SecREEts Workshop

SecREEts

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 – RESEARCH COMMUNITY

Online, 16 June 2021 - Afternoon

Led by Prospex Institute
With Vacuumschmelze

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 asbl – Belgium

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

Citizen Engagement in SecREEts

As part of the SecREEts 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 research community instead. VAC has therefore identified and invited research partners, academics and scientists with an interest in magnetic applications of rare earths to introduce SecREEts and discuss the research community's views on the project's value chain.

Together with LCM, REEtec and Quantis, Prospex Institute and VAC introduced the latest updates on SecREEts to a group of research 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

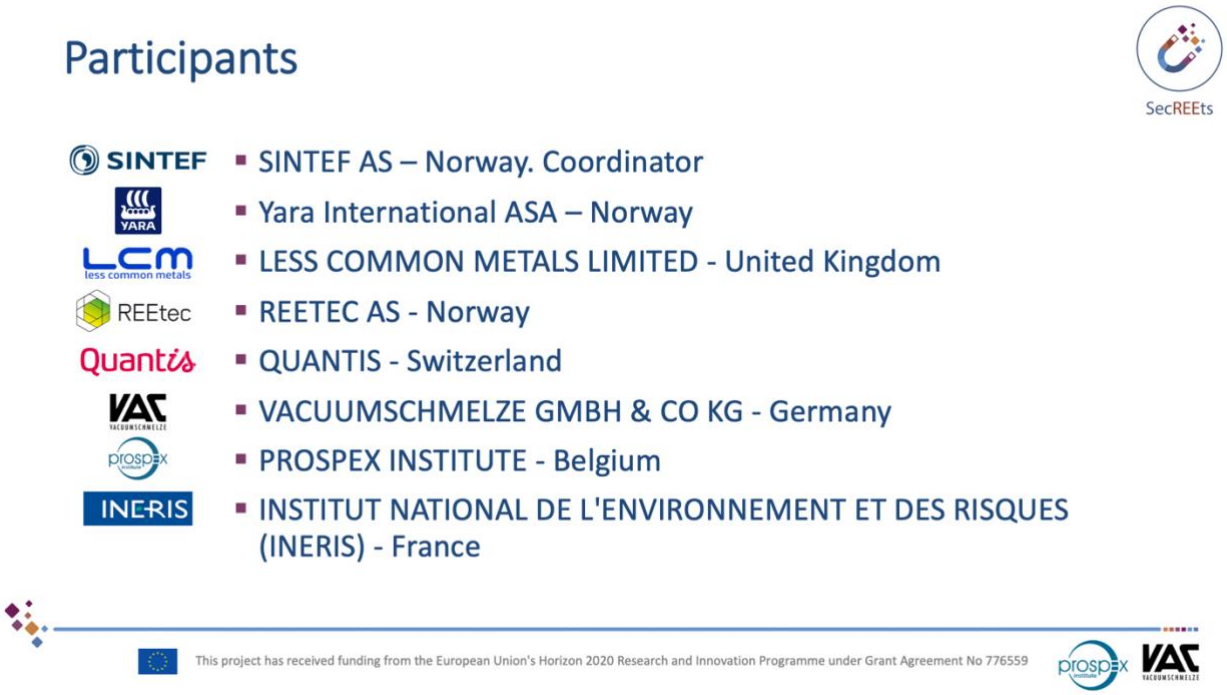
After welcoming participants to the session, Marc Gramberger from Prospex Institute (PI), and lead moderator of the session, provided an overview of the house rules for this session, as well as the agenda. To protect the anonymity of the participants in a business context, Marc Gramberger invited everyone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

Ralf Koch, Vice President of Research & Development 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 a word cloud question on the anonymous polling tool Wooclap. Here were the outcomes:

In 1 or 2 words, what advantages do you think are the most promising areas of applications for permanent magnets, and for rare earths in general

2 – Learning about the SecREEts project – w*ith Clara Boissenin, Propsex Institute*

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



Secure European Critical Rare Earth Elements

SecREEts

- 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
- SecREEts 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

SecREEts

- 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?

SecREEts

- 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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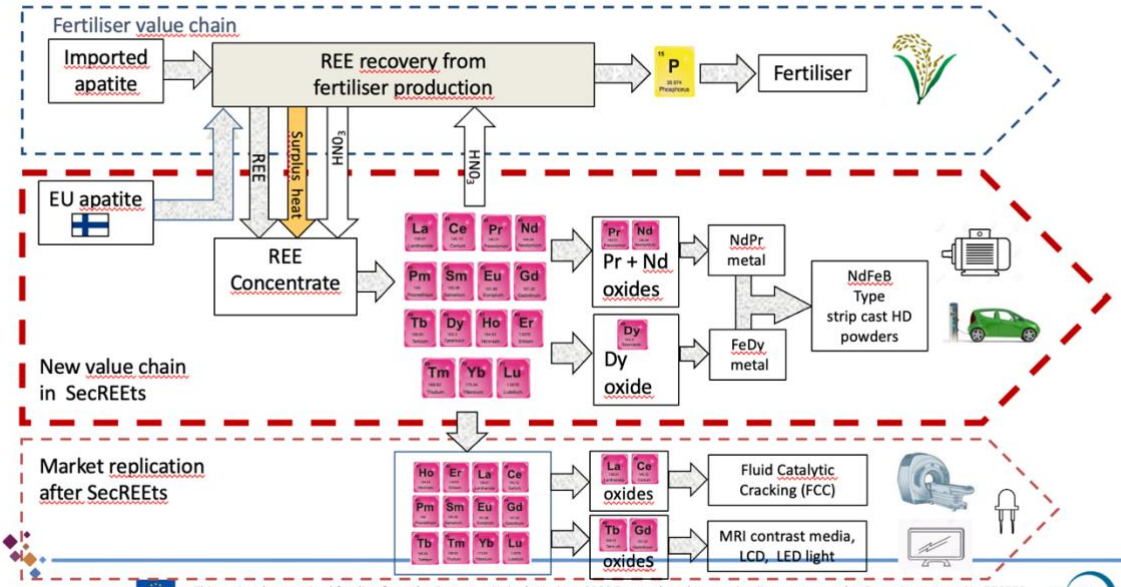
Our Concept



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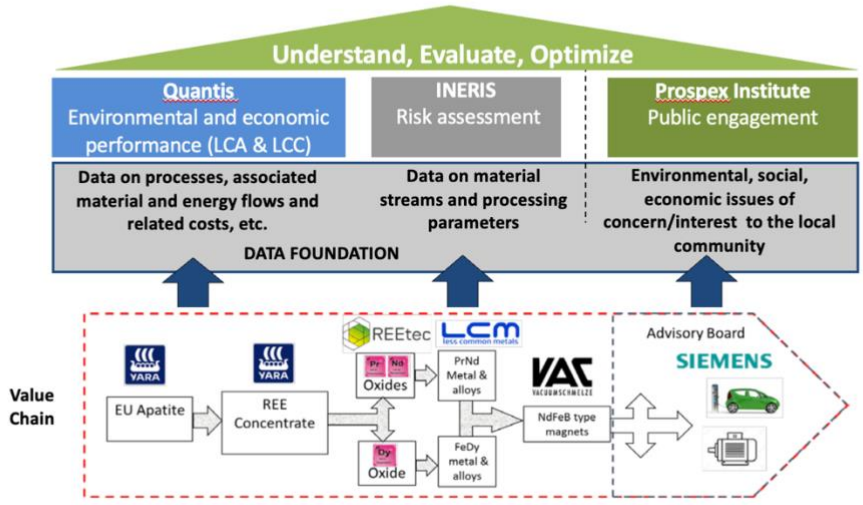
Sustainability and Risk, and Public Engagement



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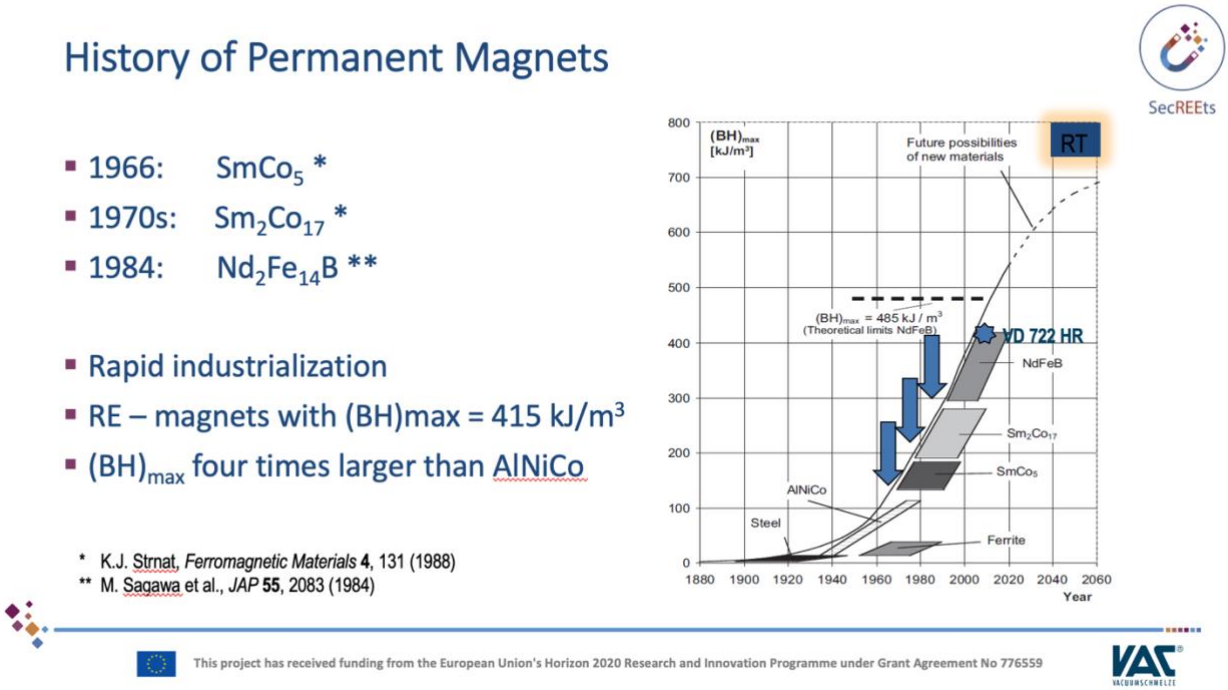
3 – Presentation of VAC's role and interest in SecREEts – *with Christoph Brombacher from Vacuumschmelze*

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

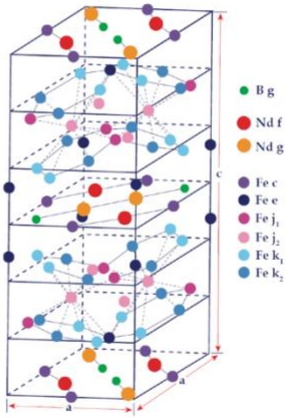


VACODYM

- VACODYM consists of a RE_2-Fe_{14}-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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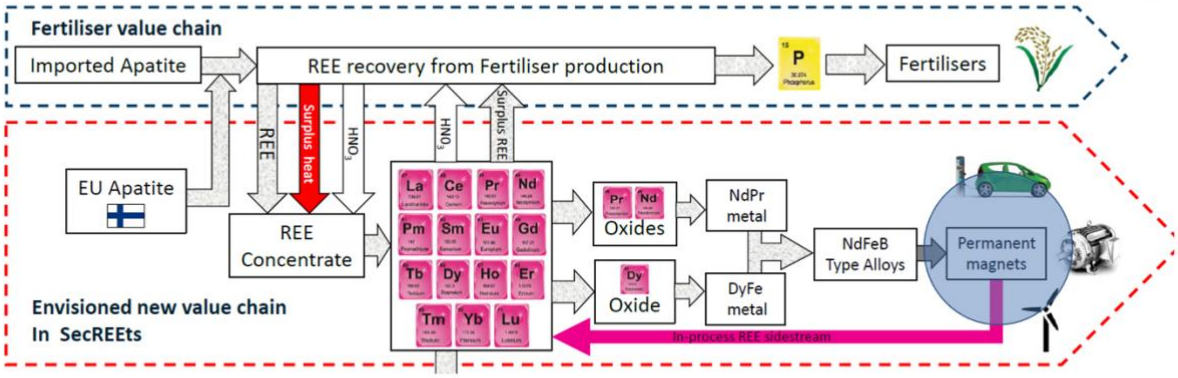
Role of VAC within SecREEts



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

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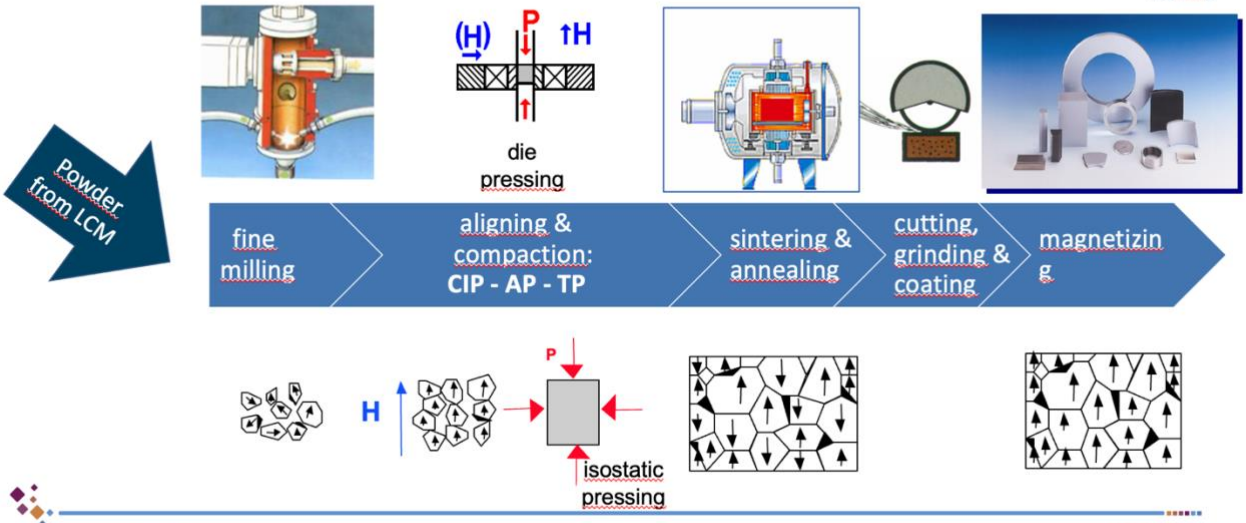
Production process



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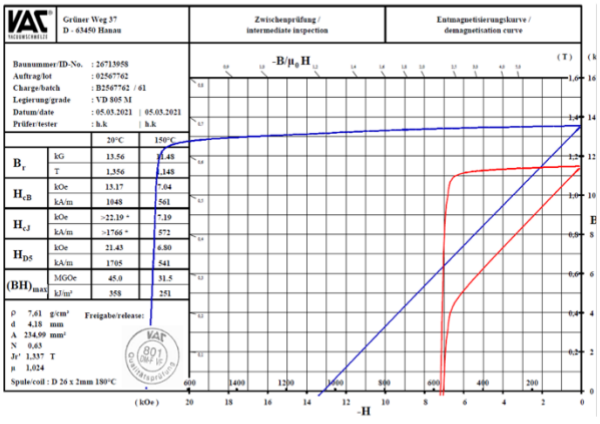
Qualification of LCM material

Conventional production process



- Qualification of HD powder from LCM
  - ✓ $B_{r,min}$ = 1,35 T
  - ✓ $H_{cJ,min}$ = 21 kOe
- Properties of VD 805 TP achieved

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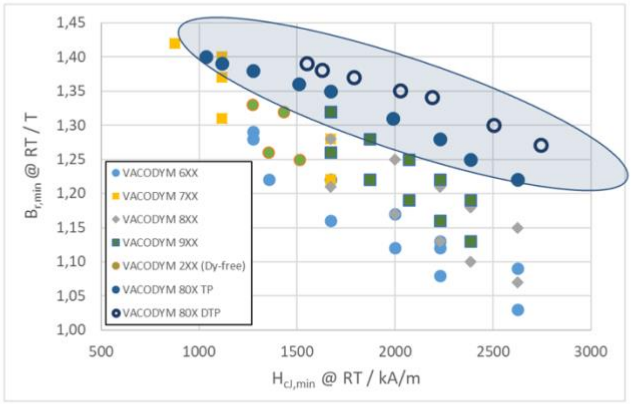
Recycling

VD 80X TP from European alloy production

SecREEts

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

SecREEts

- 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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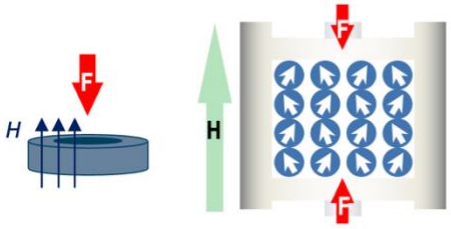
Recycling

SecREEts

- 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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VACUUMSCHMELZE

Summary

SecREEts

- Stable supply of RE elements is important for high performance magnet production
- SecREEts 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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VACUUMSCHMELZE

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

Q – If we assume that the cost from the European sources is higher, how can we make a final consumer to pay a higher price for something that is more sustainable?

A – I would say that a difference of 10-20% is not a concern and I expect that all our customers would agree if they can have a sustainable, eco-friendly source with an additional price.

4 – Upstream SecREEts value chain – *with David O'Brock (REEtec) and Ian Higgins (LCM)*

Miro Prek introduced David O'Brock, Commercial Director of REEtec and Ian Higgins, Managing Director of Less Common Metals (LCM). Here is the outcome of this session:

Q– Could you please shortly introduce REEtec and LCM, and their role in SecREEts?

A – REEtec worked out a process with YARA: once the apatite is in their process and they are using the apatite for the phosphor content, we precipitate a mixed RE concentrate out of the mother liquor and then it goes through our separation system to separate the individual elements to feed into, for example, the magnet production. Because the magnets need only 3 or 4 of the elements, we are also looking at other elements such as Gadolinium which is used for refrigeration. We then produce a high purity oxide which goes to LCM for metal production. But when we are looking at the raw materials, we are not only looking at the YARA raw material, we are also working on the circular economy aspect. If there is 10% left over of the material after they made a magnet from it, we have a process to take that material back in chemically treated material, so that it comes out as a clean element and can be used as a virgin material with no compromise on the end performance of the material.

A – LCM is located in Northwest England, we are close to our 30th anniversary and our activities in SecREEts consist in making RE metals from REEtec's oxides and then making alloys and send them to VAC to manufacture permanent magnets, so we fill the gap between REEtec and VAC. The metal-making process is the same technology as used globally for making aluminium, but the technology is applied to RE. For the RE the process has been developed almost exclusively in China, except for 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: very precise chemical composition, low levels of impurities, good reproducibility, and microstructure, a fine-grained crystallized structure.

Q – Could you please also tell us what REEtec and LCM does in the area of recycling?

A – In the SecREEts project, REEtec is taking grindings, cut offs and materials that VAC could not make into new magnets and recycling that back through chemical process to make virgin material, but we are also looking at end-of-life magnets and how to process those and getting the word out that one way of better getting at the magnets is through better design of the components that they are in. Norway being at the leading edge of using green energy and e-mobility, the shareholders have seen not only a responsibility but also an opportunity for the future to handle these end-of-life consumer products. The recyclers we work with see the electric car as a multi-elemental ore source for all the different types of recycling. We are also recycling as much as possible our own internal usages for energy, heat and chemicals.

A – LCM takes in the material which REEtec has recovered. Recycling is very important for two reasons: to avoid waste going to landfill and to use it as a low-cost source for potential new raw material. At the moment, the materials for recycling are going to the far East, ending up in the Chinese supply chain. We are also looking at recycling as a key part of inclusive circularity for the European infrastructure that we are seeking to establish and to make it as competitive as possible.

Q – Can REEtec recycle also coated magnets?

A – Yes, depending on the coating we decide how to process the materials inside

Q – Are the low prices of Chinese magnets stable for the future?

A – None of us really knows this but for our business cases we have to assume that the low prices could sustain for a long period of time. They are artificial prices, they are very much a result of central governments involved in the Chinese REE industry, hence if we are putting all these business cases and the magnet prices double or triple then we have weak business cases. We can look at this as a roller-coaster, something which sometimes can be very good and other times very bad.

Q – What are some of the advantages of LCM and REEtec processes compared to the original metal-making?

A – LCM makes metals as good as anyone else, and we cannot say that we do this better than China. LCM has its own comprehensive characterisation facilities; a lot of

measurement and process and we think we are very good but we are in a very competitive industry and the advantage for the consumer will be the transparency and ethical measures for the production and the environment. The process at LCM by itself cannot make a change in the industry, it has to be seen as a link in the whole supply chain, in order to make a difference.

A – REEtec – our advantage is that our production or our technology allows for a very diverse raw material to come in. The traditional solvent extraction mines are built for one specific type of raw material. If you put into solvent extraction mines very large ratios difference in between the elements it is not efficient enough, but we are able to take in everything and we don't have to be selective regarding the raw materials we take in and this is also important for recycling.

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

Miro Prek 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 – Could you please introduce Quantis?

A – Quantis is a sustainability consulting company supporting organisations in their journey towards sustainability, we base our work on metrics and science, which is mainly LCA (Life Cycle Assessment) and then, based on the results we have, we design our strategy and provide support to our clients. We work with different types of organisations, small and big, private companies and NGOs and we are also part of many EU-funded projects. In the SecREEts project QUANTIS is responsible for the LCA and the Life Cycle Costing (LCC), first of the SecREEts supply chain by assessing the impact on the environment of each step, 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. We are also comparing these results with the production of the same type of PM which are produced in a more conventional way, meaning from the supply chain which is happening in China.

Q – What are the plans for the environmental impact assessment in the SecREEts project?

A – We do have methodologies to calculate the environmental footprint related to climate change, global warming, to be compared to other value chains but for this we need to have primary data. It is easy to do this for the SecREEts supply chain as we collect data from our project's partners in confidential ways and we get the results. However, for the conventional supply chain in China we must rely on literature because we don't have contacts there. There is also lack of transparency in the data source that we find in these papers, we don't know where the data is coming from and there are also flows and missing information. To overcome this challenge, we are getting expert advice from the SecREEts partners, other practitioners in the field and other projects working on the same topic. Once we have these two sets of data, we can calculate the impacts and we can see the main environmental hotspots in the different supply chains.

Q – Could you please tell us something about the preliminary results you have?

A - Our preliminary results show that the SecREEts supply chain has better environmental footprint than permanent magnets produced in a conventional way. We have mainly focused on the carbon footprint or the global warming results, and we will include in the future additional indicators relevant to the SecREEts project, such as resource depletion and toxicity.

Q – Where do we stand in the SecREEts project with regards to the Chinese value chain?

A – I don't have a number to give you in percentage and we have to wait for the final results because it can change quite a lot. However, I would like to add here that the main difference we get in the two supply chains is coming from the fact that the primary element we use to extract the REE is coming from a production process which is already existing, we don't need to mine raw materials like the conventional way does, because the primary production is available at YARA. Thus, we are using a co-product which makes the allocation of the impact of the raw materials extraction much lighter in the SecREEts supply chain compared to the conventional one.

Q- May there be any regulation in the future regarding the CO2 footprint for the RE value chain?

A – So far, we are not aware of anything, this depends on the laws and regulations in Europe in this case, but we will look at this as it may influence our results, as well, especially with the LCC.

Q – The EU's proposal for carbon border adjustment mechanism would account for an imported product's carbon footprint and integrate it into the import price – based on the work you are doing, would you be able to have some figures for the carbon footprint of permanent magnet produced in China – on a producer level? Or would it be more an aggregate at the country level (China)?

A – On a producer level, per specific supplier in China, if they have their carbon footprint/ product they can use the average European or Chinese one to have a benchmark but depending on the foreground and background data and the method you are using you

can have drastic difference in results, hence it is difficult to compare and one needs to have data which is peer-reviewed, to be reliable

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

In 1 or 2 words, what do you think are key future research needs when it comes to permanent magnets and rare earths in general?

Speakers gave their reflection on the outcomes of the poll:

- The temperature stability in the centre relates to the reduced usage of heavy REE (HREE). This topic is not in the scope of SecREEts project, but it is on our agenda of developing permanent magnets. We have other projects where we are trying to reduce the level of HRE needed to get the temperature stability. Recycling, on the other hand, fits into the SecREEts project and it is a challenging topic due to the different recycling methods available now in Europe. VAC considers that the most promising recycling method is the one that takes PM and recycle them into original REE and this is also the approach used in the SecREEts project.
- From the results above we can see that this is a very well-informed research community. Looking at the extractive technologies which would help to reduce the CO2 footprint, something which REEtec is already doing, we can also talk about the process used by LCM for making metal, the electrolysis process generates CO2 as part of the chemistry. Focusing on some of the extractive technologies of making metal, there are possibilities available and taking them in the industrial processes would give an improved LCA values.
- In addition to what has been said, transparency is also an important aspect for the data and the processes if we want to have a reliable and robust assessment.

7 – Wrap-up

Miro Prek 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 would like to thank everybody for contributing to this discussion, it was a very good experience and opportunity to share some important questions and we are looking forward to the next steps, especially to get the results from Quantis. The discussion about the cost of the new supply chain is also an important topic for us.

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 SecREEts 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 SecREEts 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 of 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