can

ensure now the melting outside China and this is expected to be applied later to the mass production.

Regarding the business case of the upstream value chain, it is important to have clear specification of the incoming alloy and LCM clearly understands our specification and it is capable to translate this into a valid specification for REEtec.

Q – How important is the aspect of sustainability for you and VAC in this perspective, the environmental, economic, and social sustainability?

A – Sustainability and the supply security is something we discuss with our customers quite intensively and we see now that some big chemical companies like BASF in Germany put on their website the CO₂ footprint for each product and these elements are becoming more and more important. Perhaps we should consider this in the project, we try to find the CO₂ footprint of our value chain VS alternative means via Asia. We should put this into our promotion activities as well. VAC never had problems with the supply of RE, even at the peak of the crisis in 2011 but our production is small. However, we don't know how the political situation with China will evolve and we should think about the customers, that they trust in the Chinese supply chain, that they can live with it. The big automotive companies can influence something in China, if they want, but their pressure is not that high right now.

5 – Environmental standards in SecREEs – *with Pauline Chrobot, Quantis*

Marc Gramberger introduced Pauline Chrobot, from Quantis, in charge of the project Work Package on Sustainability and Risk Assessment. Here is the outcome of her interview:

Q – What is Quantis’ role in the SecREEs project?

A – Quantis’ role is to support companies in their journey towards sustainability. We base our work on metrics and science and mainly on Life Cycle Assessments (LCA). We work with different organisations and we are also involved in a lot of EU-funded projects. In SecREEs we are responsible for doing the LCA and the Life Cycle Costing (LCC), first of the SecREEs supply chain by assessing the impact on the environment from cradle to grave, which means from the mining of the rocks until the permanent magnet (PM) production at VAC and we are working with all the partners to assess the environmental footprint of this supply chain. Our second objective is to compare this environmental footprint with the one from the permanent magnets produced in a more conventional way, meaning from the supply chain that is currently happening in China. It is more challenging to get this kind of data from China compared to our value chain because we don’t have partners there.

Q – Can you share with us any of your preliminary findings?

A – LCA is based on data and from the SecREEs point of view we have access to all the data we need from our project partners but for our baseline data we have to rely more on the existing literature which is quite complex. There is also a lack of transparency on the data source that may not come from Chinese companies or from the government, there might be some flows missing in the modelling, but we are trying to compensate by involving some expertise from the SecREEs partners or other practitioners in the field. This data is then remodelled with our LCA software, and we can see the main environmental hotspot in the different supply chains. Our preliminary results show that the SecREEs supply chain has lower environmental footprint than PM produced in conventional way. This is just to give you an idea because there are also confidentiality issues related to these results.

The floor was then open for questions:

Q – Is there already a comparison available concerning the CO₂ emission between the standard supply chain within China and the European supply chain?

A- This has been partly answered in the previous question and I could add that we were looking more specifically at the climate change and global warming potential results, meaning that in terms of CO₂ eq so far, the European supply chain is showing lower results than the conventional one. At a later stage in the project when we have more data, we will add more indicators to look also at such as resource depletion and water use but we will have to decide first at which indicators to look beyond climate change.

Q – Could you tell us what the main factors are that make the difference in results, is it the technology, is it the physical or brutal impact on the environment, is it the know-how of the work force?

A – One of the main differences between the two processes is that in SecREEs the main material that we are using is a co-product from a process which is already existing. We are taking the impact from the cradle, meaning from the production of fertilisers from our partner YARA. As this process functions fully without SecREEs, we are not going to allocate the whole impact of the mining of the P-rocks and other upstream processes in the fertiliser production to our REE products. We will only allocate a part of the impact to the REE production which will be calculated based on economic allocation. This is one of the main differences between the two systems. In the conventional supply chain, the mining activities are fully dedicated to the fact that we are looking for the REE and the whole impact will be allocated to it. Another element is that the separation of the REOs from each other is being done now at REEtec, using an innovative separation process which is better in term of environmental impact than the Chinese solvent extraction process. This is due mainly to the use chemicals and to the energy consumption, which are the main contributors to the impact of the baseline supply chain.

Participants were then invited to use a Wooclap word cloud to reflect on the following question:

In 1 or 2 words, what are some of the main concerns raised by your customers when it comes to your rare earth or permanent magnet supply?



Speakers gave their reflection on the outcomes of the poll:

- Of course, the price volatility is a very important aspect and we have also received this feedback from our customers. This is one aspect we are working on in the SecREEs project with all the partners involved and if we have access to a mine or a fertiliser production, we could get more stable prices.
- Price volatility is our customers high priority so everyone should follow the published prices from China on the raw materials and not market-driven prices. We have every chance in this project to disconnect from the volatility if we look straight at the cost of our products and go back to a decent level of profit and display and say 'there is no volatility anymore, we know our cost and our profit within the process, on the other hand we can guarantee the prices for a longer period of time'. We need a fixed price, exactly what the automotive industry is looking for, but this is something we cannot provide right now because we must follow the prices as predicted or dictated by China and if we can disconnect from this it can be a very valuable asset.
- Regarding the 'transport security', we had a bit of a struggle with the Suez canal when some of our material shipped got blocked for few days and we had to fly the metals which is not easy to do. The raw material, if we follow the YARA part, most of the material is in or close to Europe and if we follow the Canada approach we have ore under transportation anyhow but the chain can buffer more in Europe.

-
- Being in the RE field for a very long time, I can say that volatility can be in both directions, as it happened with the drop in prices in 1999 and the high rise in 2011. Having a single supplier in the market is a massive factor in price volatility and we should be able to offer an alternative to the customers, also regarding the transparent ownership change going along with the ethics question.
 - I can only add that what we are doing is essential, this kind of collaboration for a supply chain is the only way that we can put something on the table which will be a viable alternative to China. The Chinese supply now is controlled by the state, it is an artificial supply, we see it again with the magnets that are coming to Europe at less than the raw material prices in the magnets. This collaboration is the only way to address the issues we see on the poll results.
 - Transparency is also important to us, to be able to get the best data and the best results and the price is also affecting the results of the environmental assessment because we need to separate the different REE from each other and allocate an impact to them and this is based also on the economic allocation. The fact that this European supply chain is going to show much better impact is really linked to some of the words in the poll – transparency, alternative technology, ethicality

7 – Wrap-up

Marc Gramberger thanked the participants for their active contribution as well as the speakers. To wrap up the session he invited the VAC team to give their impressions of the meeting:

Q – In closing this session, what are your impressions on what has been exchanged here today?

A – We are very pleased that we could provide important answers to our customers. The key elements of concern are exactly what SecREEs is working on, and we are happy to be part of it and to provide hopefully in this robust value chain in the near future the solutions, in a green, sustainable manner. It has to be different than what has been for the past 20 years. From the marketing perspective, we have to be much more aggressive, insisting to getting the message to the end customers who really pay at the end and who must realise the value of taking a different path to this material.

Finally, we are very grateful to the participants for providing the questions and the feedback today.

Evaluations

Participants were sent a link to an online evaluation form at the end of the meeting as well as after. These forms are designed to help the SecREEs team get feedback on their public engagement strategy, in order to improve future engagement activities. The same link was used for both the morning and afternoon sessions, the results are therefore an aggregation of both workshops.

See below for a full overview of the questions and the participants' aggregated responses. We received seven completed evaluation forms in total.

1. How do you rate this event in general?

Please mark:	5 – Very good	4 – Good	3 – OK	2 – Bad	1 – Very bad
Number of answers	3	4	0	0	0

2. How much did this lab help you understand what the SecREEs project is doing?

Please mark:	5 – Very much	4 – Much	3 – Somewhat	2 – Little	1 – Very little
Number of answers	3	4	0	0	0

3. How would you rate the following aspects of the workshop? (number of responses)

Please mark:	5 – Very good	4 – Good	3 – OK	2 – Bad	1 – Very bad
Moderation	3	3	1	0	0

Panellists' interventions	1	4	2	0	0
Opportunities given to the audience to contribute	3	2	2	0	0
Length of the activity	1	3	3	0	0
Platform and tools (Zoom webinar/Woo clap)	2	3	2	0	0

4. Do you have any other comments or suggestions?

Comments:

- If it's possible in this project, more activities by REEtec to use EOL PM's
- Maybe reduce the time of this meeting (1h30 can be enough), and mor visual information than speech, if not excellent topic and ideas, thanks again