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Alliance for Batteries Technology, Training and Skills

2019-2023

ALBATTS Workshops:

European Battery Ecosystem – Job Roles and Competencies now and in the future

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Deliverable D4.9 – Future Needs Definition for sub-sector

ISIBA – Release 3

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Executive Summary

The third and final round of workshops was kept during 2022 and at the beginning of 2023. The concept from the second round was kept, with both webinar and interview concepts with experts representing various topics of interest present.

These were the webinar topics organized:

- Lithium - European Sourcing and Skills
- BMS and Control Systems
- Skills Transition

And the following interviews:

- Second Life Bus Batteries in BESS Residential Applications
- Future geopolitical challenges in the source of raw materials and the battery value-chain

This Work Package 4 deliverable covers the above-listed interviews and webinars. Although there was a close collaboration between WP4 and WP5 in the organization of the workshops, it was decided that each workshop should be covered in the deliverable related to the WP the main organizer is from.

With this WP4 deliverable, skills, competencies, job roles, and training mechanisms were identified during the analysis of these interviews and the webinars. Some of them are described in the Key Findings section of each chapter. However, they will be described and analysed more profoundly in the coming D3.11 Analysis of Future Needs - Release 3 of Work Package 3. It will be published in May 2023.

Lithium mining and refining job roles, skills, and competencies

Chapter 2 focuses on skills and competence information from the first stage of the battery value chain, minerals, and processing, by studying lithium mining and extraction. The chapter first looks at the presentation of Dr Gerardo Herrera (Policy Officer, Raw Materials, DG GROW, European Commission). He discussed the EU's perspective on self-sufficiency with critical raw materials including lithium. Then we learned with Dr Patrice Christmann (Consultant, Krysmine) about European lithium deposits, active mines, and exploration projects. Mr Asko Saastamoinen (Chief Human Resources Officer, Keliber Oy) provided insight into their lithium

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mining and processing project in Finland, how technology has affected mining and what skills and competencies they require from their staff. In her presentation Dr Blandine Gourcerol (Economic Geologist, BRGM) described to us what geothermal extraction of lithium is about. Dr Carlos Nogueira (Head of the Materials for Energy R&D Unit, LNEG) took us through his detailed presentation about the processing of lithium from primary sources. In the end, Dr Nathalia Vieceli and PhD Student Ms Lea Rouquette presented us with the recycling of lithium.

What if batteries still have some use after being used in EVs?

Chapter 3 analyses the interview of Ylva Olofsson, a project manager at Volvo Buses and responsible for a project that consisted in implementing used batteries from the Route 55 electric bus in Gothenburg in an apartment complex. The complex already had PV panels and the batteries were seen as the solution to increasing the renewable penetration. Ylva walked us through the process, the challenges faced, and the main job roles, skills and competencies needed during the project.

The heart of a battery system is management and control.

Chapter 4 details the discussed topics around the battery management system and the control of the batteries. Three experts were heard: Jorge Pinto, a researcher at VG CoLAB am dos developing innovative hybrid-battery packs and the respective power converters; Josef Tichanek, CEO of Olife Corporation who is developing a lithium car starting battery and Mika Kauppila, a senior Electrical Engineer at Valmet Automotive, working with batteries for automotive OEMs and off-highway applications.

Raw materials, sourcing and refining and geopolitical issues around it.

Chapter 5 considers the results of the interview with Daniel Cios, Policy Officer at the European Commission. The shortage of raw materials, especially battery materials were discussed. The impacts of the Russian invasion of Ukraine were at the centre of the discussion as all the policies, strategies and ideas being implemented to mitigate similar situations in the future, mainly in the battery industry.

How do we train people that want to move to the battery industry?

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Chapter 6 groups the analysis of education experts Jakub Štolfa, academic at the Technical University of Ostrava and WP leader in the ALBATTS project, Tore Karlsson, training coordinator at the VUX Institute in the Skelleftea municipality and Fredrik Hannerz, the responsible for technology training at Volvo Cars. Exploration was conducted into the training opportunities available for individuals seeking employment within the battery industry.

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List of Abbreviations

BESS	…	Battery Energy Storage System
BEV	…	Battery Electric Vehicle
BMS	…	Battery Management System
BRGM	…	Bureau de Recherches Géologiques et Minières (French geological survey)
CEO	…	Chief Executive Officer
Co	…	Cobalt
CO2	…	Carbon dioxide
CRM	…	Critical Raw Materials
DLE	…	Direct Lithium Extraction
Dr	…	Doctor
EBA	…	European Battery Academy
EC	…	European Commission
EPF	…	École Polytechnique Féminine
EQF	…	European Qualifications Framework
EV	…	Electric Vehicle
FTA	…	Free Trade Agreement
GWh	…	Gigawatt hour
HEV	…	Hybrid Electric Vehicle
HR	…	Human Resources
ICE	…	Internal Combustion Engine
ICEV	…	Internal Combustion Engine Vehicle
IP	…	Intellectual Property
IT	…	Information technology
kt	…	kiloton
LCA	…	Life Cycle Assessment
LCE	…	Lithium Carbonate Equivalent
Li	…	Lithium
Li2CO3	…	Lithium Carbonate
Li2O	…	Lithium oxide
LiB	…	Lithium battery
Li-ion	…	Lithium-ion
LiOH	…	Lithium hydroxide
LNEG	…	Laboratório Nacional de Energia e Geologia (National Laboratory of Energy and Geology)
M.Sc.	…	Master of Science
MBA	…	Master of Business Administration
Mt	…	Megaton
NG	…	Natural Gas
NG	…	Natural Gas
Ni	…	Nickel
OEM	…	Original Equipment Manufacturer
PA	…	????
PhD	…	Doctor of Philosophy
PV	…	Photovoltaic

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R&D	…	Research and Development
SME	…	Small and Medium Enterprise
UN	…	United Nations
VCC	…	Volvo Cars Company
VET	…	Vocational Education and Training
VR	…	Virtual Reality
WP	…	Work Package

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1. Introduction

Like previous years, a series of webinars and interviews were conducted, joining several experts across the whole battery value chain. The webinars followed the previously used format, which included a Moderator that managed the presentations, an ALBATTS member to present the project, followed by the presentation of the invited speakers. The interviews similarly followed the previously used format, where a moderator/interviewer would manage the event and ask the speaker/interviewee a set of pre-prepared questions. At the end of both types of events, the moderator would ask questions to the speaker that the audience had written in the chat box during the event.

Focus and organisation of the webinars and interviews

The procedure for the interviews

The planning process took place in small, more focused meetings. Furthermore, follow-up meetings were held every other week starting in August, with partners from Work Package 4, 5, and beyond in attendance. During these meetings, tasks were allocated and the progress of the work process was tracked.

Before the event, there was coordination and communication among the interviewer, interviewee, and organizer team. Working closely with our team, the interviewee, and the interviewer, we formulated a list of questions that could be used during the interview (with some flexibility depending on the flow of the conversation and the questions that may arise from the audience). We also practised and tested the platform used for the interviews, Webex. During the testing and live events, Eupportunity (WP2) provided platform-related guidance and administration.

The procedure with webinars

As is customary, once the date had been agreed upon with the speakers, a "SAVE THE DATE" message was sent to ALBATTS stakeholders. We held regular mini meetings between partners in WP4 and WP5 to finalize the agenda timing, develop the webinar script with the moderator, and make any necessary adjustments to the program. To ensure a smooth webinar, we scheduled a rehearsal session one week in advance.

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The dissemination of the interviews and the recycling webinar are analysed in this deliverable. Regarding the marketing or dissemination of the event, we collaborated with WP2 (Eupportunity) and followed the dissemination procedure used in previous years:

- Save the Date
- Pop-Up on the Website
- Event on the Website
- Block the calendar
- Registration Open
- Email to Stakeholders
- Agendas on the Website
- Bios on the website
- First Reminder
- Last Reminder
- Email Reminder
- Workshop
- After Workshop Email
- Publication of the video + presentations

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2 Lithium - European Sourcing and Skills

"Lithium - European Sourcing and Skills" was the first webinar of the workshop round 3 organized under Task 4.4. It was kept exceptionally early, if compared to the previous, on the 27th of April 2022. The purpose of the workshop was to gather skills and competence information from the first stage of the battery value chain, minerals, and processing, by looking into lithium mining and extraction. The questions we wanted to address in the event included:

- Where are the lithium deposits?
- How is lithium mined and extracted?
- Can it be recycled?
- And naturally, what job roles, skills and competencies are needed?

The event was organised together with EIT RawMaterials. Preparing for the event involved close collaboration with Dr Laurence Lamm (Senior Advisor – Mineral and Metallurgical Processes).

The decision to keep the event arose from discussions between the ALBATTS project and Dr Lamm of EIT RawMaterials. Additionally, we felt, in the project, that the minerals and processing stage of the battery value chain required to be studied deeper. Lithium, the critical raw material with Li-ion batteries was chosen as the focus of this webinar.

The webinar was registered as an event of the European Vocational Skills Week 2022.

Figure 1. Integration of the webinar in the European Vocational Skills Week 2022

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2.1 Agenda

Figure 2. Dissemination image and agenda for the webinar

We received **138** registration requests from 24 countries, of which 8 were outside the EU. Most of them represented industry, education, research, and con sectors. The top 3 countries in terms of the number of registered were Portugal, Finland, and Czech Republic.

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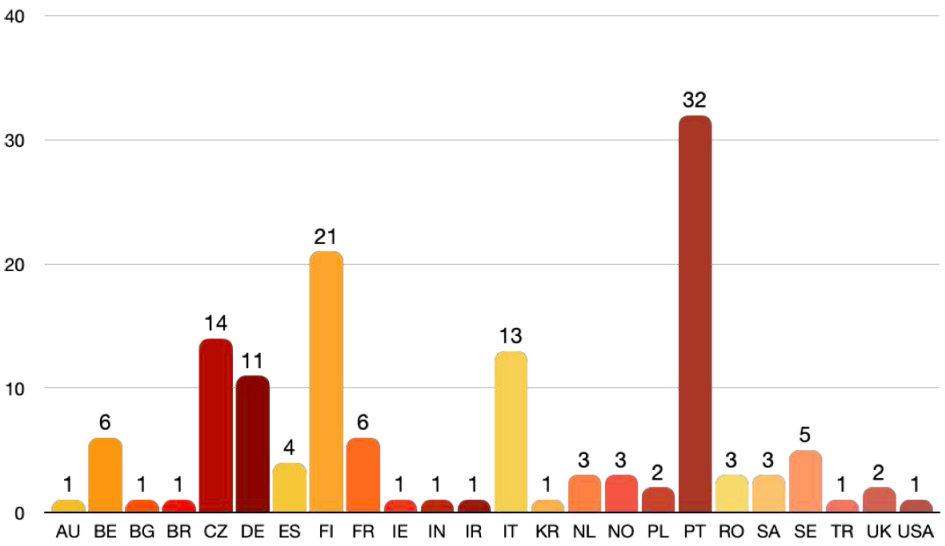

Figure 3. Number of registrations per country

Most of them represent industry, education, and research.

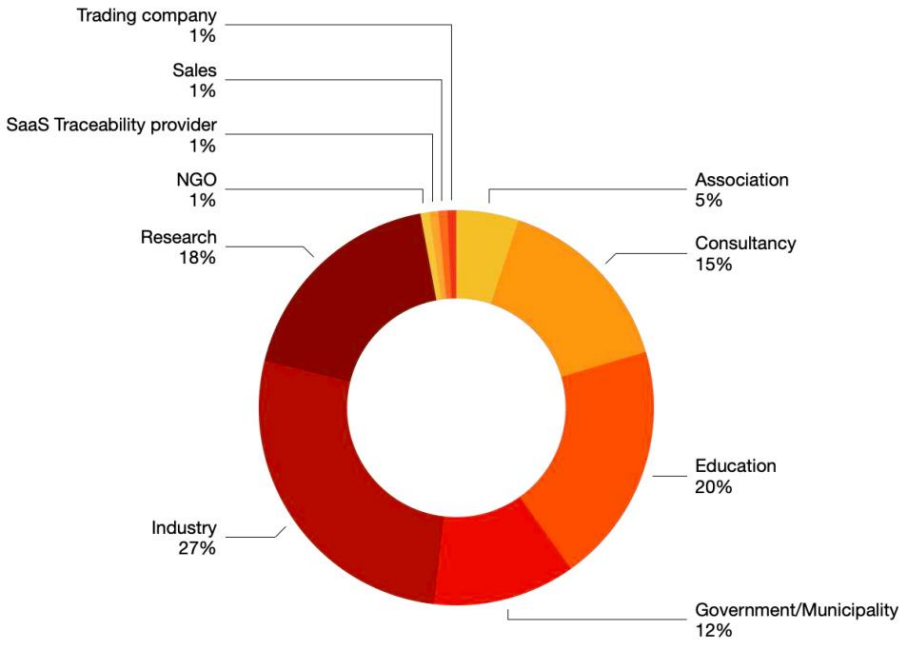

Figure 4. Distribution of the sector of the registered people

The number of viewers was **73** on the Webex platform while there were also viewers following the event's live stream on Facebook. The recording is available on the ALBATTS website.

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2.2 Workshop Speakers

Figure 5. Image with speakers used in the dissemination

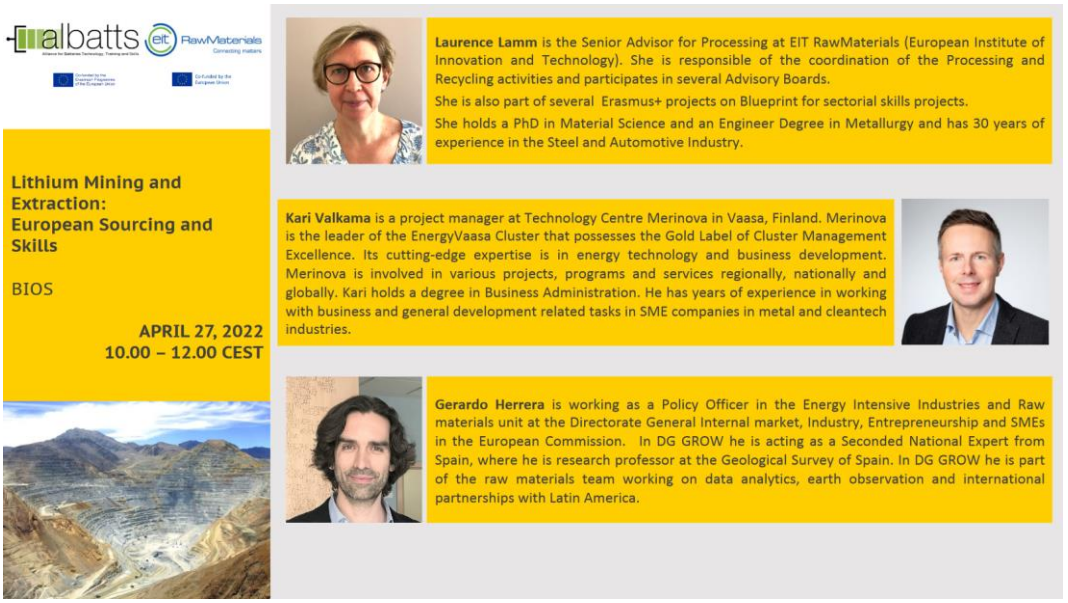

Figure 6. Dissemination image with the bios of the speakers

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Figure 7. Dissemination images with the bios of the speakers

Moderator

Laurence Lamm is the Senior Advisor for Processing at EIT RawMaterials (European Institute of Innovation and Technology). She is responsible for the coordination of the Processing and Recycling activities and participates in several Advisory Boards. She is also part of several Erasmus+ projects on Blueprint for sectorial skills projects. She holds a PhD in Material Science and an Engineer Degree in Metallurgy and has 30 years of experience in the Steel and Automotive Industry.

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Speakers

Kari Valkama (who presented the ALBATTS project) is a project manager at Technology Centre Merinova in Vaasa, Finland. He leads Work Package 4 in the ALBATTS project. Merinova operates in the centre of the EnergyVaasa Cluster in Finland. Its expertise is in energy technology and business development. Merinova is involved in various projects, programmes, and services regionally, nationally, and globally.

Gerardo Herrera is working as a Policy Officer in the Energy Intensive Industries and Raw materials unit at the Directorate General Internal Market, Industry, Entrepreneurship and SMEs in the European Commission. In DG GROW he is acting as a Seconded National Expert from Spain, where he is a research professor at the Geological Survey of Spain. In DG GROW he is part of the raw materials team working on data analytics, earth observation and international partnerships with Latin America.

Patrice Christmann, PhD, MBA, is a self-employed researcher and consultant, specialising in minerals and metals and related issues (sustainability, policies, governance, economics, research, technologies …). He retired from BRGM, the French Geological Survey, in 2016, after a 40-year-long career. He also was a member of the UN International Resource Panel (2011-2020, resourcepanel.org). He currently teaches minerals, metals; Energy Transition and Sustainable Development at EPF, a French Engineering School.

Asko Saastamoinen works for Keliber Oy as the Chief Human Resources Officer. He is an M.Sc. in Civil Engineering, having years of experience in different fields of HR and Safety in chemical and process industries as well as mining. His work is both on the strategic level of planning and leading people activities as well as on the practical level in recruiting, managing, and developing employees for Keliber, aiming to be the first company in Europe to produce Lithium from its ore resources.

Blandine Gourcerol currently works at the French Geological Survey (BRGM) as a researcher on ore deposit geology. Her research aims to characterize a variety of magmatic and hydrothermal ore systems using both traditional and novel approaches. Her work incorporates

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field studies supported by a large range of petrologic and mineral-fluid chemical studies (e.g., lithogeochemistry, fluid inclusions) using analytical facilities at the BRGM and collaborating institutions.

Carlos Nogueira is a researcher at LNEG and Head of the Materials for Energy R&D Unit. Its main expertise is in extractive metallurgy and recycling of end-of-life products, namely in the development and optimization of extractive processes by hydrometallurgy. Has an also scientific interest in the field of energy storage. Has been participating in national and international research projects and has many publications in scientific journals. Lithium has been one of the core topics of its activities in recent years.

Nathália Cristine Vieceli works at the Chalmers University Department of Chemistry and Chemical Engineering, Industrial Materials Recycling Unit. Nathália researches lithium recovery from spent Li-ion batteries by hydrometallurgical processes. Her interests in recycling include the optimization of processes to recover critical raw materials from secondary resources. Nathália also has experience in lithium recovery from natural resources (ores).

Léa Rouquette also works at the Chalmers University Department of Chemistry and Chemical Engineering, Industrial Materials Recycling Unit. Léa´s PhD project is focused on lithium-ion battery recycling. The goal is to recover valuable metals from the spent batteries.

2.3 Webinar

Moderator

- Dr Laurence Lamm, Senior Advisor – Mineral and Metallurgical Processes, EIT Raw Materials GmbH

Key Messages:

- EIT RawMaterials is an institute created and financed by European Commission.
- They aim to decrease the European dependence on imported raw materials.
- They finance upskilling and education projects and additionally support startups and networking activities.

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- The topic was chosen for the webinar due to the higher focus on the downstream phase of the battery manufacturing in the ALBATTS project earlier. It was considered that paying more attention to the minerals behind batteries would be required.
- Lithium was chosen due to having a lot of focus on and complications related to it.

Speaker 1

Mr Kari Valkama, Project Manager, Merinova Technology Centre, Finland

- Provided a presentation of the ALBATTS to introduce it to those audiences.

Speaker 2

Dr Gerardo Herrera, Policy Officer – Raw Materials, DG GROW, European Commission

Key Messages:

- We are facing raw material and energy supply chain disruptions.
- There is a political momentum at the highest political level to secure our CRM supplies.
- The ministers of the EU member states have provided the commission with a mandate to try to ensure the autonomy and resilience related to the critical raw materials.
- Key actions are needed to strengthen EU production, diversify supply sources, and secure critical raw material supplies.
- Investments needed throughout the CRM value chain
- CRM Taskforce; Stockpiling of critical raw materials
- Diversification, more recycling and domestic sourcing
- Future FTAs & PAs should include CRM provisions.
- Sustainable mining standard
- Support industrial projects in third countries
- Regarding batteries we are dependent on lithium from Chile (78 % share) and cobalt (68 % share) from Congo. The demand for battery raw materials will increase.

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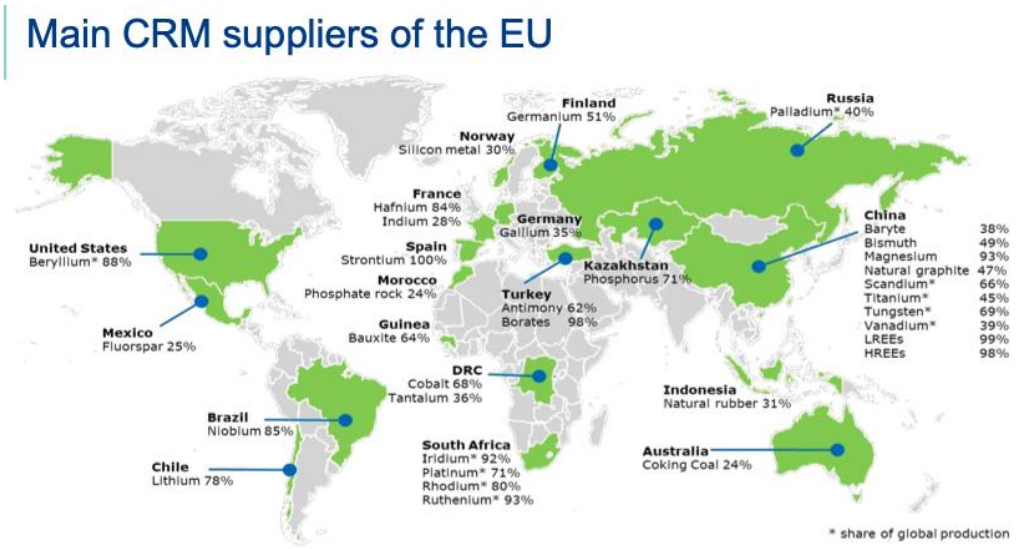

Source: "European Commission, Study on the EU's list of Critical Raw Materials – Final Report (2020)"

Figure 8. Distribution of the supply of raw materials worldwide. Source: Gerardo Herrera's presentation

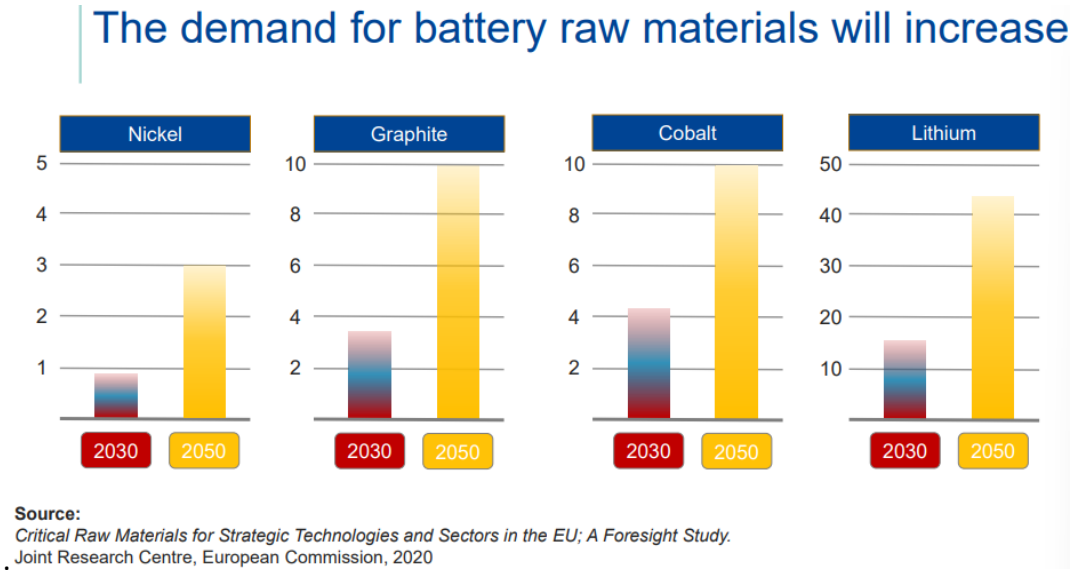

Figure 9. Prediction of demand for battery raw materials. Source: Gerardo Herrera's presentation

- Action Plan on CRM - 10 actions to ensure Europe's access to raw materials:

1. European Industrial Alliances
    a. European Battery Alliance
    b. European Raw Materials Alliance
    c. European Clean Hydrogen Alliance
    d. to get funding and accelerate investments from public and private institutions for the raw material projects in the whole value chains
2. Develop sustainable financing criteria for mining
3. Research and innovation on waste processing, advanced materials, and substitution

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4. Map the potential supply of secondary CRM from EU stocks and wastes
5. Identify priority mining and processing projects for critical raw materials in the EU
6. **Develop expertise and skills**
7. Deploy Earth observation programmes for exploration, operation and post-closure environmental management
8. Develop research and innovation projects on the exploitation and processing of CRMs
9. Develop strategic international partnerships to secure CRMs supply
10. Promote responsible mining practices for CRMs

- With batteries the gap areas we are failing in include **recycling, cathodes & anodes** and in the strategic part, **mining the critical minerals**. The gap is expected to grow.

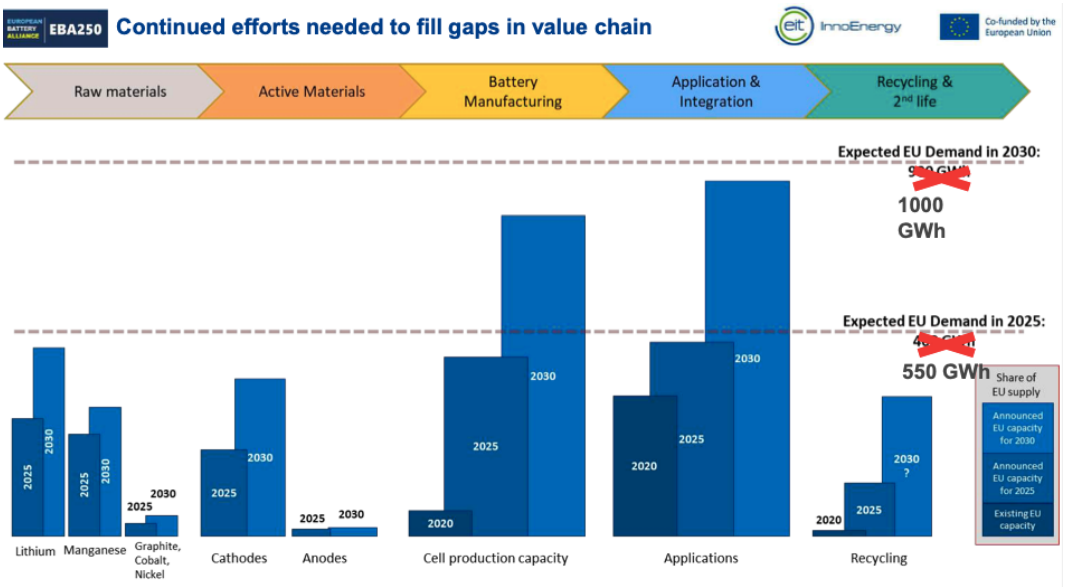

Figure 10. History and prediction of EU supply per step of the battery value chain. Source: Gerardo Herrera's presentation

- The target is meeting 70-90 % of the European battery demand by 2025-30.
- EIT Battery Academy: skills for 800.000 people by 2025 to manufacture and recycle.

Speaker 3

Dr Patrice Christmann, Consultant, Krysmine

Key Messages:

- The 2020 European primary lithium production (from geological resources) is insignificant, being limited to 0.2% of the world's production.
- Li carbonate: 0.3% of the world production (from imported Li raw material)

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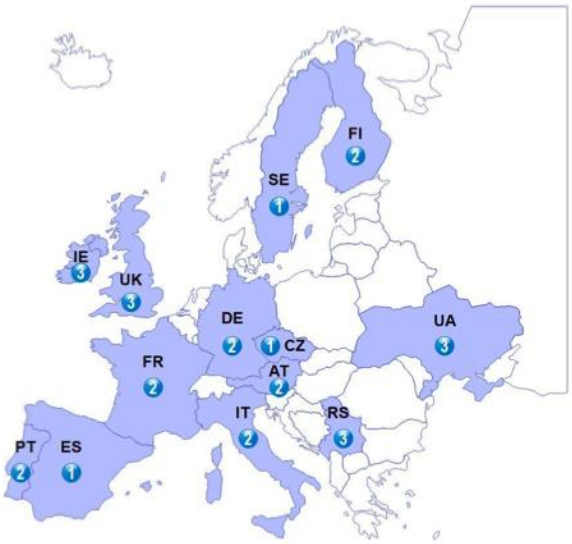
- Li hydroxide: 11% of the world production (from imported Li raw material)
- Europe is likely to confront a huge supply gap in the coming years.
- By 2024 European Gigafactories would represent a capacity of 377.5 GWh, demanding around 38 000 tons of Li per year (about 44% of the world's production in 2020).
- European lithium exploration activities include 26 projects (in 04/2022).
- These 26 projects represent a more or less well-documented inferred resource of 3.9 Mt of Li (the equivalent of 100 years of the est. 2024 European Li- battery demand).



Summary data about Europe's 5 largest publicly reported lithium production projects

Country	Location	Company	Resources (Meas. + Ind., Mt Li eq.)	Type	Status
Germany	Insheim, Upper Rhine Graben	Vulcan Energy Resources	2.98	Geothermal brine	Feasibility study in progress. Awaiting permitting. Target: 40 kt Li hydroxyde/yr.
Czech Republic	Cinovec	European Metals	0.87	Pegmatite	Feasibility study in progress. Awaiting permitting. Target: 29 kt Li hydroxyde/yr.
Serbia	Jadar	Rio Tinto	0.44	Jadarite	Project suspended due to exploration licence revoking/ local opposition. Feasibility was in progress. Target: 58 kt Li carbonate/yr.
Spain	San Jose	Infinity Lithium	0.13	Pegmatite	Feasibility study in progress. Awaiting permitting. Target: 19.5 kt Li hydroxyde/yr.
Germany	Zinnwald	Zinnwald Lithium	0.13	Li-mica greisen/ aplite	Feasibility study completed in 2019. Awaiting funding. Target: 7.5 kt Li carbonate eq./yr.

Figure 11. Location and summary of Lithium projects in Europe. Source: Patrice Christmann's presentation

- These early-stage projects may not enter the production level by 2024 or even 2025.
- Social acceptance issues with mining projects may block or delay new projects.
- The top five projects represent 96% of all the documented European resources.

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- Their cumulated planned annual production capacity is equivalent to about 29 kt Li eq./ year, 9 kt below (24%) what would be needed by 2024 to supply the planned European batteries gigafactories. If these projects will start full production in 2024.
- None of the stated projects is fully permitted (the status at the time of the webinar).
- Not only mining but also environmental permits are needed today.
- The planned EU Gigafactories will face major raw materials supply issues (Li, but also graphite, Ni and Co) unless supply agreements have already been secured with existing or near-production non-EU Lithium producers.
- Battery producers must invest in exploration and mining, or at the minimum, secure long-term supply agreements with miners or face supply bottlenecks.
- The global competition for access to battery-grade raw materials is very stiff, and will further rise in the coming years, with Chinese companies being very active internationally, **a potential security issue for the EU**, **while the EU has no legal basis to develop a full raw material strategy that would be legally binding for the member states.**
- The global demand/supply imbalance is likely to increase LiB raw material prices.
- Significant price rises may negatively impact the transition to electromobility.

Speaker 4

Mr Asko Saastamoinen, Chief Human Resources Officer, Keliber Oy

Key Messages:

- Keliber, a Finnish mining and battery chemical company is starting sustainable battery-grade lithium hydroxide production, utilizing its own in 2024.
- Central Ostrobothnia has some of the most significant lithium deposits in Europe.
- The construction phase of Keliber's project is scheduled to start in 2022.
- Using the best available technologies, aiming for the smallest possible CO2 footprint.
- The company's operations are located close to the European markets.
- Aiming to 15000 tons/year, roughly the amount of Lithium Europe is consuming now. However, that is approximately 7 % of the demand level that will exist in 7-8 years. The demand for lithium and lithium hydroxide is growing fast.
- The feasibility study indicates strong profitability.

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- Some of the environmental and mining permits have been received. They are waiting (at the time of the event) for the last environmental permits for their process facilities.
- Lithium's mining chain from exploration to mining to processing does not really differ from other minerals and metals.

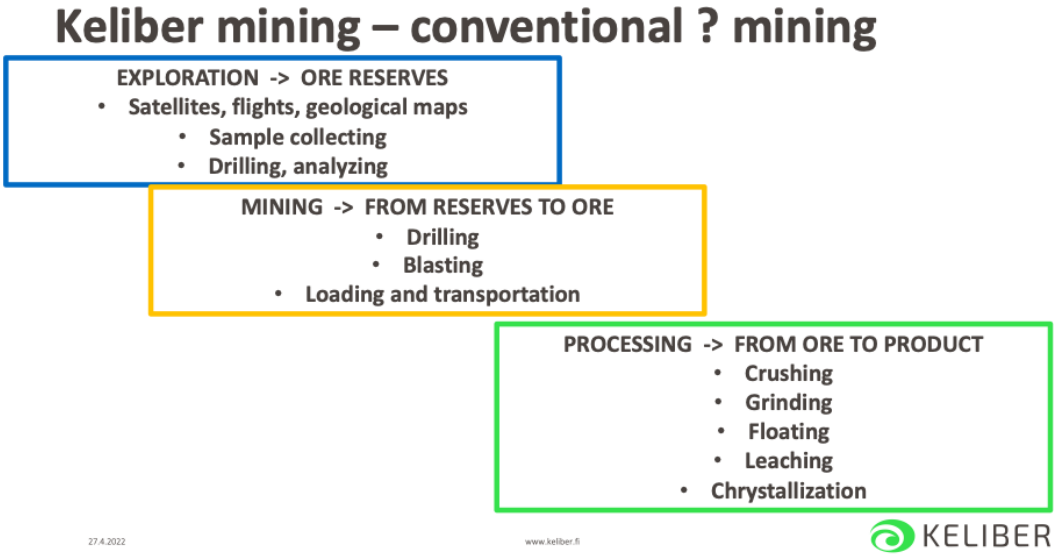

Figure 12. Mining chain of lithium. Source: Asko Saastamoinen's presentation

- **Exploration for ore reserves**
  - Expensive and time-consuming to find out data about the potential deposits
  - Collecting geological data for 3 – 15 years, collecting samples on the surface 3 – 10 years, drilling samples 3 – 15 years
  - Focused drilling on selected areas
  - Defining ore resources; grade, minerals, volume
  - Usability to plan to process
  - Economical value and the lifespan of a mine
- **Mining – from reserves to ore**
  - Mining is moving to apply very sophisticated technology (digitalized etc.).
  - Efficient mining activities require **very tight scheduling and planning** as well as a variety of skills from blue-collar workers that they have in mines and beyond.
  - Drilling a tight net for blasting; laser and GPS location
  - Blasting with matrix -explosives
  - Directed to certain grade ore to feed the production
  - Loading with excavators
  - Transportation with mine trucks (100 - 200 tons)

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- Yearly moving < 1Megatons ore +4-7 Megatons side rock

- **Processing – from ore to product**
  - Critical part of the mining
  - Normally the concentrator is located close to the mine site
    - to cut down the CO2 emissions,
    - to have the processing as close to the mine site as possible and finally,
    - to provide the final product to the market and the chemical and battery industry.
- Keliber employs over a hundred people in their activities incl. construction planning.
- When in operation in 2 years the headcount is estimated to grow up to 250-300 employees, which will be involved the production of lithium hydroxide to the market.
- **Their business, mining is not immensely labour-intensive anymore, as technology has stepped in to decrease the size of a headcount.**
- **The introduction of technology has brought high demands for the skills and know-how expected from the staff working in the mining-related positions.**
- **Working areas at Keliber**
  - Mines
  - Concentrator and chemical plants
  - Maintenance
  - Laboratories
  - Logistics as well as supportive and administrative functions
- The desired skill level of the employees is very high: experienced/trained.
- The key white-collar resources: geology, metallurgy, and process operations
- The key blue-collar resources: chemical & process operators and mine operators
- Job roles listed in the presentation of Mr Saastamoinen:
  - Process Operators
  - Qualified chemical process operators, multiskilled for electricity or maintenance technicians
  - Maintenance Technicians: Electricity, automation, mechanical
  - Laboratory technicians, Chemists
  - Supervisors, Engineers with technical education and industrial experience

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- Mining: geologists, drillers, loaders, drivers

- Basic education needed and experience recommended:
  - Process, chemical
  - For maintenance purposes mechanical, electricity, automation engineering
  - Geology, chemistry
- Mining and process industries need people with vocational or special education.
- Right mindset essential: the match between people and an employer.
- Workplace skills:
  - Working in teams, flexibility, resilience, development attitude
  - Safety, environment,
  - IT skills (digitalization entering the mining business)
- Fit for the team; different skills to fill the gaps
- Schools and universities – what would be needed for the education:
  - core skills combined with special skills they need in their field of business
- The availability of employees is not very high at the moment in Europe and especially in Finland, which is a challenge for employers.

Speaker 5

Dr Blandine Gourcerol, Economic Geologist, BRGM

Key Messages:

- The BRGM is France's public reference institution for Earth Science applications for the management of surface and subsurface resources and risks.
- Its activities include scientific research, support for public policy development and international cooperation. They focus on the value chain to
  - Exploration
  - Mineral characterization, Geochemistry & lithium isotopes analyses
  - Market and use
  - Sustainable Processing & Recycling
- Lithium is Silvery-white alkali metal that is highly reactive with excellent electrical conductivity. It is the most electronegative metal.
- Excellent for electromobility and green technologies (energy storage and LiB).

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- Lithium sources
  - brines - relatively recent, enclosed, tectonically active basins
  - hard-rocks - Li-rich mineralization in magmatic and/or sedimentary rocks
  - unconventional – seawater, hectorite, geothermal brines

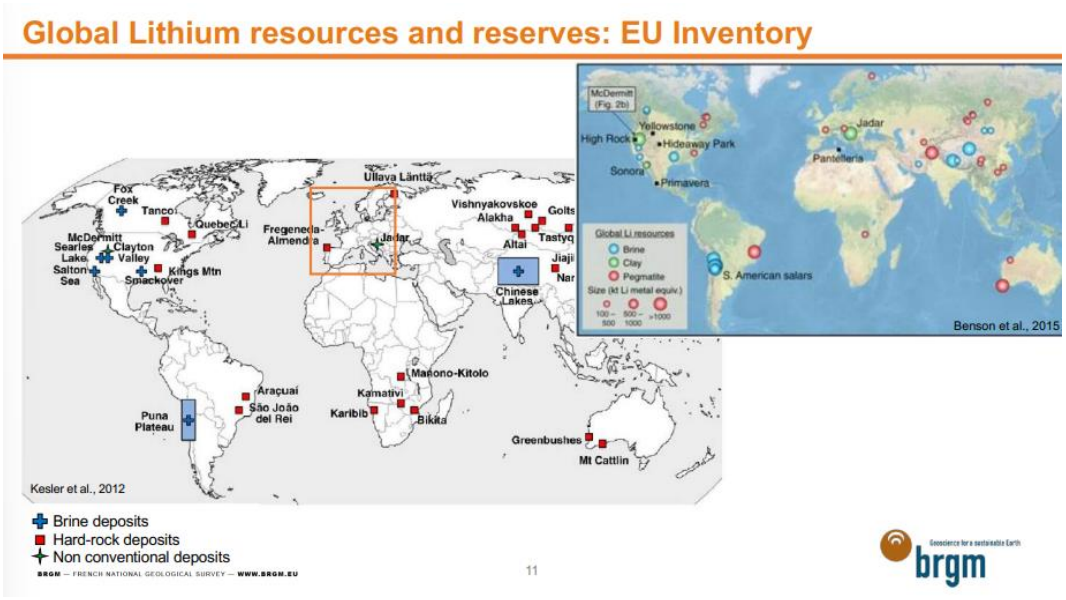

Figure 13. Inventory of global lithium resources. Source: Blandine Gourcerol's presentation

- European hard-rock deposits: 527 lithium occurrences and deposits identified

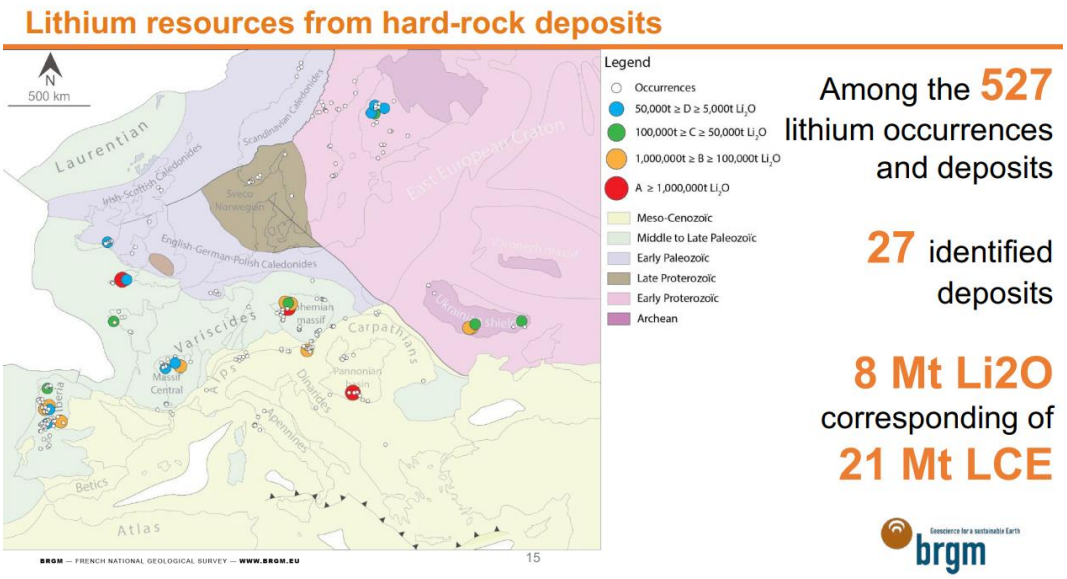

Figure 14. Location of Lithium resources from hard rock in Europe. Source: Blandine Gourcerol's presentation

- Lithium resources from geothermal brines: 182 occurrences identified

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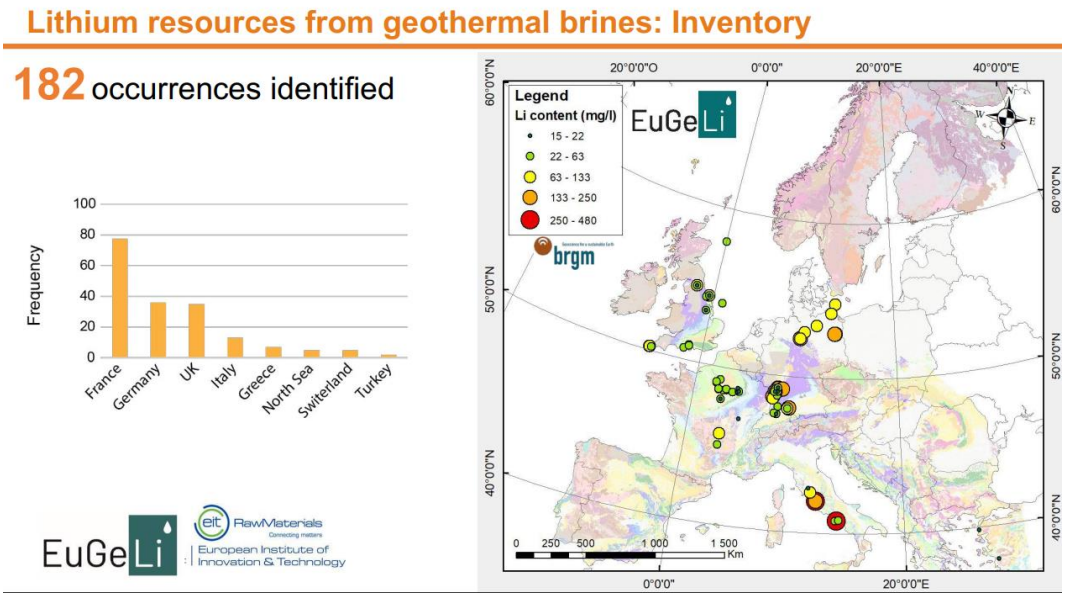

Figure 15. Location of Lithium resources from geothermal brines in Europe. Source: Blandine Gourcerol's presentation

- There are processes applied to geothermal brine and petroleum brine projects:
  - conventional process: evaporation ponds (takes 2 years)
  - Direct Lithium Extraction (DLE): chemical process (takes 2 hours)
    - 3 main types of DLE: absorption, ion exchange, solvent extraction
- Two main projects in Europe regarding the geothermal process:
  - Pilot by Eramet in partnership with Electricité de Strasbourg at Rittershoffen geothermal power plant (northern Alsace, France)
  - Pilot by Vulcan Energy at the Insheimand Landau deposit in Germany
- With geothermal process lower carbon emissions, water consumption, land use, reagents consumption and waste generation if compared to other methods.
- **Job roles, skills, and competences**
  - Geologists
  - Geochemists
  - Metallurgists
  - Engineers (chemical, electrochemical)
  - Job role areas identified in the presentation of Mrs Gourcerol:
    - Exploration
    - Mineral characterization
    - Geochemistry & lithium isotopes analyses
    - Market and use analyses

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- Sustainable Processing & Recycling

Speaker 6

Dr Carlos Nogueira, Head of the Materials for Energy R&D Unit, LNEG

- Lithium is a strategic and critical metal for the EU.
- Li-ion batteries are the current state-of-the-art battery technology supporting:
  - Energy Transition (Electric mobility, electrochemical energy storage)
  - Electronic portable devices

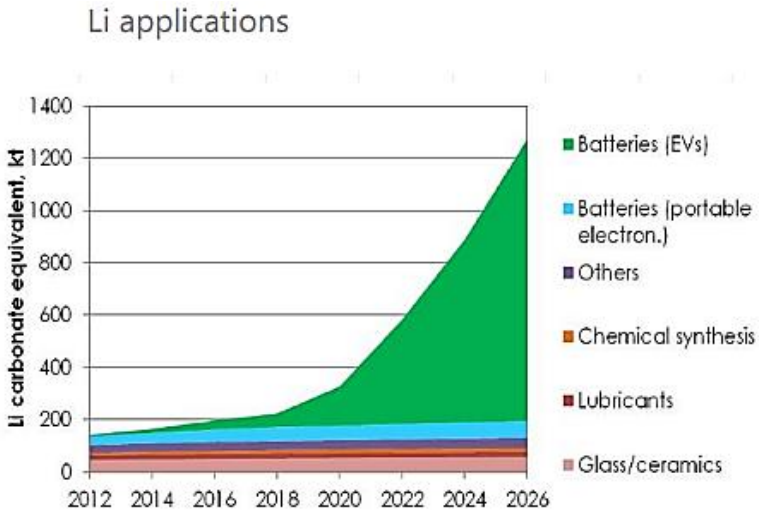

Figure 16. History and prediction of Lithium use by the application. Source: Carlos Nogueira's presentation

- Huge increase in Lithium demand forecasted due to its use in batteries.
- There are two different Li sources, primary (ores) and secondary (recycled batteries).
- Lithium primary sources include brines and hard-rock minerals (the latter becoming more relevant due to the cost reduction and increase in the market value of Lithium).
- Acquiring lithium from hard-rock minerals is more complex than from brines.

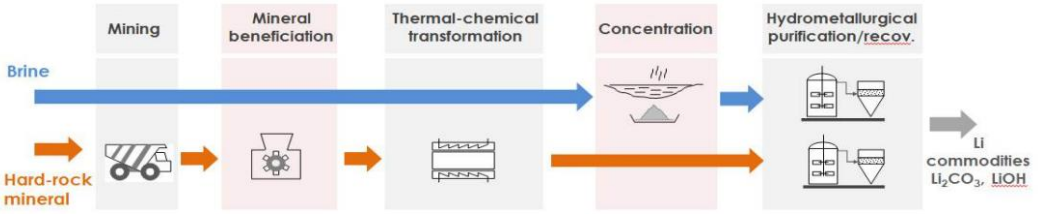

Figure 17. Process for lithium treatment from brines and hard rock materials. Source: Carlos Nogueira's presentation

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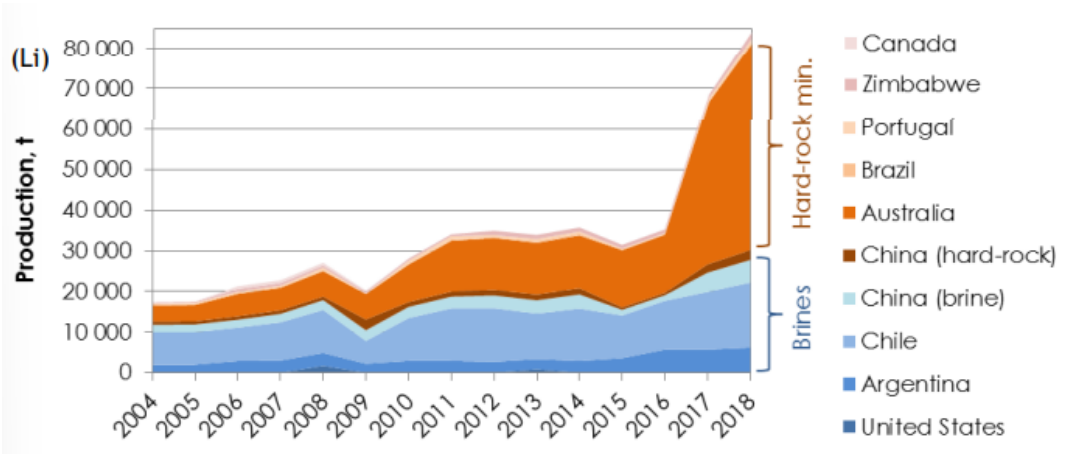

Figure 18. Production of lithium by source and location. Source: Carlos Nogueira's presentation

- Li commodity prices rapidly grew 400% in just one year (2021-22).
- Massive demand for electric vehicles and labour shortage in Australian mining operations are reasons justifying the huge growth in a short time.
- The added value of commodities is substantially higher than operating costs.

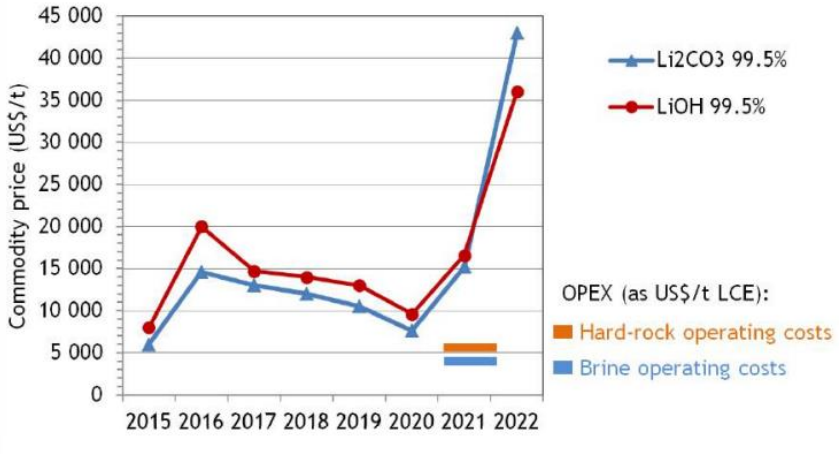

Figure 19. History of lithium's price. Source: Carlos Nogueira's presentation

- These figures do not yet consider the effects of the current energy crisis.

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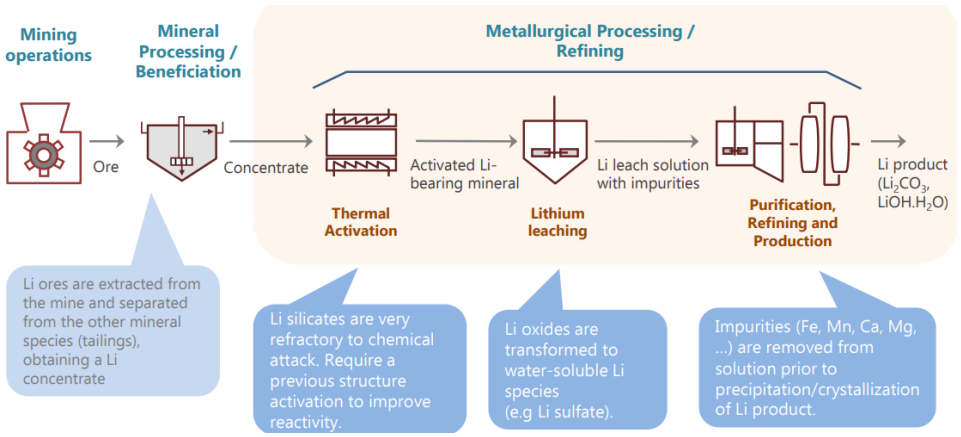

Figure 20. Process of refining lithium. Source: Carlos Nogueira's presentation

- Metallurgical treatment - from ore to Li commodity: main steps

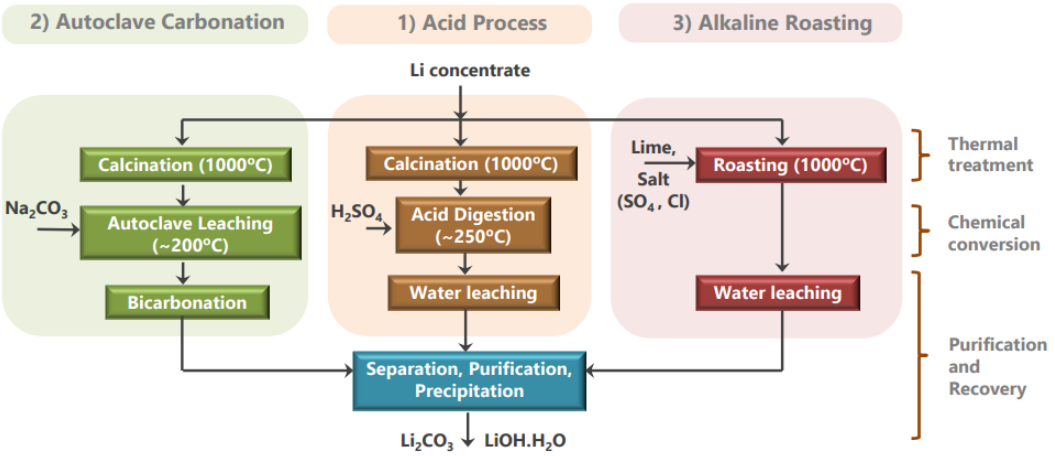

Figure 21. Different processes for lithium refining, Source: Carlos Nogueira's presentation

- Metallurgical treatment - Hydrometallurgical processing options (above)
  - The Acid Process is the most common.
- The advantages of producing LiOH.H2O instead of Li2CO3:
  - Lithium hydroxide (LiOH.H2O) is a direct precursor for manufacturing of battery cathode materials; Lithium carbonate (Li2CO3) will require previous conversion to lithium hydroxide, with CO2 release.
  - Improved classical routes with Acid Leaching produce Lithium hydroxide.
- Environmental concerns (Green mining / green metallurgy):
  - Green process design, waste-water management in hydrometallurgical operations, gas emissions in thermal treatment
- **Skills and Training in Metallurgical Processing**

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- Resume the training effort in chemical/extractive metallurgy in universities (in Metallurgical/Materials Engineering, among others), which has been mostly forgotten in recent years in Europe;
- Promote advanced courses focusing on the new purification technologies to apply in industrial projects, aiming at attaining the high purity required battery-grade Li compounds;
- Promote training in process sustainability, a fundamental topic for the success of projects of new lithium refining facilities:
  - Water management
  - Energy needs and alternative energy sources (e.g. H2)
  - Optimization of reagents/chemicals usage

Speakers 7 and 8

Dr Nathalia Vieceli, **Ms Lea Rouquette PhD Student**, Chemistry and Chemical Engineering, Industrial Materials Recycling, Chalmers University

- Why recycle:
  - Critical materials crucial for the transition to greener technologies
  - Create additional supply:
    - Reduce the need for primary resources
    - Reduce the reliance on imports
  - Environmental concerns
- Battery Regulation Proposal released in 2020 (probably implemented 2022-2023), following the Directive 2006/66/EC. Its objective is to establish clear and harmonized rules to make recycling profitable and mandatory.
- Recycling efficiency targets/scenarios in the new legislation (examples below)

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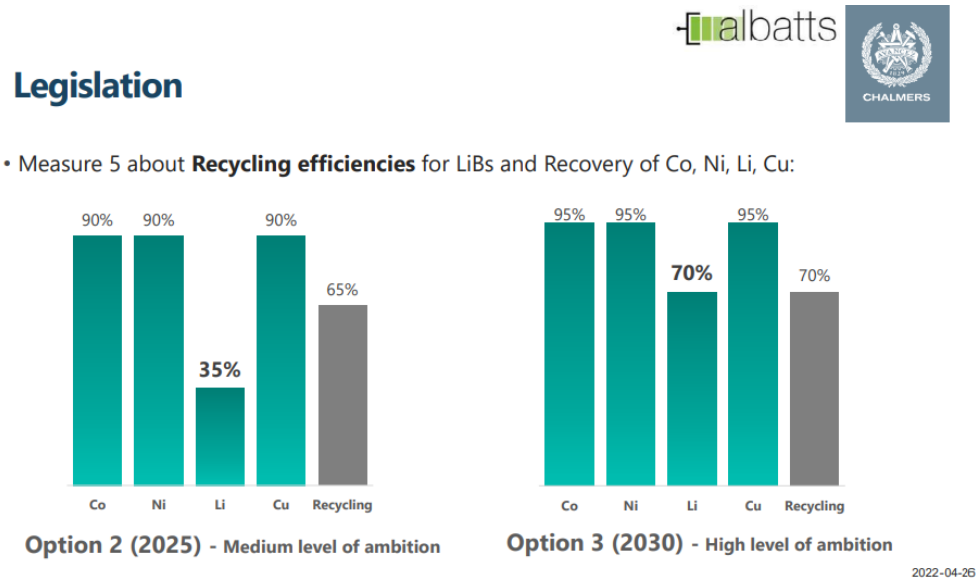

Figure 22. Efficiency targets in recycling LiBs materials. Source: the presentation of Nathalia Vieceli and Lea Rouquette

- Article 8 concerns the minimum share of recycled material in new batteries: 4 % in 2030 and 10 % in 2035.
- When comparing recycling to a primary source, ore, or brine, how much material is needed to obtain 1 ton of lithium: 2tonston of ore or 750tonsn of brine vs 2tonson of LiBs from laptops or 256 LiBs from EVs.
- EU is reliant on imports of lithium from primary sources. 87 % of lithium was imported in the timeframe of 2012-16. The end-of-life recycling input rate of lithium was 0 %.
- In 2015 only Lithuania exceeded the 20 % collection rate of the amount of used rechargeable LiBs. Batteries cannot be recycled If they are not collected.
- There is a need for safe handling and processing during the collection and storage. For categorizing batteries for recycling purposes, labelling is required.

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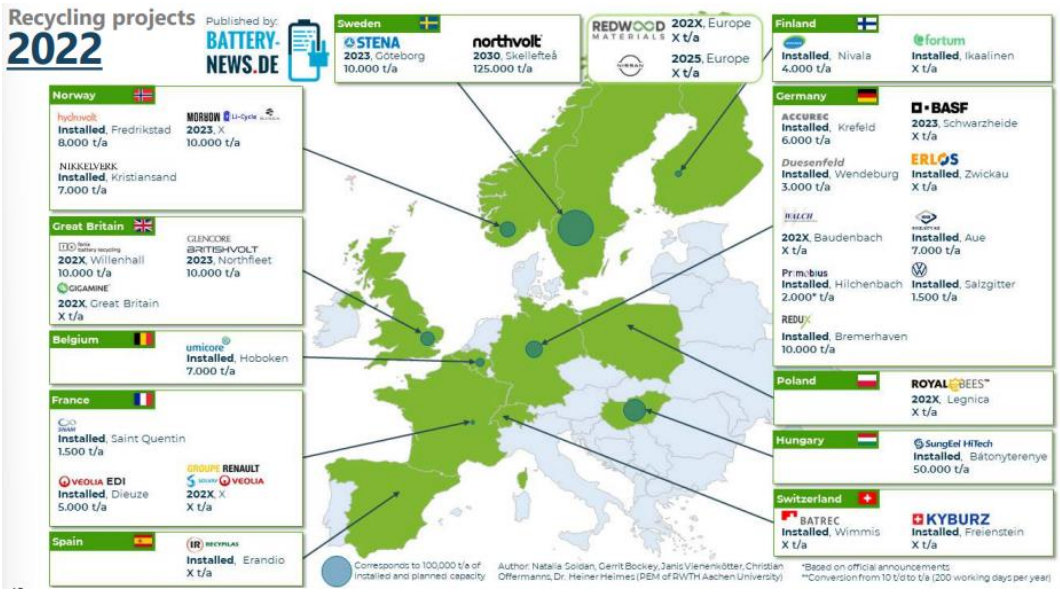

Figure 23. Recycling battery projects in Europe. Source: the presentation of Nathalia Vieceli and Lea Rouquette

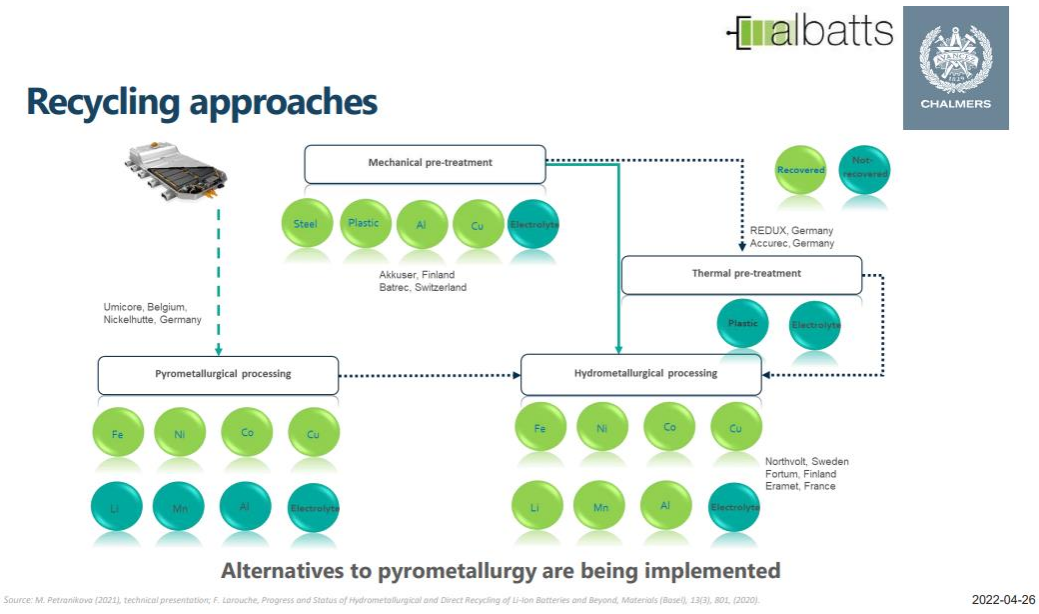

Figure 24. Different battery recycling processes. Source: the presentation of Nathalia Vieceli and Lea Rouquette

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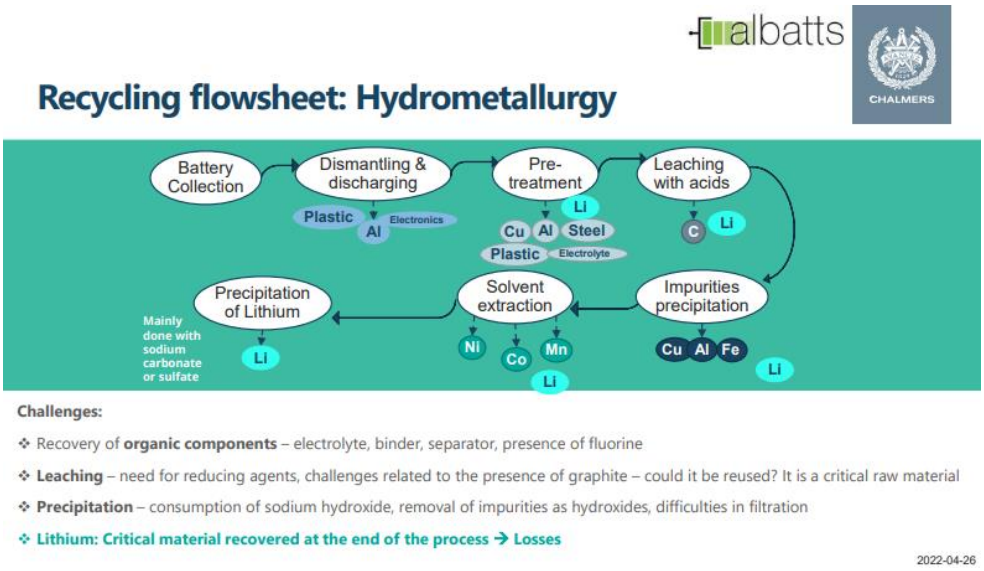

Figure 25. Recycling for hydrometallurgy flowsheet. Source: the presentation of Nathalia Vieceli and Lea Rouquette

- Ongoing research activity at Chalmers University is aiming to improve the lithium recovery rate from 3% to 95% using reducing thermal treatment followed by early-stage water leaching to produce battery grade Li2CO3 - purity of 99.95%.
- Skills, competencies, and understanding needed:
  - recycling, chemistry, battery production, life cycle assessment, social sciences,
  - chemical engineering, mining, material sciences, design for recycling
  - technical competencies, metallurgy, analytical techniques
  - law and regulations, battery safety

Questions and Answers

Do we have a shortage of skilled people in the upstream production of batteries? Are there specific skills related to lithium un exploration, mining, and processing?

Asko Saastamoinen:

- Lithium is not different from the other types of mining or process industry. Therefore, similar skills are needed with lithium.
- Skills in chemical and process engineering are essential.
- Geology, the education of which has been at a low level, is important.
- The skill/competence areas mentioned by Mr Saastamoinen must be made more attractive for newcomers (new students).

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In addition to the earlier question have you been approached regarding how curricula should be updated (in education)?

Carlos Nogueira:

- They have been contacted by several companies that are interested in going ahead with lithium refining.
- They are very interested in not only research, as all the processes need to be improved but also questions related to training and skills are among top concerns for industry people. This is due to them feeling that there is a lack of people with adequate training for example in the mining engineering, in metallurgy materials engineering and chemical engineering.
- Regarding skills related to the primary and secondary resources of lithium there are not enough university courses or advanced courses correctly addressing them. More should be invested in it in Europe.
- Lithium mining and metallurgy are not quite different from the ones with other metals. There are specific aspects with different metals and their behaviour, but essentially, we are talking about a thermal treatment and a leaching operation, precipitation, and extraction.

Nathalia Vieceli:

- We should pay attention to the European trend of people not keen on having (mining etc.) operations in the proximity of where they live.
- These topics should be thus addressed in an early stage, at school.
- People should realise that for certain things (for example batteries) to be available, mining, and other operations are needed. If this is not addressed, we may continue to face these kinds of obstacles in the EU.

Laurence Lamm:

- It is vital to address the public about the importance of raw materials.

If you were asked to work in lithium's geothermal extraction, would you be able to operate in that position with your background and studies?

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Blandine Gourcerol:

- Geothermal brine lithium has more similarity to a petroleum brine project than a mining project.
- In her case, with her background in mining, she would need to get more involved with petroleum project specifics.
- Generally, while lithium has special characteristics it's mining and extraction requires similar skills and competencies as other metals.

The industry needs a lot of blue-collar workers, technicians etc. Do we have enough training available? Also, how to train people who want to change careers and move into a new industry? Do you have internal programmes and how do you deal with up-/reskilling?

Asko Saastamoinen:

- The training issue has been solved by local institutions: VET schools and universities.
- They have collaborated to "catch" people willing to change careers and work in the mining, exploration, the or chemical industry. There are programmes to retrain people to new positions in different levels for white-collar and especially for blue-collar employees.
- There is an interested workforce available. The fact that their company is in the business of building a greener world attracts people.
- Aging and other career opportunities provide challenges to employers who also must be able to be attractive enough to potential employees.
- People can choose their employers at the moment.

How are the EC and member states dealing with the shortage of skills and employees?

Gerardo Herrera:

- While I do not work directly on skills, I know that this issue is one of the main priorities of the industrial alliances regarding batteries.
- We are putting a great effort into producing a lot of batteries in Europe within a very short time span, 2025-30.
- The estimation is we need to re-/upskill 800 thousand of people by 2050.

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- 3-4 million jobs could emerge in the battery raw material value chain. Thus (for example) EBA Academy was created to bridge the skills gap.
- This is why initiatives/projects such as ALBATTS are important, and the EC has been encouraging member states to use the funding available through for example the Recovery and Resilience Facility or the Just Transition fund to bridge the skills gap.

Are there specific safety aspects that need to be paid attention to?

Carlos Nogueira:

- Mining and metallurgical operations with lithium are not specifically dangerous or more dangerous if compared to other metals.
- While lithium's metallic form is very reactive, it doesn't exist in such an explosive form when mined or in metallurgical operations. There are no specific dangers with it, as it always exists in oxidized forms.
- There potentially exist other metallurgical operations with other metals that are more dangerous than with lithium. This should be communicated to the public to diminish the social acceptance issues.
- In general, the lithium metallurgy is similar to that of other metals such as zinc, cobalt and aluminium mentioned by Mr Nogueira.
- In the context of recycling, batteries can be dangerous if they are not properly managed. The first step should be deactivation, and discharging of batteries to avoid remaining dangerous voltages.
- Electrolyte material is an organic substance with a fire risk.
- Regarding skills and training there is also a need to train people in the collection and handling of used batteries.
- Recyclers should have well-trained blue-collars with electricity skills for correct/safe battery deactivation before the processing.

Mr Ludger Michels, Director Standards, Safety & Environment, Innolith Science and Technology GmbH (audience):

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- The main thermal reaction usually occurs with the decomposition process of the cathode material and the reaction with the carrier. That generates lots of energy and cannot be easily extinguished.
- The usual misunderstanding: lithium is a battery's dangerous part.
- People need education about handling batteries. Stockpiling batteries safely before recycling requires taking measures and a well-educated staff.

Information about the event with a recording can be found on the ALBATTS website.

The post-event satisfaction survey is not available for this event.

2.4 Key findings

Dr Gerardo Herrera & Dr Patrice Christmann:

- We are dependent on lithium coming from abroad.
- The demand for battery raw materials, incl. lithium will increase significantly by 2050.
- Europe is likely to confront a huge supply gap in the coming years.
- The global competition for battery-grade raw materials is a potential security issue.
- Actions are needed to strengthen EU production and diversify supply sources.
- Communicating with the public is important due to social acceptance issues.
- Expertise & skills need to be developed (re-/upskilling among the EC priorities).

Mr. Asko Saastamoinen

- Lithium's exploration, mining and processing do not differ from other minerals/metals.
- We are moving from conventional to more digitalized and sophisticated mining.
- Introduction of technology to mining brings high demands for skills and know-how.
- Key white-collar manpower resources: geology, metallurgy & process operations
- Key blue-collar manpower resources: chemical & process and mine operators
- The availability of employees is not high in Europe which is a challenge at the moment.

Dr Blandine Gourcerol:

- Lithium has high electrical conductivity and is thus excellent material for batteries.
- The sources: brines, hard-rocks and other (seawater, hectorite and geothermal brines)
- 527 European hard-rock deposits and 182 geothermal brine occurrences identified.

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- The skill & competence areas: exploration, mineral characterization, geochemistry & lithium isotopes analyses, market and use analyses, sustainable processing & recycling

Dr Carlos Nogueira

- Lithium is a strategic, critical metal. Its prices have increased significantly since 2020.
- Lithium battery's biggest estimated future use area, by far, is EVs.
- The main steps in the metallurgical treatment, from ore to lithium commodity include the acid process (the most common), autoclave carbonation and alkaline roasting.
- The main environmental concerns include waste-water management in hydrometallurgical operations and gas emissions in thermal treatment.
- Chemical/extractive metallurgy education in materials engineering should be increased in universities.

Dr Nathalia Vieceli, **Ms Lea Rouquette PhD Student:**

- Recycling batteries provide critical materials crucial for the green transition, reduces the need for primary resources and reliance on imports, and is essential in dealing with environmental concerns.
- Battery Regulation has been proposed for clear and harmonized rules to make recycling profitable and mandatory.
- Collection of batteries is an essential element enabling recycling.
- Safe handling and processing are important with battery collection and storage. Labelling required recycling-related categorizing.
- Multidisciplinary skill/competence needs: recycling, chemistry, metallurgy, safety etc.

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3 Second Life Bus Batteries in BESS Residential Applications

"Second Life Bus Batteries in BESS Residential Applications: Job Roles, Skills and Competences" was the first interview and the second event in the third round of webinars under Task 4.10. The event was organised on the 22nd of November 2022. The interviewee was Mrs Ylva Olofsson, System Design Engineer & Project Manager at Volvo GTT.

The purpose of the interview was to explore the use of second-life bus batteries in stationary residential applications and which job roles, skills and competencies are required.

Choosing the Topic

The number of batteries ending their life cycle is increasing exponentially as EV (electric vehicles) batteries reach their end capacity for this application. If the growth rate of used batteries continues the increasing rates from previous years, we may soon find a shortage of materials to produce batteries and the landfills will be saturated with batteries. It is in the best interest of the business and the environment to increase as much as possible the use of a battery before it is disposed of or recycled. One opportunity that was found by Volvo GTT was to reuse the batteries from the Route 55 buses in Gothenburg, Sweden in a residential context. This application has several benefits for all parties:

1. It alleviates the burden on battery factories by reducing the need to produce additional batteries;
2. It optimizes battery usage before its end-of-life phase;
3. The apartment complex has implemented a system that stores surplus electricity generated by photovoltaic panels during the day and releases it at night, thereby bolstering the adoption of renewable energy sources and promoting carbon neutrality in the electricity sector;
4. Recycling of resources, including energy and materials, is deferred until all possible uses for the batteries have been exhausted.

Given the challenges faced by Europe in the areas of sustainability and environmental goals, such as the Green Deal initiative, which aims to reduce the usage of raw materials and mitigate greenhouse gas emissions, we find the case study involving the use of 2nd life bus batteries in stationary storage systems to be a highly compelling and relevant topic for investigation, with potential for significant growth in the future.

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3.1 Agenda

Figure 26. Dissemination image for the interview

We received 52 registration requests from 16 countries, of which 2 were outside the EU. The top 3 countries in terms of the number of registered were Portugal, Finland and Sweden and the Czech Republic tied.

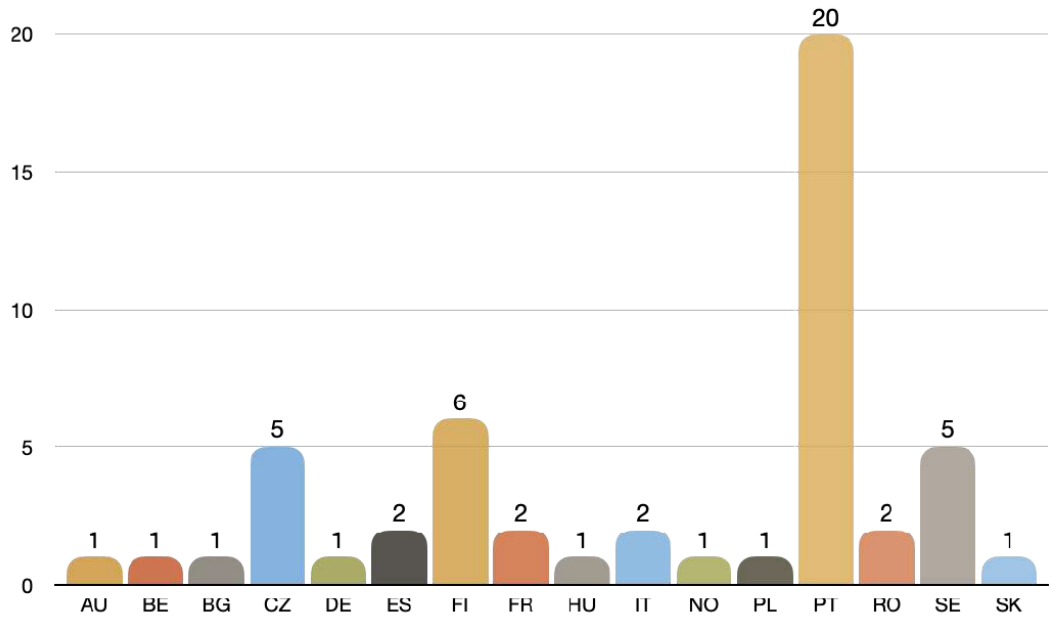

Figure 27. Number of registrations per country

Most of them represent education, industry, consultancy, and research sectors.

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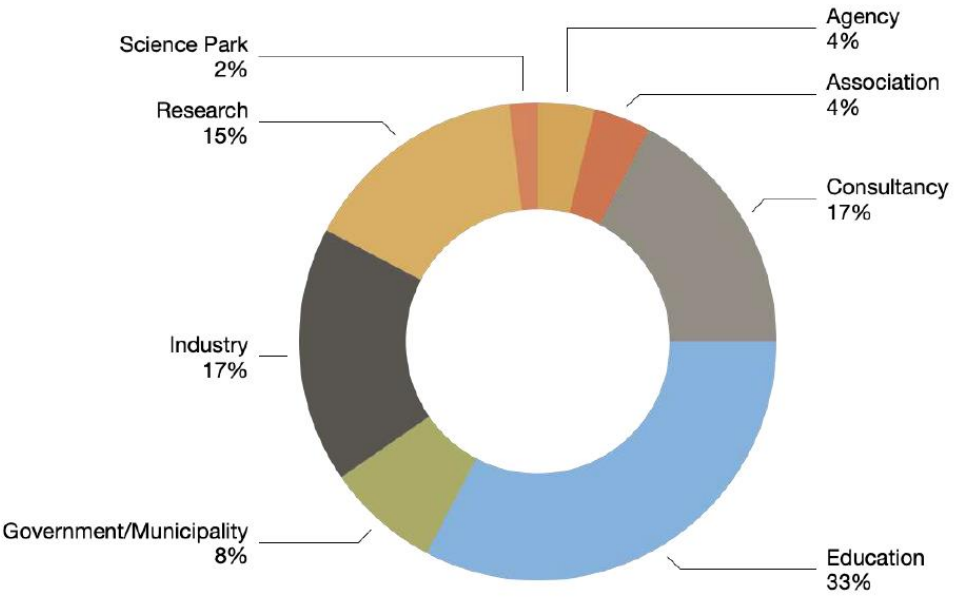

Figure 28. Distribution of the sector of the registered people

The number of viewers was 22 following the event's live stream. Viewers were following the live stream also on ALBATTS's Facebook profile. At the time of the writing of the report, it counts 24 views. The stream remains available on the ALBATTS website and Facebook profile.

3.2 Workshop Speakers

Moderator

The moderator of the event was Jakub Gajdušek an active member of the ALBATTS project in two working groups focusing on Stationary energy storage and Mobile battery applications. His expertise comes from being a project manager for a battery start-up HE3DA since 2017. The company is also an early member of the European Battery Alliance where Jakub attended many workshops and networking experiences. Jakub also joined a 1-year study exchange program at U.S. high school and followed his English studies at the Anglo-American University in Prague until his 2019 bachelor's graduation.

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Interviewee/Speaker

Figure 29. Bio of Ylva Olofsson used in the dissemination

3.3 Interview

Brief introduction of yourself and your background.

- Volvo Employee since 2013. Started as Research Engineer at cell testing and moved on to battery laboratory management. Later (2016) received a proposal to move to 2nd Life Bus Battery repurposed to support PV panels in the residential sector. She was one of the first people in Volvo to get involved with the topic.
- She is a systems design engineer and project manager - Using both **engineering skills and management skills** in day-to-day work.
- **Creativity** is a big part of the work.

What were the changes over the years since she has been a part of these projects?

- At the beginning, she started as a recently graduated with MSc in Sustainable Energy. They were working with batteries, but the company was not there yet. But now, they are a huge department working with electric mobility.
- There is a high demand for EVs that is shaping the business.
- Although it is a big company, it felt like a start-up environment – Creativity and high-speed going towards the solution.
- Change over the years has been very noticeable. Lots of changes are happening quickly.

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What kind of skills and competencies are needed in day-to-day work, to achieve a better product? What makes you a specialist in the project of 2nd life batteries?

- Fundamental interest in seeing a substantial change in society – Sustainability.
- Batteries are the solution for EVs – but high use of materials and life cycle assessment with huge impact – What about recycling, what is the end of the life of the batteries? No one was dealing with it -> It is a feasible opportunity.
- **Laboratory Management** and **Electrical Safety for fire hazards and battery safety** – key knowledge to accomplish this project.
- Project with media coverage and in a Residential Building carries a massive responsibility – There is no space for mistakes and **Bravery** is also essential.
- A company dedicated to **Electrical Safety** was key to providing confidence in the project.
- She was young at the beginning. Having more experience in **Project Management** would have helped in the project development. After the years, it leads to a **Strategic Development** of the area – There is a maturity of the project.

Figure 30. 2nd life Bus batteries and battery system used in the apartment complex in Gothenburg. Source: Ylva Olofsson's presentation

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- Building in Gothenburg with 132 apartments equipped with solar panels on the roof. The building was projected with a socially and environmentally sustainable architecture. There was a question if should exist a BESS in the building to store the extra produced energy by the solar panels.
- Volvo was questioned if they had batteries for the context. It was coincident with the start of route 55 of the Electric Bus – it was an **opportunity** to use the 2nd life batteries and proof of concept.
- How difficult is it technically? Possibility to evaluate the batteries over time with the **capacity degradation**.

How do you see the future of 2nd life batteries? What lessons have you learned from your experience? What results were unpredicted from the past and you learnt how to deal with?

- The **site**: preparation of the **mechanical, electrical and safety** solutions: **comparing with 1st life batteries helps**. The **software algorithm** can also be transferred from mobile to stationary applications. It is a good cost saver and enabler for the future.
- There was no need to update the software existing in the batteries, only the external software to the battery.
- Volvo wants the best product for safety, value, and efficiency.
- It is in the goals of Volvo to have re-manufacturing of 2nd life batteries.
- Large volume of batteries distributed across the world: implies that you must know a lot about the batteries and organize well the research and then the logistics of collecting batteries. All the **battery parameters** need to be known in detail to access if the batteries are usable for 2nd life or not.

Will in the short period be a sustainable model and/or a business case for 2nd life batteries?

- There needs to be a business for the sector to thrive, but it is hard to define a price yet and risk because it is a relatively new topic in the battery area. Batteries have been around for a while, but only now there is a volume of them to start investing in 2nd life.
- It is possible to calculate the supply of batteries and possibilities and it is being taken care of in another department of the company.

Safety is a concern of customers since they are being used in residential areas. How do you handle the safety of the batteries?

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- It was the first question that arose when starting the project: fire protection, safety alarms and signalling.
- Colleagues from manufacturing assured the batteries were very safe with mechanical protection, software protection, and safety limits.
- The room has fire insulation walls, heat detectors, smoke detectors, gas detection, and external ventilation. There is a contract with the fire brigade in case something happens – it is more than what is done with batteries installed in the houses and more than the standards require – but there is no specific standard to this case.
- Safety is a cost and may not be the most cost-effective solution. But it is a research system – and extra safety is required.

How far does Volvo deal with the data gathered from the BMS and process it as big data to improve safety issues when applied to 2nd life batteries? (Audience question)

- They have a PhD student working on the topic – It is an important topic, but Ylva is not the person with the knowledge and details on it.

2nd life batteries are interesting for their raw materials through recycling. Battery Cell factories do not want 2nd life as they can make better batteries of raw materials. Any Comment? (Audience question)

- Recycling is always part of the loop.
- Maximizing the use before recycling is the key.
- There's resource consumption for manufacturing. Recycling is important when it is time for it.
- **Detailed LCAs** are needed to better define the most sustainable option.

A short description of the team members' skills and competencies on Ylva's team.

- **Software** for controlling the batteries and **signals** towards the safety and the house control unit. Software is the key aspect.
- **Cables and connection- electrical engineers** to connect the batteries and create the fuse boxes and all the circuits.
- **Thermal Management – Thermal Engineers, cooling experts.**
- **Safety – Standards, Fire Standards, Chemistry, Battery Reactions.**
- **Ageing expert – PhD** to study **chemistry and reactions** inside the **batteries.** When does it stop working, and how much energy can we get from of it.

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- **Legal Aspects –** creating agreements between partners (supplier, 2nd party, 3rd party, installation, diagnostic repairs) – **you must have IP rights.**
- **Knowledge of the electricity market,** spot market – who gets which rights of the electricity.
- **Sales Department** – Sell the product.

Did you find it difficult to find people with the right skills for the project?

- Internally, the team is mature. There are enough people working with the battery topic. When she started it was harder, but the amount of people with the skills is growing.
- The business going from linear to circular helps to interchanging skills.
- **Leadership** skills are a key to have success in the business.
- Competencies are something you create. Example: Project management may learn about the batteries, but the mindset is the basis, and the rest is learned.

How far can you go with the process of reusing the batteries?

- There is still a lot of research to be done.
- It depends on the demand of the application to access 2nd life or even 3rd life.

A video from the Volvo company was shown about 2nd life batteries.

Where do you see the future of the battery industry and value-chain in Europe?

- It is good to engage in the conversation as batteries are very important in the future of a sustainable society.

The relevant questions in the chat have been integrated into the above question list. Information about the event with a recording can be found on the website of the ALBATTS project.

Post-event satisfaction survey

After the workshop, a satisfaction mini survey was sent to the participants. The response rate was very low, with 2 people answering. Overall, the participants were very satisfied with the workshop. Although the sample is not statistically relevant, the answers were very positive.

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What is your overall assessment of the event?		
Choice	**Answers**	**%**
1=Insufficient	0	0%
2	0	0%
3	0	0%
4	0	0%
5=Excellent	2	100%
Total	2	100%

Both people that responded to the survey were very satisfied with the event, classifying it as a 5.

Knowledge and information gained from participation at this event?		
Choice	**Answer**	**%**
Yes	2	100%
Somehow	0	0%
No	0	0%
Total	2	100%

Both people that responded to the survey claimed they learned something new in the interview.

Written feedback:

- How do you think the webinar could have been made more effective?

  "it's short time"
- In your opinion, what are the battery relevant future jobs and skills needed in the battery production sector and why?

  "Skills in chemistry, industry and market"
- Comments and suggestions (including activities or initiatives you think would be useful for the future).
- *"Presenting our work (for example researchers and students)"*
- *"I think that for students-this is of great value. Hopefully you can be a bridge to different kind of education systems-even for the vocational colleges and not only for universities."*

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Recommendations for the organisation of future webinars:

- A short video was prepared to be shown. It was the first time and it should be better trained in the rehearsal meeting. A video was shown in a later webinar and with proper training, it was possible to be shown.
- There was not enough time for dissemination. Although the topic is interesting, it is reflected in the number of registrations and attendance.

3.4 Key findings

- 2nd life BESS use majorly the same skills and competencies as a 1st life BESS with a focus on engineering and project management skills;
- Creativity is key;
- The EV market is changing very rapidly – There are a lot of opportunities in different market sectors such as recycling and 2nd use of batteries;
- An opportunity for EV (car, buses, etc.) batteries is to be re-used in a stationary BESS to increase their lifespan;
- It is needed to create the business case for 2nd life batteries for the area to thrive. Right now the efforts are in R&D to make the systems viable – maximizing the use of the battery before recycling;
- Fundamental interest in seeing a change in society is as important as having the right skills and competencies;
- Job roles, technical skills and competencies identified: Laboratory management, electrical safety for fire hazards or fire brigades (fire insulation rooms, heat, smoke and gas detectors, external ventilation), battery safety (standards, fire standards, chemistry, battery reactions), mechanical safety, software safety (alarms and signalling), battery parameters evaluation, software algorithms, cabling and connections (electrical engineer), Thermal management (thermal engineers, cooling experts), ageing testing (PhD with knowledge in chemistry and battery reactions. Testing the batteries for ageing) project management, strategic development, logistics, LCA studies, Legal aspects (agreements between parties, IP rights), knowledge on the electricity market, sales;

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- Soft Skills identified: interest in the topic, creativity, bravery in making decisions, leadership, mindset towards the goal, interest in engaging in conversation about batteries.

Job roles, skills, training tools and recommendations were identified in the webinar. These will be covered in the Work-Package 3 report that will be published in May 2023.

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4 BMS and Control Systems

Battery Management Systems (BMS) and Controls Systems: Job Roles, Skills & Competencies, November 24th,2022, with guest speakers: Mr. Jorge Pinto from Vasco da Gama CoLAB, Mr. Josef Tichanek from Olife Corporation and Mr. Mika Kauppila from Valmet Automotive.

The workshop is focused on the role of BMS and Control Systems in Stationary Energy Storage Systems, in EV Charging Stations and in Electric Vehicles

Choosing the Topic

The BMS system is the hearth of the battery system which manages the power input and output as well as balancing the battery modules and cells in the electric application. With further improvements in the battery sector the safety aspect is the most important one as well as transition of used batteries from the automotive industry to the energy storage market as a second-life cells. Therefore, a great emphasis is towards highly skilled workers and new job roles are identified. The webinar allows our public viewers to gather information from the industry players what are the current job roles and skills required for the BMS sector as well as where do they see the future development of their products in regards of new job roles and skills in specific areas.

4.1 Agenda

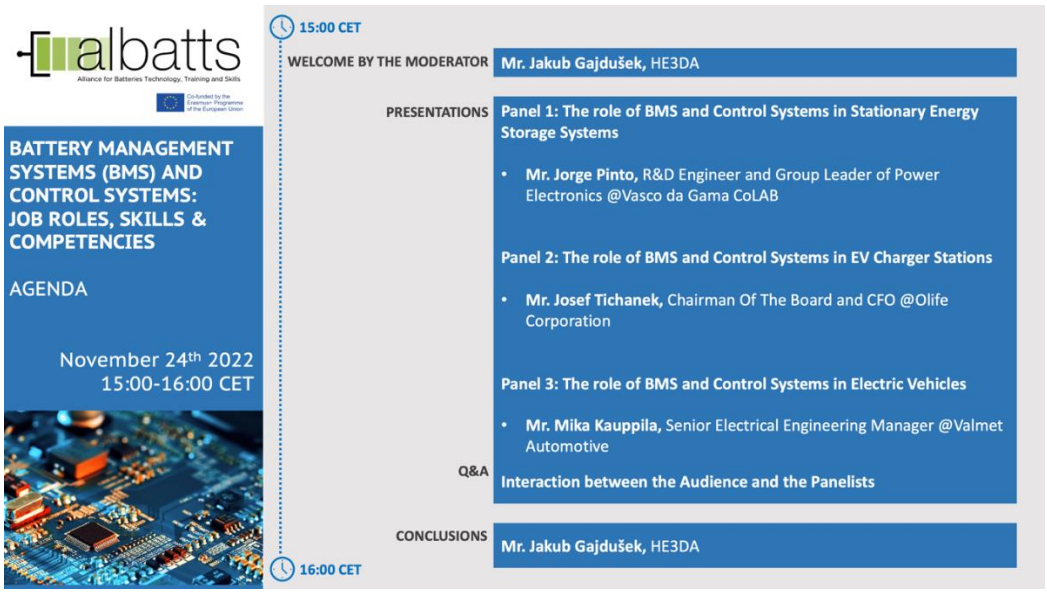

Figure 31. Agenda for the webinar

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We received 67 registration requests from 20 countries, of which 5 were outside the EU. Most of them represent industry and education sectors although other major representatives were from research and consultancy group. The top 3 countries in terms of the number of registered were Portugal, Romania, and Sweden.

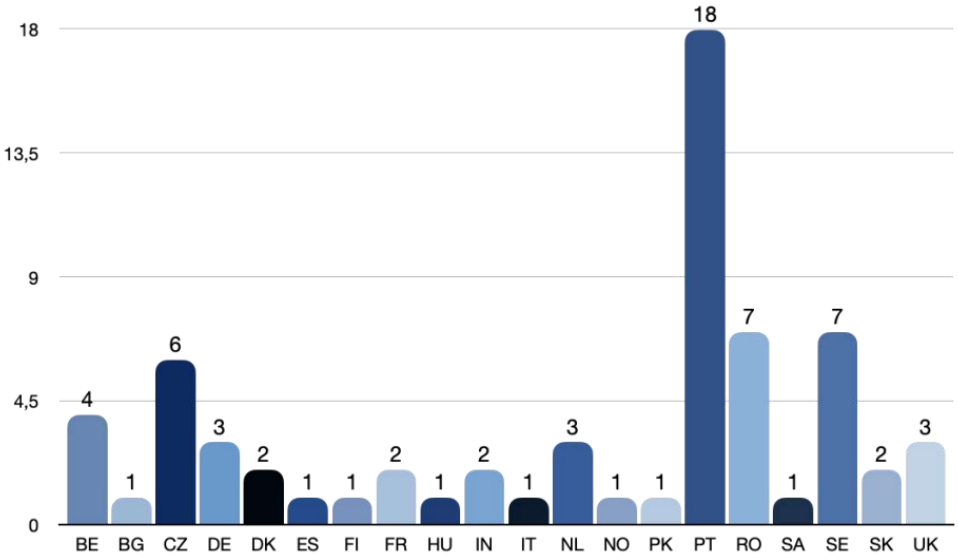

Figure 32. Number of registrations per country

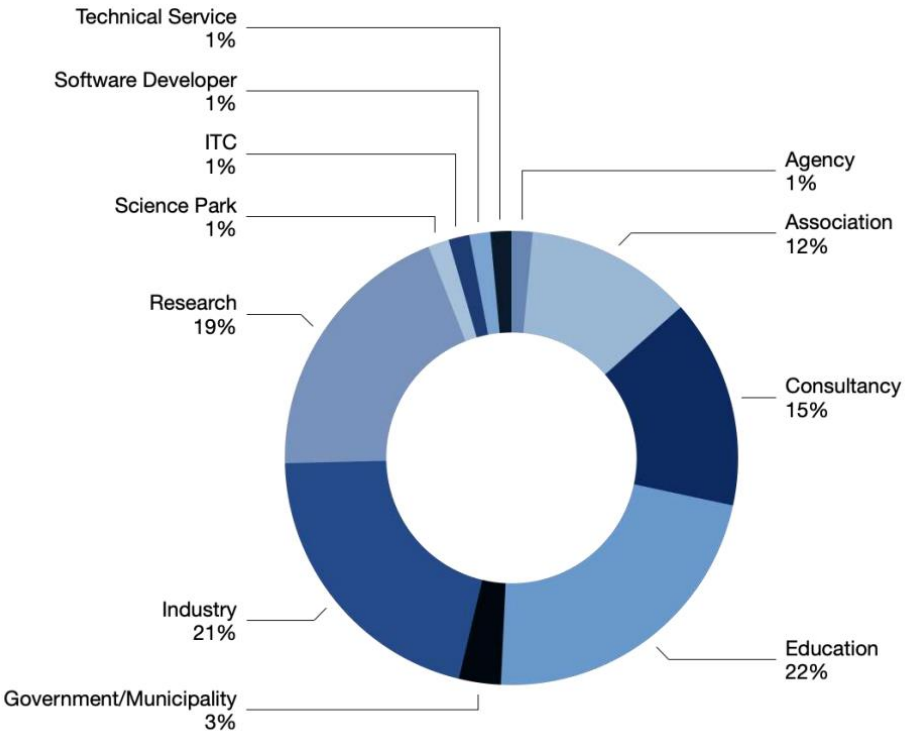

Figure 33. . Distribution of the sector of the registered people

The number of viewers was 42. The rest have accessed the recording on the ALBATTS website. Viewers were following the live stream also on ALBATTS's Facebook profile.

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4.2 Workshop Speakers

Figure 34. Dissemination image for the interview

Moderator

Jakub Gajdušek has been an active member of the ALBATTS project in two working groups focusing on Stationary energy storage and Mobile battery applications. His expertise comes from being a project manager for a battery start-up HE3DA since 2017. The company is also an early member of the European Battery Alliance where Jakub attended many workshops and networking experiences. Jakub also joined a 1-year study exchange program at U.S. high school and followed his English studies at the Anglo-American University in Prague until his 2019 bachelor's graduation.

Interviewee/Speaker

Jorge Pinto is Team Leader at VG CoLAB (Porto, Portugal) in the field of power electronics and energy management. During his PhD, he researched and developed control methods integrating battery management functionalities in decentralised power-sharing of parallel connected power converters in island microgrids. He is currently responsible for projects related to the development of innovative hybrid-battery packs and respective power converters MVPs to ensure microgrid energy security and extend battery lifespan.

Josef Tichanek is CEO of Olife Corporation a.s. in the Czech Republic, a company that is developing a lithium car starting battery. He was also responsible for technical development of Olife battery. Prior to joining the company, Josef worked in consulting - Deloitte and PwC,

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where he was focusing on credit risk management and enterprise risk management. He studied at Technical University in Ostrava - VSB.

Mika Kauppila is Senior Electrical Engineering Manager at Valmet Automotive. He is currently working with batteries for automotive OEMs and off-highway applications. He has over 15 years of experience on power management, including power electronics, stationary storage systems and electrical vehicles.

4.3 Webinar

Key Messages:

- Recent and future development of battery cells and battery modules requires an intensive development of BMS systems and therefore an increasing demand for highly skilled workers was well discussed and explained by all speakers. A specific job roles and skills were presented as well.
- The importance of a high-quality BMS systems is growing due to rapid changes in the automotive sector where a second-life batteries and especially their safety is a major concern of their future growth and usability in different systems and applications such as solar storage system.

Speaker presentations:

Speaker 1

Jorge Pinto, Team Leader at VG CoLAB

- Company Vasco da Gama CoLAB is the No. 1 recognized lab in Portugal. Their main focus is on promotion of high skill jobs, research between education and industry and developing prototypes for the industry. The company develops BMS system from modules up to pack designs and also power converters and other management systems.

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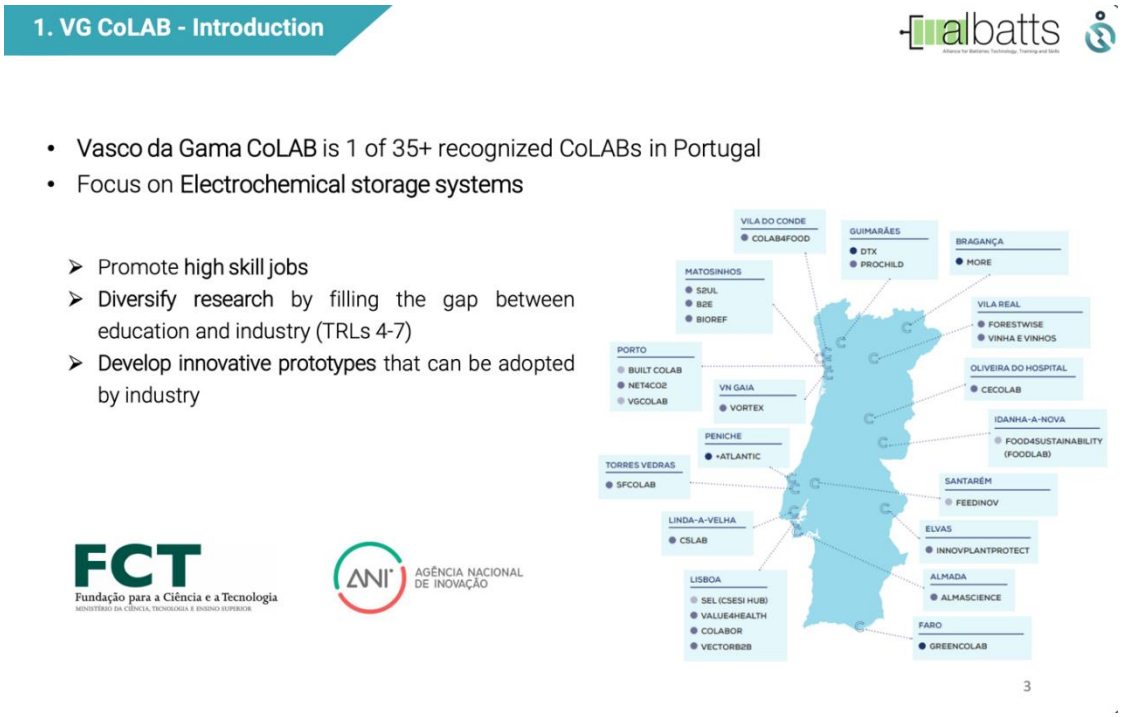

Figure 35. Vasco da Gama CoLab introduction. Source: Jorge Pinto's presentation

- The company forecasts a great improvement in battery management systems and therefore a high skilled workers will be needed. The state of technology and its future is presented below.

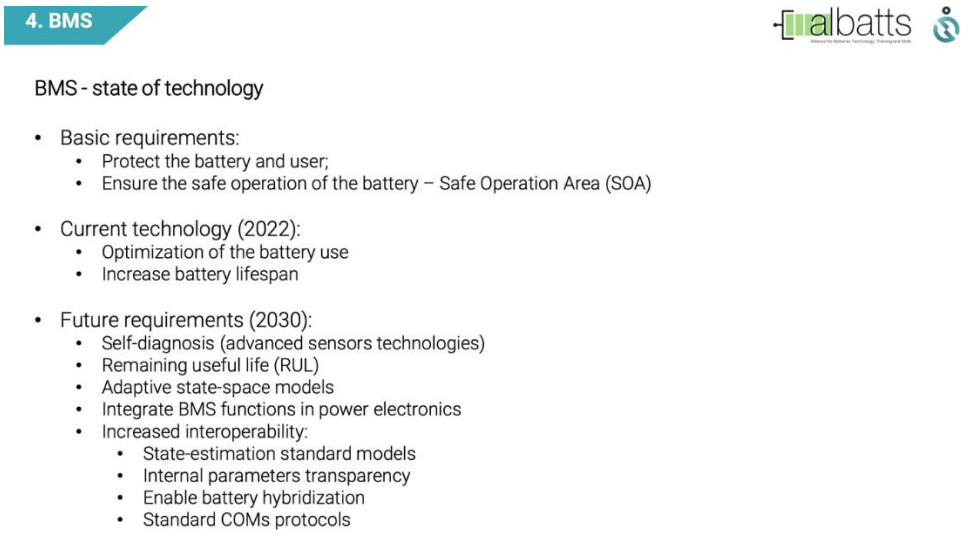

Figure 36. State of BMS technology. Source: Jorge Pinto's presentation

- Jorge provided a great summary of critical sectors in the BMS development where high skilled workers are needed. A rather simple looking BMS box requires multiple departments to collaborate with each other and high-qualified workers are needed to proceed the work to a high-end product standard.

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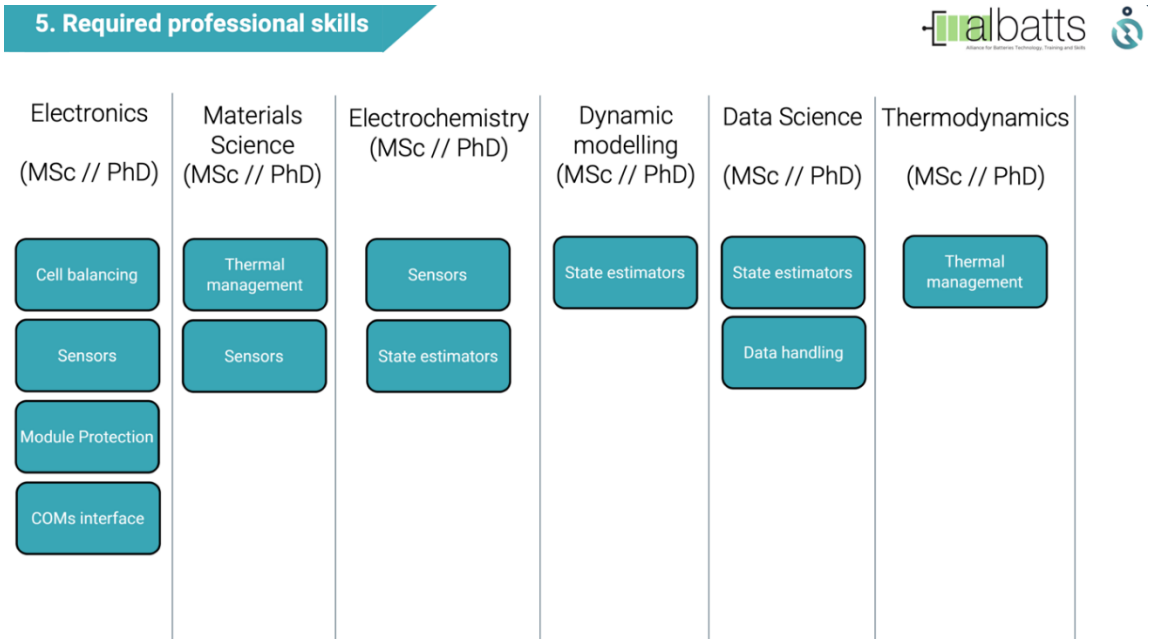

Figure 37. Description of professional skills. Source: Jorge Pinto's presentation

Speaker 2

Josef Tichanek, CEO of Olife Corporation a.s.

- Olife Corporation has developed a unique car starting battery using lithium cells and supercapacitors. During their development they have experienced a numerous challenge not only in regards of the technological research and development of final products but also in finding the right people with the skills needed for Olife team.

Figure 38. Introduction of Olife Corp. Source: Josef Tichanek's presentation

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- Originally the company thought they would hire a professional firm to do the research and development, but Olife had to remain the control of the project. Throughout the project the company identified the main job roles needed for the BMS development. While the development required such job roles, during live testing a thermal BMS manager had to be hired due to natural processes of charging and discharging of batteries.

6. Job roles and skills involved in the field

Main job roles involved in BMS development

- Battery Management System Engineer
- Functional Safety Manager
- Eletrical Engineeers and technicians
- Lithium Battery Specialists
- Programmers
- Technical managers – Documentation preparation
- Testing specialists

The requirements in terms of experience depend on the complexity of the project and maturity of the organization.

Figure 39. A list of job roles and skills. Source: Josef Tichanek's presentation

- Josef also presented a key requirement for one of the most important positions within the BMS development which is Functional Safety Manager – the main goal of the Olife battery project was to develop the safest starting lithium car battery in the market. For the project overall, most job roles do not require such high level of skills, but the job described below was identified as one of the key project managers for the technicians.

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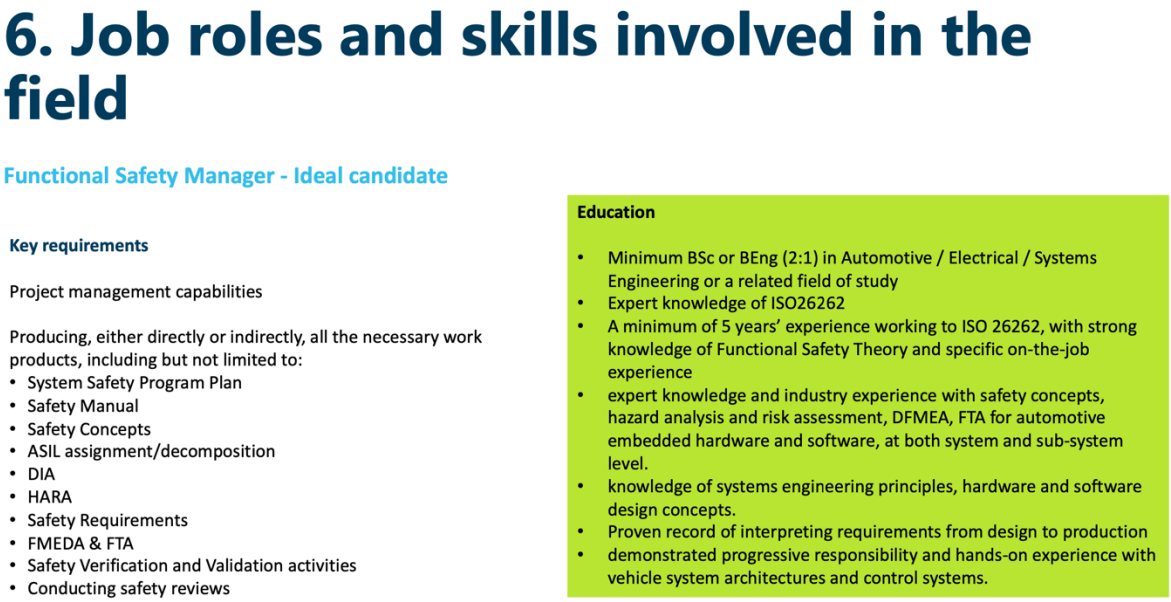

Figure 40. Descriptions of job roles and skills. Source: Josef Tichanek's presentation

- Apart from technical skills a several soft skills were presented as well. Josef addressed that even though it is hard to know soft skills from newly hired people, certain aspects needed to be addressed before signing the contract to overcome future problems within the team colleagues.

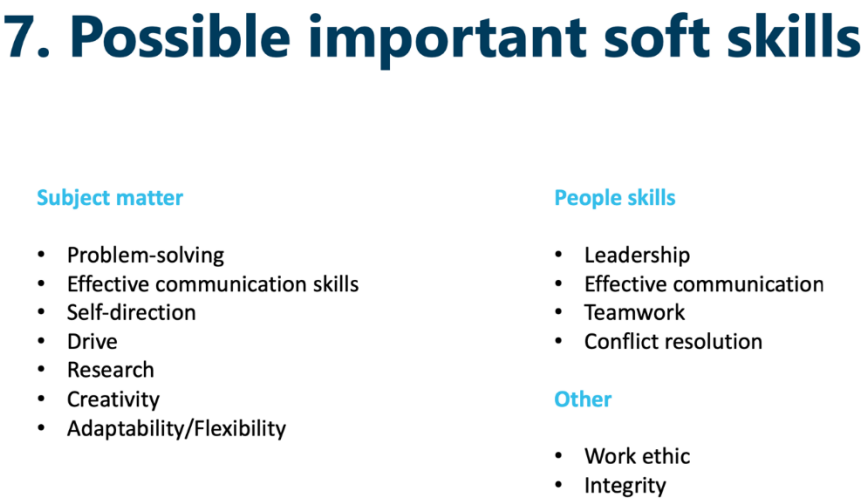

Figure 41. List of soft skills. Source: Josef Tichanek's presentation

Speaker 3

Mika Kauppila, Senior Electrical Engineering Manager at Valmet Automotive

- From a battery business the Valmet Automotive is working from a concept idea and 48V up to a high-voltage complex systems in electric and hybrid cars. The company specializes in various stages of project & process management.

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Figure 42. EV battery system presented. Source: Mika Kauppila's presentation

- Mika also explained how BMS functions and software elements are very complex and introduced the structure of work tasks within Valmet company. Such various elements are also a great challenge for specific job roles and skills required for each position within the BMS functionality.

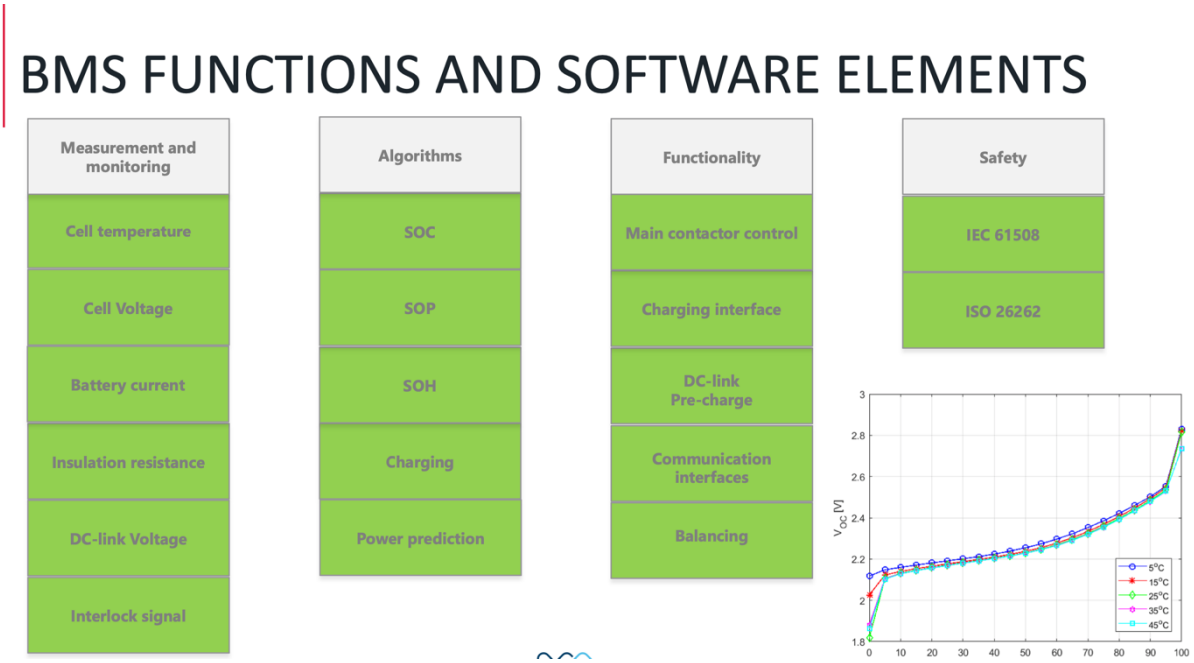

Figure 43. BMS functions and software elements. Source: Mika Kauppila's presentation

- The most relevant areas for BMS research, production, and development for Valmet Automotive are across hardware and software the areas stated below.

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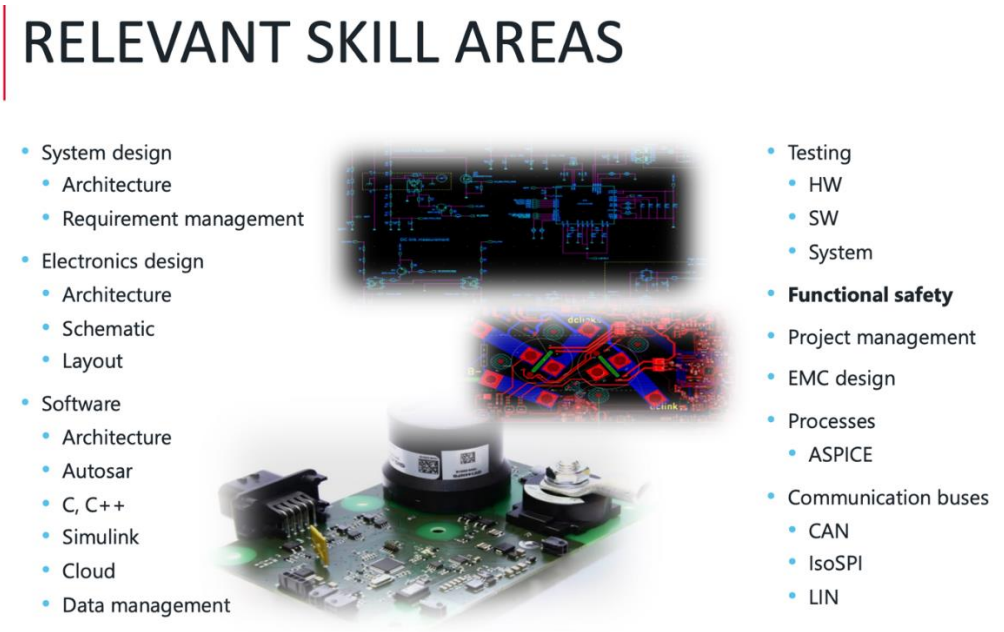

Figure 44. Relevant skill areas. Source: Mika Kauppila's presentation

Relevant Comments from the chat

- How can the BMS system adapt to new cells? Is it necessary to go through the whole process again?
    - Mika: The BMS is very adaptable and in most cases the only part to be tuned is the software but to only a certain level of change in the elementary parameters.
    - Jorge: The BMS exists for safety and therefore a right input is our ultimate task.
    - Josef: There could be a future technologies like smart meters added to BMS and therefore a certain redesign of the system is necessary.
- How will the expanding market of battery applications such as second-life batteries effect the BMS development?
    - Jorge: It is my favourite topic, and my answer is it gets into the same alignment with the adaptive modelling of BMS systems. The second-life batteries are a growing segment, and we see it from the automotive industry to scale the production higher and higher. We do not want those batteries to go directly into recycling and waste, there is always a possibility for second implementation after the batteries are not suitable for the automotive sector anymore. The batteries will not have a state of health on 100% and therefore

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the system must be ready to accept battery modules with a state of health on a level of 70% or below. In our case it is one of the most important topic in regards of the BMS development.

- Josef: I agree and definitely one of the most suitable market for batteries from automotive sector is a solar storage systems using older batteries.

Post-event satisfaction survey

After the workshop, a satisfaction mini-survey was sent to the participants. The response rate was below 5%, with 2 people answering. Overall, the participants were very satisfied with the workshop.

What is your overall assessment of the event?		
Choice	**Answers**	**%**
1=Insufficient	0	0%
2	0	0%
3	0	0%
4	0	0%
5=Excellent	2	100%
Total	0	0%

Analysis of question 1

Knowledge and information gained from participation at this event?		
Choice	**Answer**	**%**
Yes	2	100%
Somehow	0	0%
No	0	0%
Total	0	0%

Analysis of question 2

Written feedback:

- How do you think the webinar could have been made more effective?

  “The time for the webinar was too short.”

- In your opinion, what are the battery relevant future jobs and skills needed in the battery production sector and why?

  “Skills in chemistry, industry and market”

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- Comments and suggestions (including activities or initiatives you think would be useful for the future).
- "Presenting our work (for example researchers and students)"
- "I think that for students-this is of great value. Hopefully you can be a bridge to different kind of education systems-even for the vocational colleges and not only for universities.

Recommendations for the organisation of future webinars:

- There could be more questions in the beginning before we launch the main event for people already in the lobby to have a task to do.
- More time for three and more speakers invited to the webinar. Also questions from the audience could be answered between presentations.

4.4 Key findings

- The most important aspect of battery management systems is their safety functionality. Therefore, proper skills are needed and every speakers introduced their positions and requirements for the level of expertise on each assignment related to the completion of the BMS systems.
- Apart from the complexity of these systems they are very flexible for new technologies adopted in the battery field. The hardware is not changing as often as the software as it was stated by our speakers.
- Important finding was also relevant to the changes in the automotive industry where old batteries are moving to the second-life market where the BMS plays a key role to maintain the overall safety of the battery modules. A suggestion was made towards high usability of second-life batteries in the solar storage systems.

Job roles, skills, training tools and recommendations were identified in the webinar. These will be covered in the Work-Package 3 report that will be published in May 2023.

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5 Future geopolitical challenges in the source of raw materials and the battery value-chain

"Future geopolitical challenges in the source of raw materials and the battery value-chain" was the second interview and the fourth event in the third round of webinars under Task 4.10. The event was organised on the 19th of January 2023. The interviewee was Mr Daniel Cios, Policy Officer – Raw Materials at DG Grow, European Commission.

Europe is going through a rough period where the supply of different materials may be at risk. How does it affect the green transition and the consequent need for skills and competent workforce? What risks can be identified in the materials and battery value chain in possible future crisis scenarios?

Choosing the Topic

Regarding the provision of raw materials, Europe is currently experiencing a challenging period owing to the ongoing war between Russia and Ukraine. Notably, this conflict has significantly affected the availability of natural gas (NG), which has resulted in an immediate impact on the prices of essential commodities, including electricity. Both nations also represent critical suppliers of additional materials, including some with relevance to the battery industry.

The objective of this interview was to comprehensively examine the potential ramifications of the ongoing conflict on the supply of raw materials for the battery industry. Furthermore, the focus was on identifying the job roles, skills, and competencies that would be vital to alleviate the challenges created by the ongoing war.

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5.1 Agenda

Figure 45. Dissemination image for the interview

We received 69 registration requests from 19 countries, of which 5 were outside the EU. The top 3 countries in terms of the number of registered were Portugal, Sweden, and France.

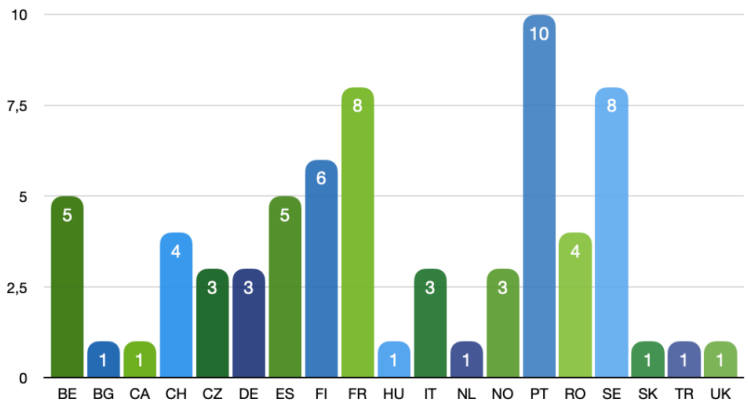

Figure 46. Number of registrations per country

Most of them represent industry, education, and research sectors.

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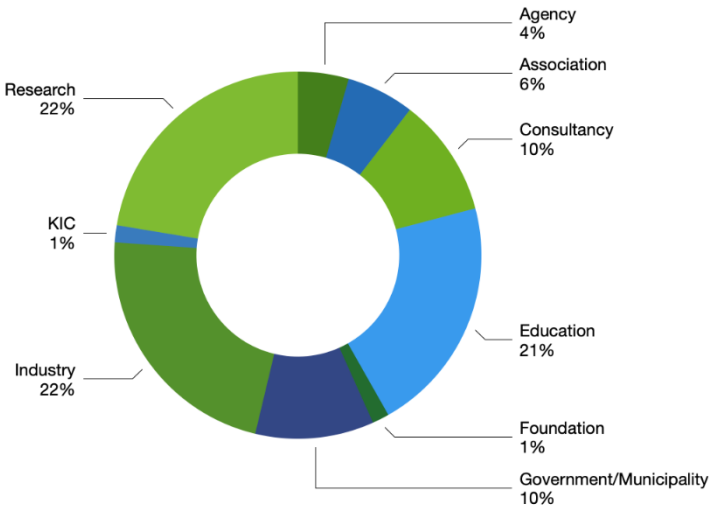

Figure 47. Distribution of the sector of the registered people

The number of viewers was 42 following the event's live stream. Viewers were following the live stream also on ALBATTS's Facebook profile. At the time of the writing of the report it counts 25 views. The stream remains available in the ALBATTS website and Facebook profile.

5.2 Workshop Speakers

Moderator

Kari Valkama is the leader of Work-Package 4 in the ALBATTS Project and a project manager at Technology Centre Merinova in Vaasa, Finland. Merinova is the leader of the EnergyVaasa Cluster which possesses the Gold Label of Cluster Management Excellence. Its cutting-edge expertise is in energy technology and business development. Merinova is involved in various projects, programs, and services regionally, nationally, and globally. Kari holds a degree in Business Administration. He has years of experience in working with business and general development-related tasks in SME companies in the metal and cleantech industries.

Interviewee/Speaker

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Figure 48. Bio of Daniel Cios used for dissemination.

5.3 Interview

Briefly introduce yourself, your background, and your current position

- Works in the European Commission and is the Director General for the Internal Market industry, entrepreneurship, and SMEs, particularly in the unit responsible for raw materials since 2018 – when the commission started supporting the battery value chain (creation of the Battery Alliance for example).
- Responsible for the raw materials policy, monitoring the market and performing EU policies in this regard.
- Supporting the EU efforts to guarantee access to battery raw materials, working in the critical raw materials (CRM) list, and working in the calls for Horizon 2020 and Horizon Europe are the main tasks currently.

Europe is going through a transition phase with the recent events in Ukraine and the energy sector is affected by it. What do you highlight in this change we are currently experiencing?

- We are observing big disruptions in the energy supply, high energy prices for the EU industry, and shortages in the supply of other issues (raw materials, products) supplied by either Russia or Ukraine.
- The energy dimension is the most important as it affects both industry and individual consumers/households with the electricity and heating costs increasing. The industry

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is struggling also with high energy prices, creating problems in their cashflows, even bankruptcies can happen.

- The commission is continuously meeting with energy-intensive industries that provide feedback on the impact of the crisis in the industry.

Natural and gas are the first words that occur when talking about the conflict. What other resources could be at risk now and what are they used to?

- The battery value chain has some materials that are at risk:
  - Nickel is sourced from Russia (100%) and goes to Finland for refining.
  - Platinum group metals: Palladium is also sourced from Russia.
- Ukraine is a very resource-rich country with:
  - Around 20 of the 40 CRMs.
  - Holds about 6% of the reserves of Titanium – used for paint, engines, aerospace etc.
  - They also have Cobalt, Lithium and one of the biggest deposits of Graphite.
  - Best quality available in the market minerals for ceramics
- Many materials may not be on the "Critical" list, but for individual companies, they may be crucial.

What kind of changes would you like to see in the EU strategy to guarantee the availability of raw materials in Europe?

- It is in discussion inside the commission. With the pandemic and the green goals, it became clear the importance and the disturbance of the raw materials supply.
- The Russian invasion of Ukraine emphasized the importance of the action. The European Council asked the commission to take actions with the raw material supplies.
- The possibility of a Raw Materials act was mentioned and confirmed by Ursula Von der Leyen – The legislative response for raw material legislation at an EU Level
- The proposal is still in progress and to be ready in the coming weeks or months. 5 areas of action: 1) proper identification of raw materials that need action - the CRM list was the start in terms of demand, production, and availability – but other materials (metals) that could be needed in emerging technologies should also be considered. The list will help in the identification and decision-making. 2) Improve monitoring framework and reinforce government discussion with organizations related to raw materials supply. 3) Improve the support of the raw materials value chain (mining,

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refining, treating, and recycling) through strategic projects and supporting investments in financial and non-financial ways. 4) Strengthening the waste and looking for a circular framework, creating a secondary use for raw materials. Strongly improve the performance in the field. 5) International cooperation in raw materials: developing international relationships between interested parties in raw materials. Supporting Countries that are close to the EU values and standards.

Renewable energy generation is pointed as a solution to the energy crisis giving the battery market another opportunity to thrive. Is Europe prepared to supply the needed materials for this growing industry?

- We need to look not only at battery production but at the whole battery value chain, with focus on raw materials. What is available in Europe, what is already extracted and what are the refining plants? Europe has a lot of raw materials available and potential domestic sourcing in Europe is possible. But 100% independence will not be achieved.
- Since 2018 we see a lot of projects announcing the interest in seeking lithium, graphite etc. mining together with the development of the battery market.
- But even if we have Lithium mining in Europe, there is no refining capacity, and it would need to be sent to China to complete this step.
- Investors and projects are starting to also look at refining, which was a flaw before.

How can Research and Development (R&D) activities impact raw materials in the future? Do you have any initiatives that can impact the area in the future?

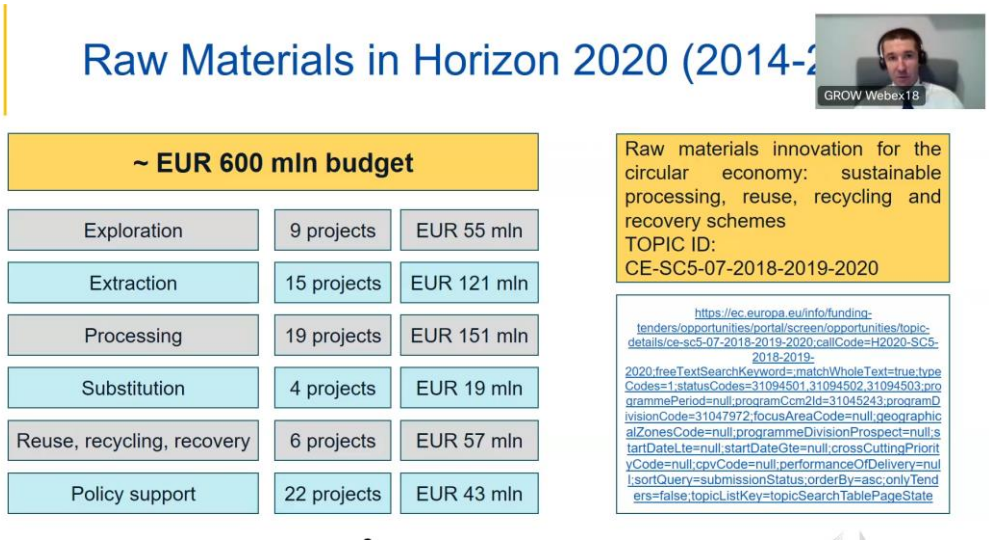

Figure 49. Sectors invested in Horizon 2020 program related to raw materials. Source: Daniel Cios's presentation

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- There are financial support programs for raw materials topics: Horizon 2020 with around 80 projects and funding of 600 M€.
- 2020-2022 calls are closed, and the agreements signed. Currently, 6 calls are open for 2023/2024. They cover the full value chain for raw materials.

Figure 50. Calls open for Raw Materials in Horizon 2020. Source: Daniel Cios's presentation

- The project Batraw started in May 2022- Focused on recycling and end-of-life battery packs for domestic material. Pilots for dismantling battery packs and separating waste materials. 2nd pilot for hydrometallurgical recycling processes.
- The project CRM-geothermal started in May 2022 – Focused on the occurrence, enrichment, and extraction of raw materials from geothermal brines and fluids in Europe and East-Africa. Looking for new sources of raw materials
- The project FutuRam started in June 2022 – Looks at the availability of secondary raw materials.

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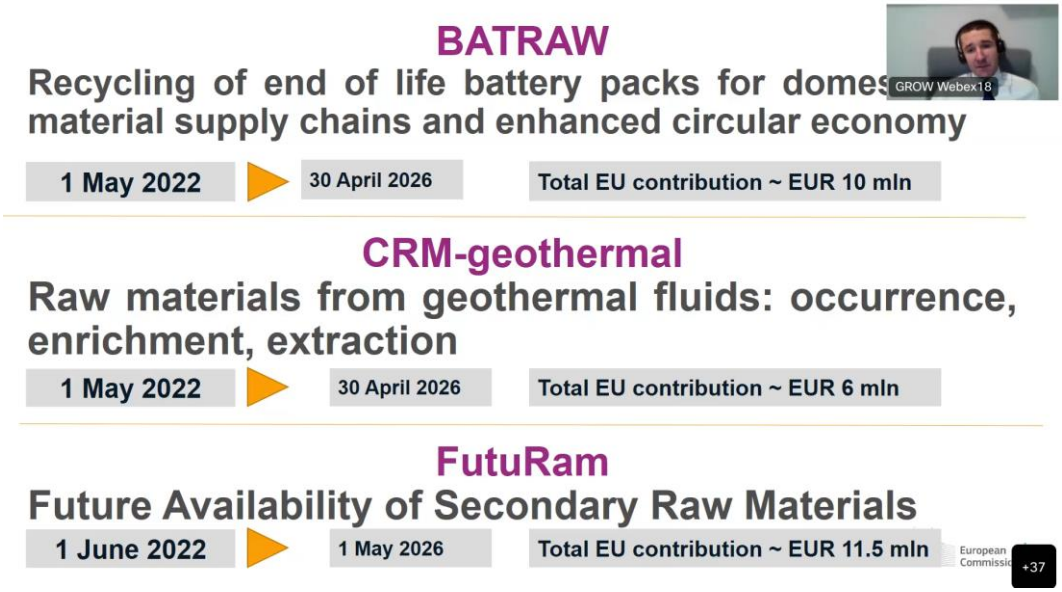

Figure 51. Horizon 2020 projects with relevant interest for the raw materials sector. Source: Daniel Cios's presentation

- R&D is an important source of knowledge and to develop the weaknesses found in the sector. The results will be crucial to develop policies to support the sector.
- The projects and calls launched and in preparation are always close to the battery sector needs.

How independent Europe can be from other parts of the world in terms of raw materials? What are the biggest risks in terms of raw materials that need to be sourced outside Europe at the moment?

- When it comes to raw materials, we are dependent on their geological availability.

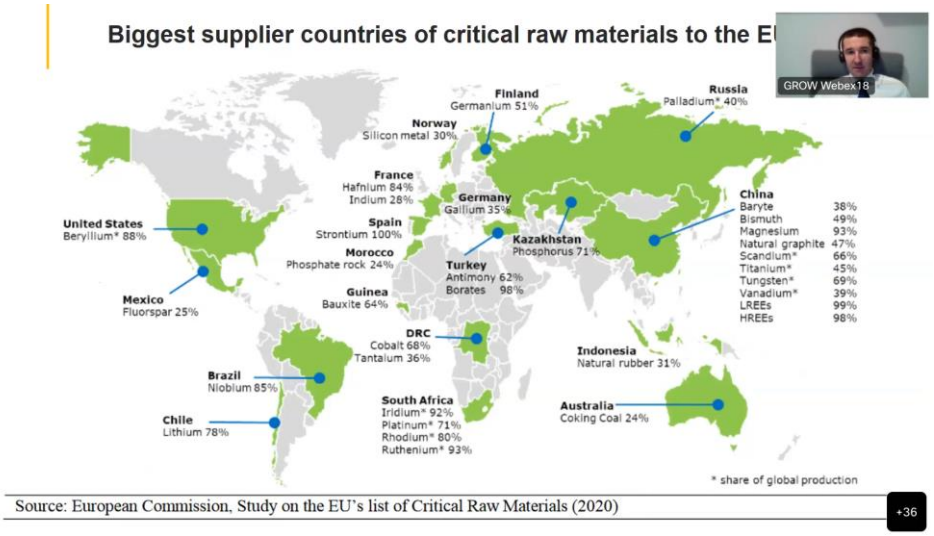

Figure 52. Global distribution of raw material supplies. Source: Daniel Cios's presentation

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- Only 5 of the CRM are sourced in Europe. The majority are sourced in China, and it is almost 100 % dependent.
- During the pandemic it was noted a slow in the supply of certain raw materials.
- The demand for raw materials will always rise strongly. It is not possible to see Europe as independent. It is a global competition.
- Where do we want to source and what are the conditions of the sourcing are the most relevant questions to answer. The sustainability of the sourcing is relevant to achieve the real sustainability of batteries.
- Sustainability is not achieved just because combustion engines are not used if child labour or tonnes of emissions are used in the sourcing of the material.
- The EU is developing criteria and principles to define the sustainability of sourcing raw materials. They include social, economic, and environmental criteria.
- The traceability of raw materials is important. It is being developed by associations such as the Global Battery Alliance.
- Before the pandemic, mostly investors were involved in these developments, but the context allowed technical people to join the meetings and have an impact on the solutions and decisions.
- Consumers want to know where the materials come from and that puts pressure on producers to disclose it.

What are Europe's strengths and opportunities related to batteries and their raw materials?

- Europe has high-quality experts in production and manufacturing.
- There is high support in Brussels and public institutes to be in the battery sector and improve the raw materials industry. It is shown in the number of gigafactories appearing for example.
- The battery alliance gathered all the interested stakeholders to work together. Before each company was working alone and results do not appear as fast. This is what European integration is about.

What are the most relevant job roles, skills, and competencies in the raw material sector for batteries?

- Very important question since we are in the European year of skills.

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- Experts on the industrial process, and how to operate the manufacturing plants. Manufacturing experience is needed. Operating machines, optimization of the process.
- Proper training by universities, companies and institutions needs to be developed – the reason why the Battery Academy was founded and has already trained around 800 000 of people.
- The university should have courses in geology, metallurgy, mining engineering, and material sciences. And we need to know how to attract the students and make this training interesting. Make sure this will give them a good job in the future. Universities are struggling because students are switching from materials courses to IT and opportunities should be disseminated to attract more students.

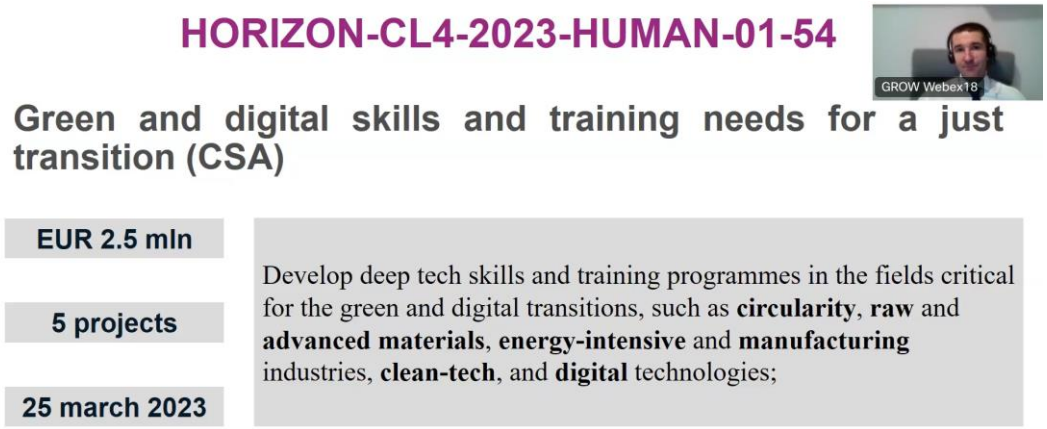

Figure 53. Open Horizon 2020 - call for raw material skills. Source: Daniel Cios's presentation

- There is currently a call open dedicated to skills and training programs in critical fields.

Is your 5th point on international sourcing discussed whether is a short, medium, or long-term plan for the EU? (Audience question)

- It is a long-term cooperation with the countries and a few partnerships are signed (with Canada, Ukraine, Namibia, Kazakhstan) and others are being worked on (Norway).
- Looking at investment, business matchmaking and cooperation between stakeholders. How can R&D Horizon Projects involve partners from third countries or how to advance the projects that are already in the course?

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Do you recognize any situation/material/area that could pose a risk in the future? How can we mitigate the impact of a similar situation as the one occurring right now with Russia and Ukraine in the future? (Audience question)

- Forecasting political risks that occur unexpectedly is a very difficult situation.
- We can try to forecast demand for some materials and technologies – what materials and in what amounts – to help to know where to focus our activities.
- Have sourcing from primary and secondary sourcing, looking at the substitutes and diversifying the sourcing of the materials (maps in Figure 52)

Are the legislations flexible for future change? If for example flow batteries based on vanadium will boom in the next years, how these legislations will accommodate that? (Audience question)

- On the EU level it takes some time to prepare legislation, but with battery-related regulation, it is very fast compared with others.
- First, we should look at non-legislative issues because they are faster to apply.
- Forecasting should be important to play ahead of the changes.

In your 2nd point on the Commission's actions, you mentioned coordination between the Commission and the Member States on raw materials. Does the Raw Materials Supply Group provide the institutional framework for this coordination or does this coordination happen within other channels? (Audience question)

- The RMSG is present and representatives of the member states (environment or industry ministers). There are meetings several times a year.

I am doing research on raw materials strategies in the Chinese context. I can resonate with many of the strategies that the EU is pursuing in the Chinese context. However, the time factor is very important in such raw material strategies because of the long lead times. In your opinion, in what realistic time frame can material problems be solved so that they do not become obstacles to the upscaling of sustainability transitions in the years to come? When you talk about international collaborations, would it really be possible to bypass China given that most of the refining capacities are based in China? (Audience question)

- It is a long process to bring mining and refining investment (5 to 10 years). There are lots of analysis to be performed and are very capital-intensive. Lithium projects have been announced in 2018 but they are still not producing.

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- China is the main supplier of many raw materials. It would be very hard to have independence. The faster solution is to have a more diversified sourcing from other countries.

The relevant questions in the chat have been integrated into the above question list. Information about the event with a recording can be found on the website of the ALBATTS project.

Post-event satisfaction survey

After the workshop, two satisfaction mini surveys were sent to the participants.

One survey was sent by e-mail after the workshop for those who registered. The response rate was very low, as no answers were provided in the survey sent by e-mail.

The other survey was performed live in the webinar, at the end of the Q&A section. The number of answers was very high, with approximately 22 people answering.

What is your overall assessment of the event?		
Choice	**Answers**	**%**
1=Insufficient	1	4%
2	0	0%
3	1	4%
4	4	18%
5=Excellent	16	70%
No Answer	1	4%
Total	23	100%

The satisfaction of the people attending the interview was excellent. 70% of the answers classified the event as excellent (5) and 18% classified it as very good (4). Only one person classified it as very bad (1) and another as regular (3). From the people that remained online at the time of the survey, only one did not provide feedback.

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Did you learn something new from this event?		
Choice	**Answer**	**%**
Yes	19	86%
Somehow	2	9%
No	0	0%
No answer	2	9
Total	22	100%

Following the previous results, 86% of the people who answered the survey claim they learned something new and 9% claim that they somehow learned something new. No one claims they learned nothing from the event. We can conclude that the innovative character and presentation of a new theme was successful for the audience.

Recommendations for the organisation of future webinars:

- The confirmation of speakers should be done with antecedence to the workshop date. If there is no possibility to work on a certain workshop because working with others is demanding the time, the number of workshops planned should be reduced.
- Dissemination should start at least a month before the day of the event. 2 weeks is not enough to reach all the potential interested people in the event.

5.4 Key findings

- Materials at risk other than NG: Nickel sourced from Russia, refined in Finland; Platinum group metals (Palladium) sourced from Russia, around 20 CRMs are sourced in Ukraine, 60% of Titanium reserves are in Ukraine, cobalt, lithium and one of the biggest deposits of Natural Graphite are in Ukraine, big quality minerals for ceramics.
- Europe's context (Green Goals, invasion of Ukraine, disruption in material supply) led to EU to develop (5) strategies to guarantee the supply of raw materials.
- The battery industry hardly will achieve 100% independence from sourcing outside Europe. However, Lithium mining and refining is gathering investors' interest, although it is a very long process.
- Europe is not very rich in raw materials (CRM specifically). But the global demand will rise in the future.

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- EU is developing criteria and principles to define the sustainability of sourcing raw materials (social, economic, and environmental).
- Horizon 2020 has a long list of calls for R&D projects related to sourcing, refining, processing, substituting, reusing, recycling, recovery, and policy support of raw materials.
- Attraction of students to raw materials relevant courses is crucial and it faces high competition with other courses (IT for example).
- Forecasting political risks, the demand for materials and technology, sourcing from primary and secondary materials, finding substitutes and diversifying the source of the materials are the strategies to mitigate future materials shortage.
- China is the main supplier of many raw materials. It would be very hard to have independence. The faster solution is to have more diversified sourcing from other countries.
- Drivers of change found: disruption in energy supply; high energy prices; shortages in supplies of materials; disturbance in the supply of raw materials due to war; investors are interested in sourcing and refining battery materials; EU is investing in R&D to prevent the shortage of battery materials; technical people are joining the meetings and events for decision-making policies, not only investors.
- Job roles, skills, and competencies found: investors for funding mining and refining of materials; R&D technicians and developers, policymakers; experts on the industrial process, and how to operate the manufacturing plants, operating machines, optimization of the process; geology; metallurgy; mining engineering; material sciences; forecasting demand for materials and technology.

Job roles, skills, training tools and recommendations were identified in the webinar. These will be covered in the Work-Package 3 report that will be published in May 2023.

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6 Skills Transition

"Skills Transition in The Battery Industry: Training People from Other Industries" was the last webinar of the workshop round 3 organized under Task 4.4. It was kept on the 9th of February 2023. The event was organised to gain understanding of the skills transition processes designed for blue- and white-collar level employees. We wanted to learn about for example, the possibilities and challenges encountered by our Swedish speakers, Mr. Tore Karlsson (discussing adult education at VUX and related cooperation with Northvolt in Skellefteå) and Mr. Fredrik Hannerz (discussing the collaboration of the Volvo Cars Company and Gothenburg Technical College in the context of electric vehicles).

Choosing the Topic

Skills transition as a topic area had been discussed in the ALBATTS project already much earlier and thus we felt that the final round of webinars is opportunity to address the topic area with experts from the education providers that are already involved in re- and upskilling of employees in the context of batteries or electrification. The representatives chosen due to their working or collaboration with entities related to battery industry and electrification.

6.1 Agenda

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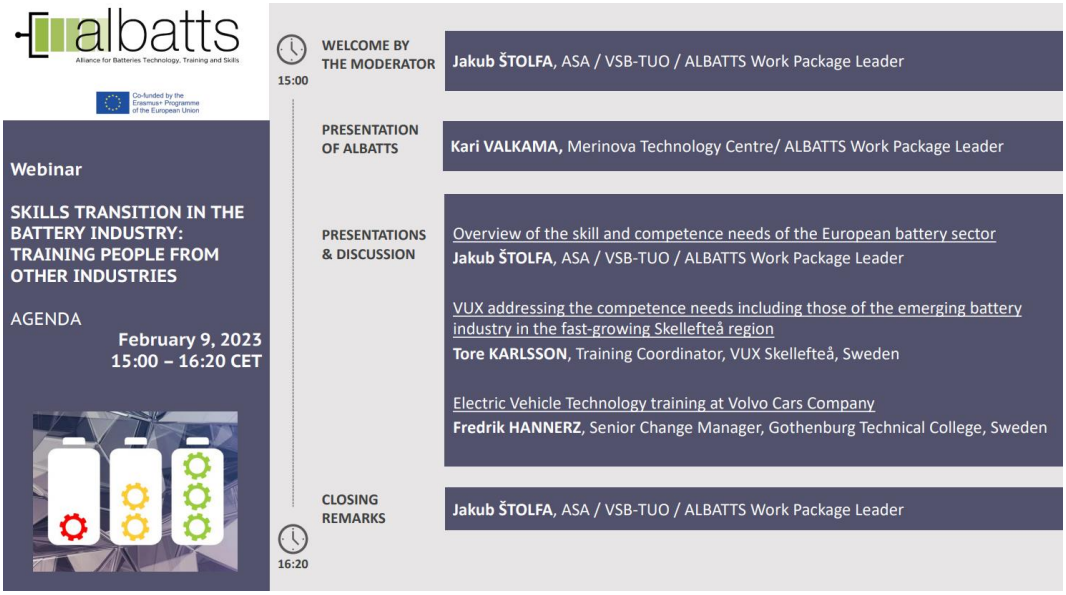

Figure 54. Dissemination image and agenda for the webinar

We received **89** registration requests from **23** countries, of which **7** were outside the EU. Most of them represent industry, education, research, and consultancy sectors. The top 3 countries in terms of the number of registered were **Finland, Portugal, and Norway**.

NUMBER AND ORIGIN OF REGISTRATIONS:

We received **89 registration requests** from **23 countries (7 from outside the EU),** as shown in the graphic below.

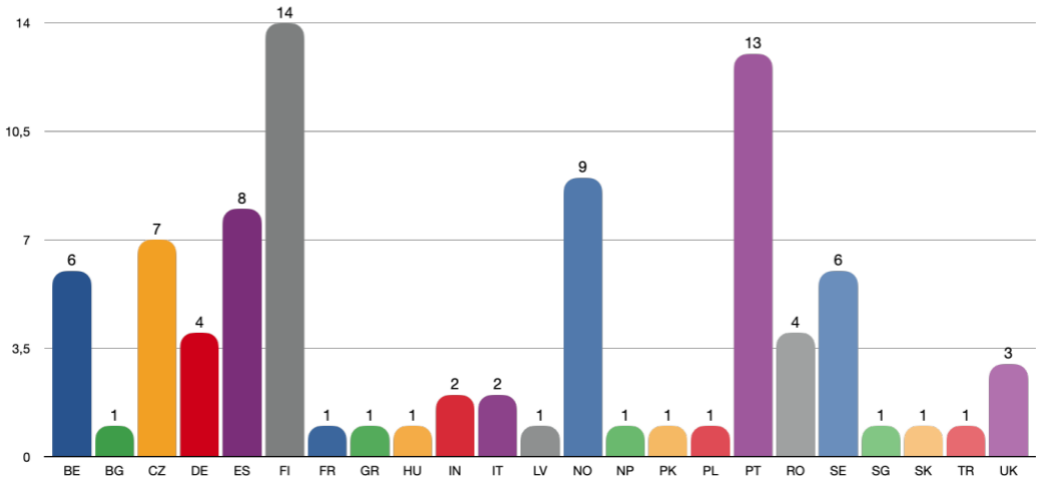

Figure 55. Number of people registered by country

Most of them represent industry, education, and research sectors.

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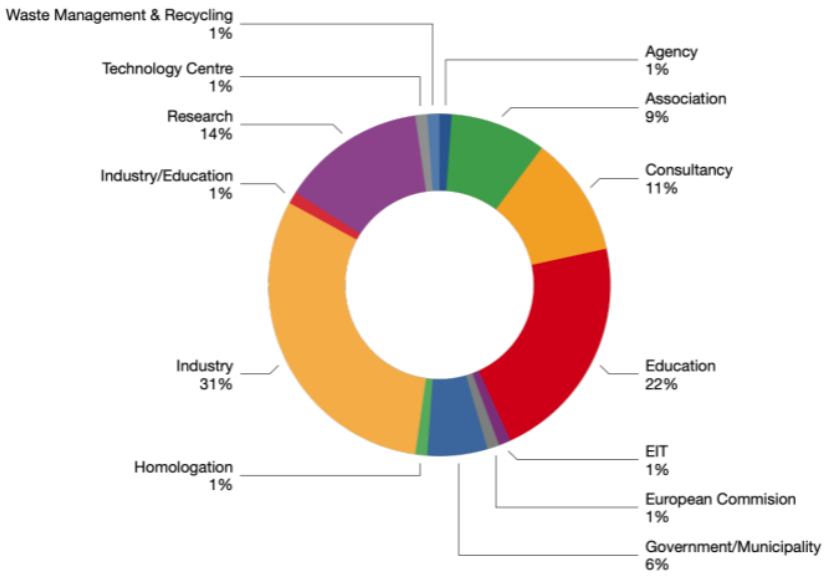

The number of viewers was **54**. Viewers were following the live stream also on ALBATTS's Facebook profile. The recording of the event is available on the ALBATTS website.

6.2 Workshop Speakers

Figure 56. Image with the speakers used in the dissemination

Moderator/speaker

Jakub Štolfa is an academic staff member at VSB – Technical University of Ostrava, where he has also received his Ph.D. He is also the President of the Automotive Skills Alliance, and a WP leader in the ALBATTS project. His recent activities focus on a sustainable and pragmatic

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approach towards the skills agenda in Automotive Ecosystem. He has experience in project/program management, development of training and educational programs, technical background in Informatics and Mechatronics in the Automotive ecosystem.

Speakers

José Fonseca (replaced Kari Valkama, who was not able to participate) is a chemical engineer with experience in R&D for battery energy storage systems. He has been active in the simulation of batteries and also in the development of new battery technologies such as Sodium-ion and Redox Flow Batteries. He is involved with the ALBATTs project since the beginning, leading the task of the organization of the webinars.

Tore Karlsson works as a training coordinator at VUX, which provides adult and higher education in Skelleftea, Sweden. The city has become a growing centre for the European battery industry with the increasing need for battery-skilled employees. Mr. Karlsson's role is to function as a hub between VUX, as an education provider, and the companies in their region. Before his current position, he worked as an automation technician in the manufacturing industry and later as a vocational teacher in the same field.

Fredrik Hannerz is a MSc, Theoretical physics and Chemistry and has 4 years of experience from a reskilling & upskilling project, for 1000+ civil engineers and technical specialists at VCC with focus on Strategy, tactics and operations of a highly successful implementation. He has been Senior Change Manager: 30+ years of engineering, computer system design, development of production and organizations and is currently responsible for Electric Vehicle Technology training at Volvo Cars Company, by Gothenburg Technical College

6.3 Webinar

Speaker 1

Mr. José Fonseca, Chemical Engineer, ALBATTS project

Key Messages:

- Mr. Fonseca provided a presentation of the ALBATTS project.

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Speaker 2

Jakub ŠTOLFA, ASA / VSB-TUO / ALBATTS Work Package Leader

Key Messages:

- While the battery production is concentrated to few European countries currently, it is relevant for the whole Europe. Consequently, related skills are and will be needed.
  - Battery cell manufacturers, module, and pack manufacturers
  - Equipment suppliers, Active material suppliers
  - Recycling companies
  - Battery test centres
- Boosted by the electromobility it is emerging and highly rising sector in Europe, which needs to be supported by the workforce with the right skills.
- Constant change of the skills/competences or knowledge needs during one's career.
- High demand for workers at the sector.
- It is important to see which competence is possible to transfer from one job to another or even from one industry to the other.
- Where to attract and retrain the workforce for the battery sector?
  - Initial education – create and integrate new curricula to the VET and higher education levels.
  - 85% of required manpower will occur on the VET level.
- Continuous education: up- & reskill existing workforce from other descending sectors.
  - Need for new training courses, new ways of training courses delivery (training on the work, VR, etc.) and offer (to be able to react flexibly).
- Up to 500,000 jobs will be lost by 2040 in parts of the automotive value chain, mainly within ICE suppliers in Europe reducing 84 % of the current jobs in the ICE value chain.
- The loss of jobs will be partially compensated by the BEV powertrain production that is expected to create 226,000 jobs.
- Up to 2.4 million jobs will require partly high retraining in this transition by 2030 while 1.6 million persons need re-skilling within the same job profile and 610,000 persons must change their job profiles slightly. In comparison, just 225,000 persons need radical retraining into different job profiles and industries.
- Sectors supporting the battery sector e.g.:

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- Mining: Extracting of raw materials – lithium, cobalt, nickel, manganese
- Manufacturing: line operators, quality control technicians, production supervisors Information technology: Battery management system, AI
- Chemical industry: work with electrolytes and cathode materials
- Engineering: Electrical and material engineers
- Information technology: Battery management system, artificial intelligence
- Energy: expertise in renewable energy, energy storage, and grid integration

- Industries that involve similar skillsets that might be transferable to the battery sector:
  - Manufacturing experience: Workforce familiar with volume production processes and techniques. Pharmaceutical; chemical; automotive; industry with the ultra-clean environment; pulp and paper production industry; etc.
  - Supply chain and logistics experience: Battery sector requires coordination of a complex supply chain.
  - Sales and Marketing: Increasing need for workers with sales and marketing skills to promote and sell batteries.
  - IT industry: Includes skills as data analysis, automation, and robotics.
  - Project management: large-scale, complex projects to be managed.

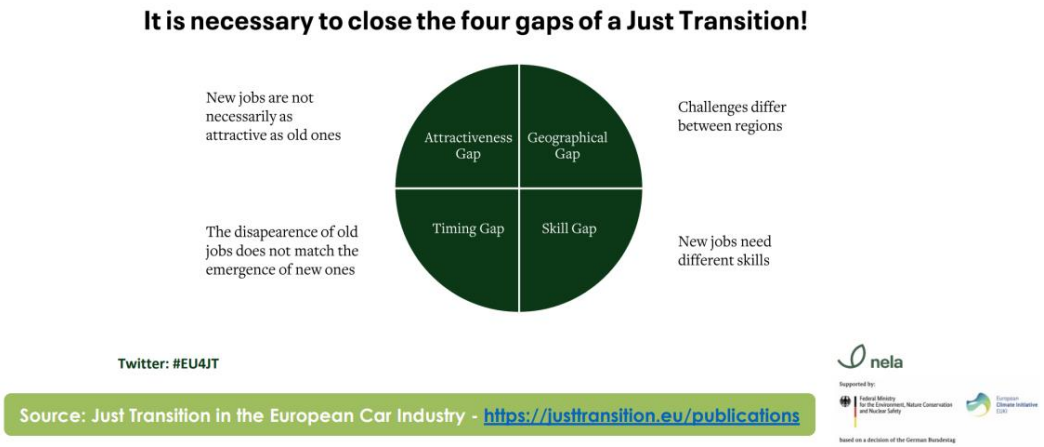

Figure 57. Reasons for investing in upskilling. Source: Jakub Štolfa 's presentation

Speaker 2

Tore KARLSSON, Training Coordinator, VUX Skellefteå, Sweden

Key Messages:

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- Northvolt's announcement, in 2016, about establishing their plant in Skellefteå, a city of just 75 000 inhabitants, had earthshattering impact on the area.
- The announcement divided the people in two groups: some were reacting positively while the others were doubters thinking it is never going to happen.
- Northvolt and its subcontractors started the hiring processes.
- Tore, as a part of a delegation visited Reno, USA to learn about the implications of Tesla and Panasonic establishing their facilities in there years earlier.
- Some of the insights from the Reno trip:
    - Make people to believe it's really going to happen.
    - Don't be blinded by the new establishment. It will affect all the sectors and companies in the region. There will be a big rotation when it comes to the labour. It will affect so many different sectors. As a provider of education, we must look into the big picture instead of a certain particular one.
    - Coordination. This has an important role with starting a good relationship and collaboration with the company/companies. If you don't have it in place in early stage, the process will never work.
    - Factor 3.0. There will be 5000 people starting to work at Northvolt and that will affect the whole area. That will create 15000 new jobs in the area. That will have an impact considering that there 75000 people living in Skellefteå municipality and only 35000 in the centre, in the city.
- The first education programme was based on a draft from Northvolt.

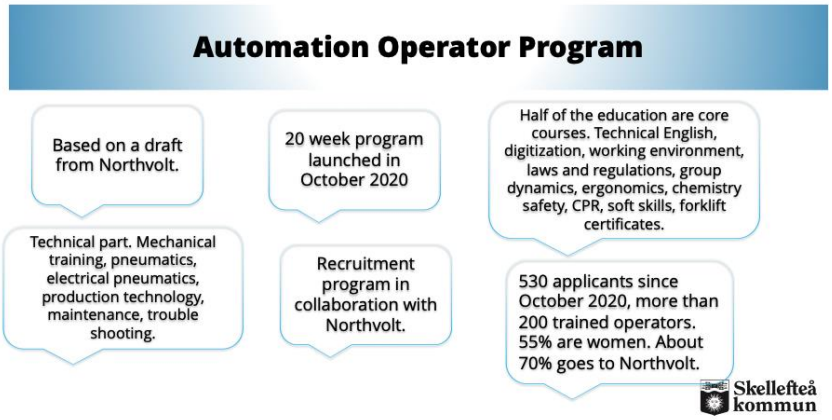

Figure 58. First education program based on Northvolt draft. Source: Tore Karlsson's presentation

- How to get students

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- public application procedure
  - not enough people in the area to satisfy the demand
- Relocation efforts
  - to get people from elsewhere in Sweden and beyond
- Upskilling programs
  - some people go through their education and get employed or
  - are first employed, get some training at the company, and then come to VUX to get upskilled

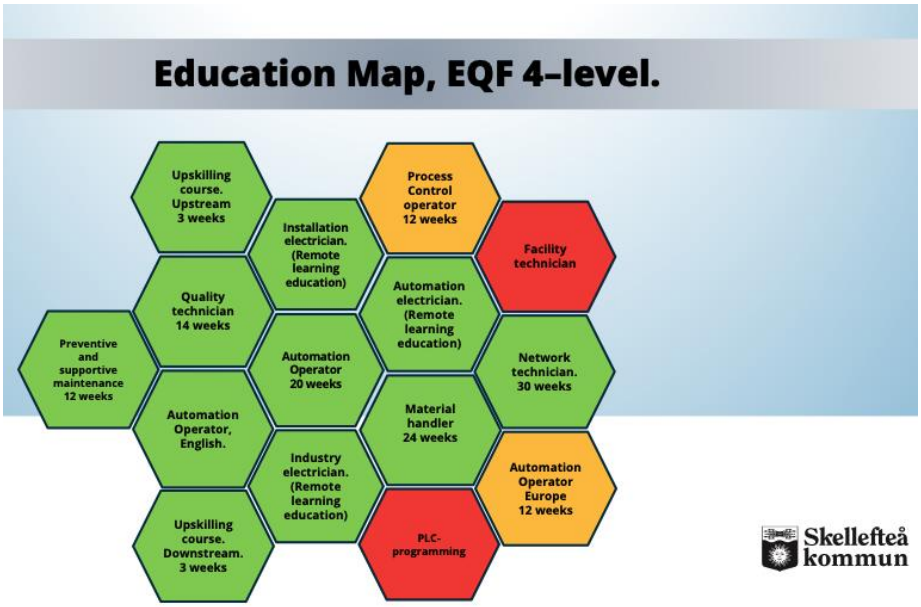

Figure 59. Map of courses EQF-4 level. Source: Tore Karlsson's presentation

- Material handler was requested by Northvolt and other companies.
  - forklifts etc. competence
- Quality technician is a collaboration between VUX and a university. There is a big need for quality technicians at Northvolt, subcontractors and other companies.
- Automation operator, English. Almost all their education is in English now.
- Three electrician educations (1,5 year-long due to certification) programmes: installation, automation, and industry electricians (all remote learning).
- Network technicians
- Preventive and supportive maintenance
- Upskilling courses
  - Upstream – process industry
  - Downstream - production

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- Process Control operator (technician)
  - Closely connected to the upstream upskilling (Tore referred to it as “the next level education”)
- Automation Operator Europe
  - Students from elsewhere in Europe
  - The first half of their education will occur remotely.
  - After that they will move to Skellefteå for 5-6 weeks for their training.
  - After that they will start their employment at Northvolt.
- Facility technician and Automation Operator Europe
  - These two education programmes are in the planning stage.

- The PLC programming schedule is being planned at the time of this webinar.
- A video of their former student was shown by Mr. Karlsson as an example:
  - The interviewed person took the Automation Operator course at VUX.
  - She had worked eight years in customer service in a grocery store earlier.
  - The challenges included speaking English until she got confident with it and absorbing everything learned.
  - The education combined technical and practical courses to such subjects as humans in industry, history of industry, laws etc.
  - She learned the best when practical and theoretical exercises were combined.
  - According to her the time spent in a pneumatical and mechanical laboratory was important for her to fully understand and tie everything together.
  - Teachers’ support was also regarded important by her.
  - Her goal was to get employed by Northvolt, which happened after the course.
  - She started as an operator. Soon she became a shift manager for her team.

Speaker 3

Fredrik Hannerz, Senior Change Manager, Gothenburg Technical College, Sweden

Key Messages:

- Importance of **change management:** how to change anything into something new and how to meet and deal with the challenges and opposition to a change.

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- Responsible for EV Technology training: Volvo Cars Company (by Gothenburg Technical College).
- In 2018 they were assigned by Volvo Cars to start the electromobility project.
- During the process they have met a lot of opposition.
- Fossil fuel vehicle specialists were suddenly left without work and were not wanted, which was painful making it a troublesome period.
- Trying to catalyse the transition and to make them eager to learn new things - that was achieved by making them to realise that while much is new most remain the same.
- While EV specifications look different familiar physics and chemistry are behind them.
- Most trained, 1100 persons, have been civil engineers and post-doctors.
- There is a close collaboration with Chalmers Technical University and the joint venture between Northvolt and Volvo Cars.
- Extensive knowledge of Volvo HEV provided.
- Transition to BEV has been more troublesome.
- When adjustments are needed for an EV the details of the technology are important. You cannot address them unless you have knowledge of chemistry and physics.
- Understanding what consequences there will be from adjustments on the system level:
    - Top to bottom view
    - Doing simulations
    - Trying to predict the collective behaviour of all those detailed adjustments.
- For their project they collected publications, scientific papers etc. building an EV reference library about areas of importance for the work with electric mobility.
    - **http://www.gtc.com/electromobility/**
    - Climate change topic (met a lot of opposition), Environmental and health
    - Market and society, Sustainable energy systems, sourcing, and recycling
    - vehicle technology, Li-ion battery systems, charging and power supply
    - electrical machines and transmission, autonomous vehicles, and computing
    - hydrogen fuel cell technology, nuclear energy
    - materials and methods
- The strategy and tactics of their suite of E-mobility courses:

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- To target the key questions regarding the transformation of our society and the automotive industry
  - What is happening? Why is it happening? When is it happening?
  - Where is it happening? Who does it effect? How will it happen?
  - The most relevant question of all "What's in it for me?"

- An extensive knowledge of automotive industry can always be useful with EVs.
- **Meeting the hopes, fears and needs of the participants to the courses.**
- There has been **a massive change to these curricula over the time: they have listened both to Volvo Cars as well as the participants**.
- Introduced courses become full in the matter of hours (high popularity).

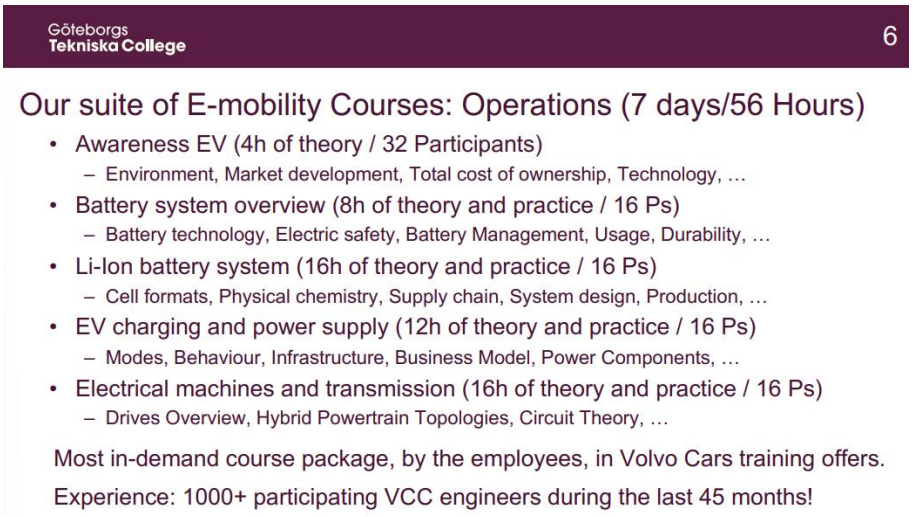

Figure 60. Small courses for E-mobility. Source: Fredrik Hannerz 's presentation

- Change management is challenging.
- What are the qualities of the future employees. The jobs people are getting do not exist (at the moment). How do you prepare people to do the work?
  - Try to make them curious, as curious people are paying attention and when you pay attention you understand what needs to be done.
  - Take charge of your destiny: "Be curious and interested in what you are doing".
- Project Findings - thoughts on Change Management:
  1. If what you're doing is working, do more of it
  2. If it doesn't work; change the way you do it.
  3. If the result still is not satisfactory, then you know that too (try section 2 again).

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- Basic knowledge of economics and budget management are useful prerequisites for change management.

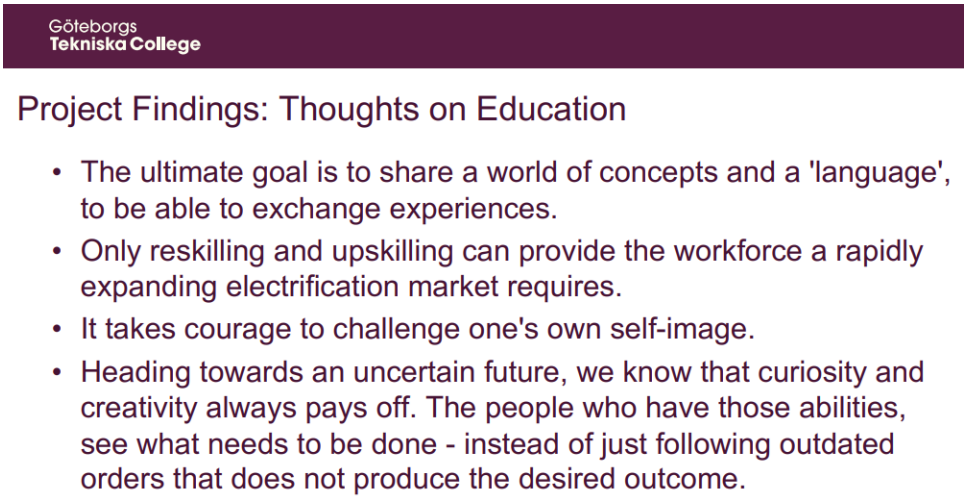

Figure 61. Lessons learned from the education projects. Source: Fredrik Hannerz 's presentation

Questions and Answers

Who can join the education or courses that we have covered?

Mr. Tore Karlsson:

- Anyone can join VUX adult education as long as 20 years or older.
- Many come to change their careers (even taxi drivers and hairdressers).
- Many feel excited about the chance to be a part of the area's ongoing transformation.
- **55 % of their students are women and Mr. Karlsson considers that it is a result of the way they have marketed their programme. Instead of focusing on technology-related things in their marketing they have communicated about the chance to be a part of the transformation and the process of doing something for the environment.**

Mr. Fredrik Hannerz:

- Nurses and other healthcare people have been hired by Northvolt, due to "a precision mind" and experience with complex equipment etc.
- In Gothenburg they will need fewer employees in the car assembly in the future, as EVs are less complex. There will be layoffs and those laid off will be suitable for up-/reskilling for battery production.
- The worst mistake or waste in any business would be to get rid of experienced people. Someone else will benefit from that experience.

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- They have initially addressed the EQF levels 6-8 mainly, but they are now focusing on the EQF levels 4-5 by designing training equipment and facilities for those who are going to work hands-on with battery assembling, modules and packs.
- The main drawback has been the lack of EV production in Gothenburg. Eventually, they will have a battery factory. They will also start producing EVs in the area by 2025.
- They will be prepared to those when it comes to the basic skills including measurement, calibration, automation, and quality.

How do you address the moving of people to Skellefteå to work at Northvolt etc.?

Mr. Tore Karlsson:

- It is a big issue for them. Attracting people to a place with long dark winters is not easy.
- They work with all the possible tools they can have.
- They are involved in relocation projects funded by EU.
- They cooperate with companies including Northvolt and some of their subcontractors. The hired people first join onboarding programmes. After that they come to VUX to go through up-/reskilling or some more specific courses such as quality or maintenance.
- They have practically zero unemployment in Skellefteå currently and they struggle to get people there. Companies must help with that.

Mr. Fredrik Hannerz:

- Gothenburg, as an industrialized area, has related knowledge available.
- The main challenge is the lack of trainers and teachers there.
- They have initiated a programme to train the trainers and to get teachers in any level to become interested in electrification.
- One incentive is that “it is good to be where the money is” and being a part of building the new world. There will be job roles that do not currently exist. People can be part of building their own roles that suit them and not only the needs of companies.
- It is important to have good teachers on each level that can make their students to be interested in this process of electrification.
- Getting people to battery field is essential for having batteries available to enable the EV production. It must be addressed and make the battery sector attractive to people.

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How do you see the involvement of the initial education in this process in Skellefteå?

Mr. Tore Karlsson:

- There are others providing suitable education, but not many currently.
- They have a good relationship with Northvolt and its subcontractors. When a need for a new competence or role emerges, they contact VUX.

Are you able to offer train-the-trainer courses or related cooperation to others in Europe, as they could learn from you? Are you thinking of exporting your approach?

Mr. Tore Karlsson:

- They have been contacted with help requests from all over Europe.
- They do not have secrets and are willing to share.
- **If anyone is interested in learning from them, they are open to communication.**

Mr. Fredrik Hannerz:

- They are very occupied with different projects and the latest one is to get mechanical engineers to use batteries as structural parts of cars. Suddenly you need new competences for calculating the strength of the physical battery cell into a pack and then further on to a battery system.
- They can't do large-scale education. We must use our resources to keep up with Volvo Cars and others, but of course we could share an opportunity to educate etc. He recommended contacting him if any entity wants to take part in the education process.

More about the employees who need to change the course of their careers:

Mr. Fredrik Hannerz:

- It is painful for employees when their expertise with ICEVs is no longer needed.
- While they have been successful in keeping people interested in the new development, they have not succeeded in convincing and retraining them all to work with EVs.
- The hardest part for an individual is to challenge how he/she sees him-/herself and get out of the comfort zone.

Information about the event with a recording can be found on the website of ALBATTS project.

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Post-event satisfaction survey

At the end of the workshop, a satisfaction mini survey was opened to the participants. The response rate was low, with 2 people answering. These participants were very satisfied with the workshop.

What is your overall assessment of the event?		
Choice	**Answers**	**%**
1=Insufficient	0	0%
2	0	0%
3	0	0%
4	1	50%
5=Excellent	1	50%
Total	2	100%

Knowledge and information gained from participation at this event?		
Choice	**Answer**	**%**
Yes	2	100%
Somehow	0	0%
No	0	0%
Total	2	100%

Written feedback:

- How do you think the webinar could have been made more effective?

  "It's good as it is"
- In your opinion, what are the battery relevant future jobs and skills needed in the battery production sector and why?

  "I don't have competence yet to give a concrete idea"
- Comments and suggestions (including activities or initiatives you think would be useful for the future).
- *none*

Recommendations for the organisation of future webinars:

- none

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6.4 Key findings

Jakub Štolfa:

- High demand for manpower for battery sector and 85 % of them are on the VET level.
- Constant change of the skills/competences or knowledge needs during one's career.
- Up- & reskilling workforce from descending sectors
- Need for new training courses, new ways of training courses delivery and offer
- By 2030 2.4 million jobs will require partly high retraining, 1.6 million persons need re-skilling within the same job profile and 610,000 must change their job profiles slightly. Just 225,000 persons need radical retraining into different job profiles and industries.

Tore Karlsson:

- Northvolt establishing their plant in Skellefteå had a major impact on the area.
- Reacting to such a major change required for example in Skellefteå's case understanding how it affects all the sectors and companies. Consequently, the education providers have to be able to look into the big picture.
- Automation Operator Programme was the first one based on a draft from Northvolt.
- 15 programmes at VUX requested by and supporting Northvolt and others in the area.
- Getting students with public application, relocation efforts and upskilling programmes.
- VUX combines successfully practise to theory in the education programmes.
- People with very different backgrounds can be re-/upskilled (for example from a grocery store's customer service to an operator via automation operator programme)
- Many participate the education programmes of VUX to change their careers.
- Attracting women to the technical education by VUX has been achieved by communicating more about the chance to be a part of the transformation and the process of doing something for the environment and less about technologies.

Fredrik Hannerz:

- Understanding the Importance of change management and how challenging it can be.
- Importance of dealing with opposition during the change process
- Electrification of vehicles is leaving fossil fuel specialists without work.

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- It is important to meet the hopes, fears and needs of the participants taking part to up-/reskilling courses and how are in the middle of the transition.
- Try to make them curious, as curious people are paying attention and when you pay attention you understand what needs to be done.
- Making people to be more eager to learn new things by making them to realise that while much is new most remain the same in the case of case ICEV vs EV.
- With EVs understanding chemistry and physics required.
- In their E-mobility courses they target questions such as what is happening or why is it happening. However, the most relevant question is "What's in it for me?".
- It is important to have the flexibility to change the curricula based on the feedback from the students and the companies.
- Lack of trainers and teachers is a challenge for them. Teachers who can make their students to be interested in electrification are needed on every level.
- There will be jobs in the future that do not currently exist.

Job roles, skills, training tools and recommendations were identified in the webinar. These will be covered in the Work-Package 3 report that will be published in May 2023.

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