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Alliance for Batteries Technology, Training and Skills
2019-2023

APPENDIX A: Workshop Notes and First Analysis

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Future Job Roles & Skills in Stationary Battery Storage: Battery Safety, Grid & Telecom Applications

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Workshop Evaluation

Workshop name:

Future Job Roles & Skills in Stationary Battery Storage: Battery Safety, Grid & Telecom Applications

Date and venue:

26-1-2021 15:00-16:15 CET Online Webex

Workshop purpose:

Identification of future job roles and skills; evaluation and verification of project progress/outputs

Organizer:

ALBATTS

Format:

Online Webinar

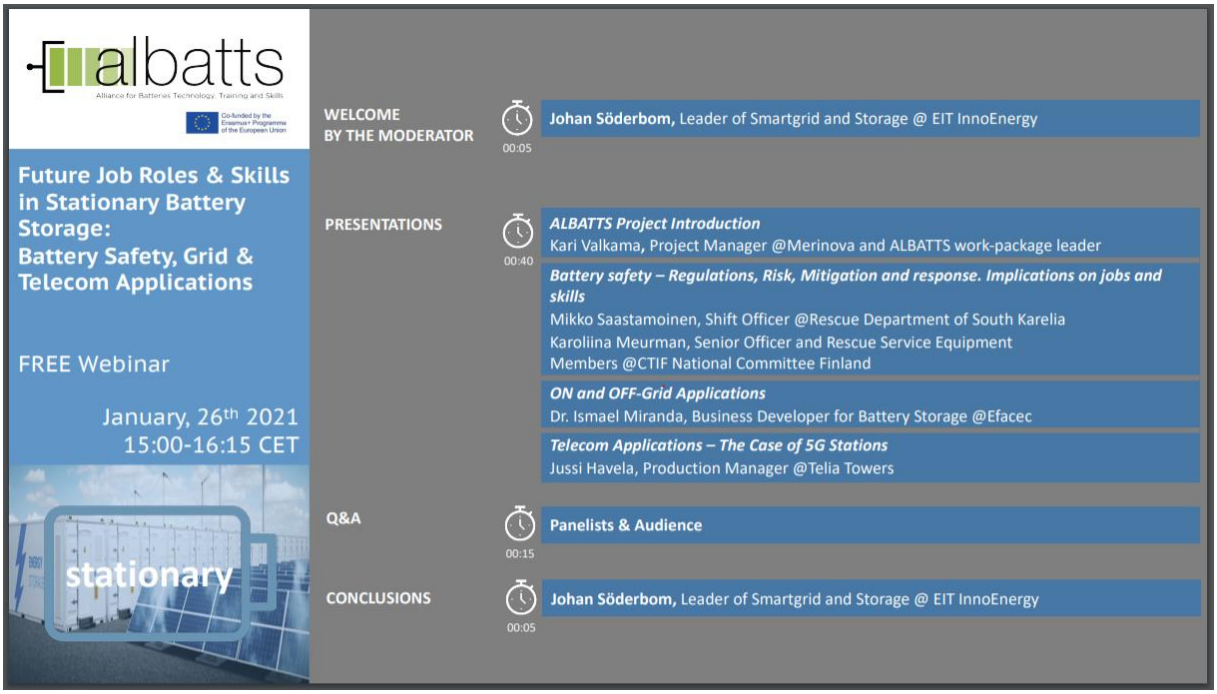
Location:

Webex

Content:

- Welcome by the moderator;
- Presentation on job roles & skills;
- Q&A Panel.

Proposed schedule:



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Workshop Minutes

Battery safety: Mikko Saastamoinen – shift officer in rescue department of south Karelia

Mr Saastamoinen is a member of the Finnish association of fire officers and the Finnish representative in CTIF commission for extrication & new technology. CTIF is an international fire & rescue association which has several different commissions. He was awarded the Firefighter of the Year 2020.

Fire hazards have been happening all over the world already since the year 2013. Water has been used the battery fires. It is a difficult fire to extinguish, and the risk of re-ignition is very high.

In one situation in Netherlands, where a car fire had been extinguished five times by firefighters, they finally put it into the canal.

There is need for new methods and tactics. We cannot do it as we have always done it. We submerge all electric vehicle to a container, which European rescue departments has purchase those. When you sink a battery to the water, it will become toxic.

Fire blanket is a new rapid extinguish method, which blocks and isolate any fire even lithium battery fire. Development and research are in Europe, France and in Finland. This method is still very new, and we do not know how to act with it. Fire blankets do not need any maintenance.

CTIF Commission, where Mikko Saastamoinen is a Finnish representer, is "Extrication and new technology" is trying to encourage and promote the cooperation between fire services and other emergency services around the world. The Commission is active in three working fields, extrication road safety (un decade), Energy storage systems (batteries, solar panels), Smarttech (robots, self-driving cars, data transmission). Education, innovation, information, installation, regulation are the key words. The organization has the goal to share information with the involved entities.

ISO 17840 standard -project for alternative propulsion identification of EV storage technology. It is very important in case of fire or in accident. There are different stickers at fire and rescue trucks, heavy duty vehicle, buses, helps to identify the propulsion. Some countries are further in this implementation.

An example is a CNG-bus and the torsion, which occurs if a bus starts to burn, for the serious threats for pedestrians and fire rescue.

We need sharing, testing, and training.

Battery Safety: Karoliina Meurman – Senior officer and rescue department at Tukes

Master's in chemistry, the Finnish Safety and Chemicals Agency (Tukes) with market surveillance of products meant for early fire detection and extinguishing small fires, for example smoke alarms, CO alarms and first-aid extinguishing equipment. Lithium-ion battery fires have become familiar to Karoliina Meurman when estimating the effect of lithium-ion battery fire extinguishers. She has also expanded her expertise into bigger battery applications and their fire risks. Karoliina is Master of Science in Technology (chemistry) and has worked as a public authority for 15 years.

Battery Network at TUKES, where experts from different type of Li-ion battery authorities are (Traficom, construction authorities, rescue services, Pirkanmaa ELY Centre as the National authority for producer control, Pirkanmaa ELY Centre as the National authority for producer control, Environmental administration, Finnish Environment Institute SYKE). Experts are from mineral

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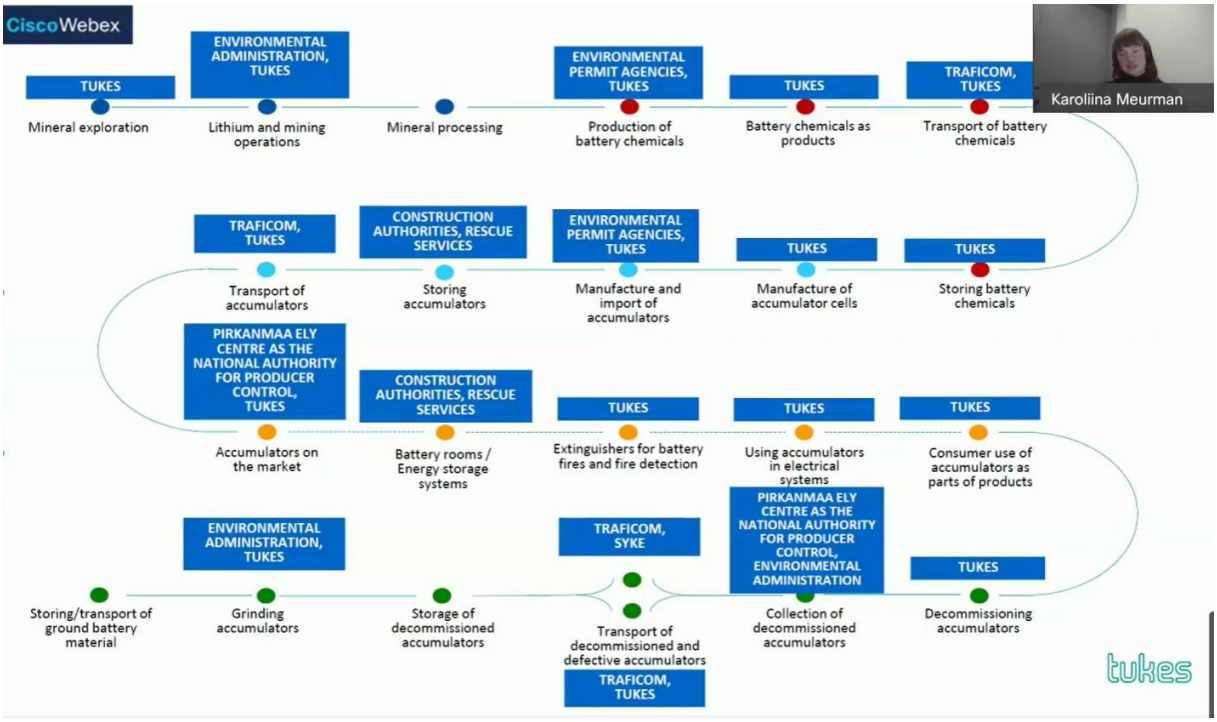
explosion to storing/transport of ground material. Tukes is mentioned 15 times in different life cycle positions, which demonstrates how complicated the whole life cycle is as from authorities respective.

A picture of Battery Network



Knowledge and roles of different parties

Manufacturer

- Safety of the product
- Legislation, standards
- Relevant information for users and authorities

Authorities

- Legislation laws
- Market surveillance
- Deliver and gather information.
- Guidance

Possessor (owner/user)

Responsible for the system in use

Right kind of installation, maintenance, right use.

ESS not covered very well by EU legislation.

Installation standards – HD 60364 Low-voltage electric installations (CENELEC European Committee for Electrotechnical Standardization), EN 50110-1 Operation of electrical installations- Part 1: General requirements (CENELEC)

Safe working methods is given in Standard IEC 60364 Electrical Installations for Buildings.

Competence – electrical works and qualification, electrical safety examination

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In order to be granted a certificate of qualification in Finland you must have:

- suitable **education** in the electrical field
- suitable electrical **working experience**
- passed the electrical **safety examination** (Electrical safety examination page on tukes.fi, in Finnish and Swedish).

In addition to the electrical safety examination, the minimum requirements for the certificates of qualification are as follows:

- **Electrical qualification 1**, S1: **at least a technician's or engineer's training**, and sufficiently extensive **two-year work experience.**
- **Limited electrical qualification 1: senior electrician's special professional degree and at least six years if work experience**
- **Electrical qualification 2**, S2: **applicable education**, such as electrician's basic degree, followed by **three years of experience in work** familiarising oneself with the building of electrical equipment and work supervision.
- **Electrical qualification 3**, S3: the education can be replaced by **applicable work experience.**

Electrical qualification S1 and the person can work above 1000 V. A certificate of qualification issued by SETI Oy is needed. The certificate of qualification gives the right to act as a supervisor of electrical with the limitations set forth in the certificate. In practice, the duties of an electrical work supervisor involve guiding the work, ensuring the competence of the employees, instructing them, providing tools, and managing the external framework of the work.

There are several standards for Energy Storage Systems ESS. A standard from America is NFPA 855, "Standard for the Installation of Energy Storage Systems", which is very good from Merman's point of view. Five more standards are mentioned in the presentation.

A new proposal for EU regulation has been given concerning the batteries and their waste. In chapter II safety requirements for stationary battery energy storage system is written "shall be accompanied by technical documentation demonstrating that they are safe during their normal operation and use". In the Annex V Safety requirements are given "Shall be accompanied by evidence that they have been successfully tested for the safety parameters laid down in Annex V".

Nine different safety parameters have been given for ESS and those will be tested.

Stopping of thermal propagation between cells and a possible risk of gas explosion, if fire occurs.

Automatic fire suppression systems are using either water, which has an effective cooling power or inert gasses, which works best if enough minimum space between modules exists.

ON-OFF Grid applications – Ismael Miranda Business developer at EFACEC

Ismael Miranda has a PhD in electrical and computer engineering, has been working at EFACEC since 2012 in several areas from R&D to business development for energy storage. EFACEC is an integrator of battery energy storage and works in designing the system, manufacturing, and scaling battery inverters, and develop their own control system.

Lithium ion is and will be the leading technology for stationary battery storage due to the fall of costs, 87% of price has dropped also due to the EVs revolution -> for stationary applications on commercial

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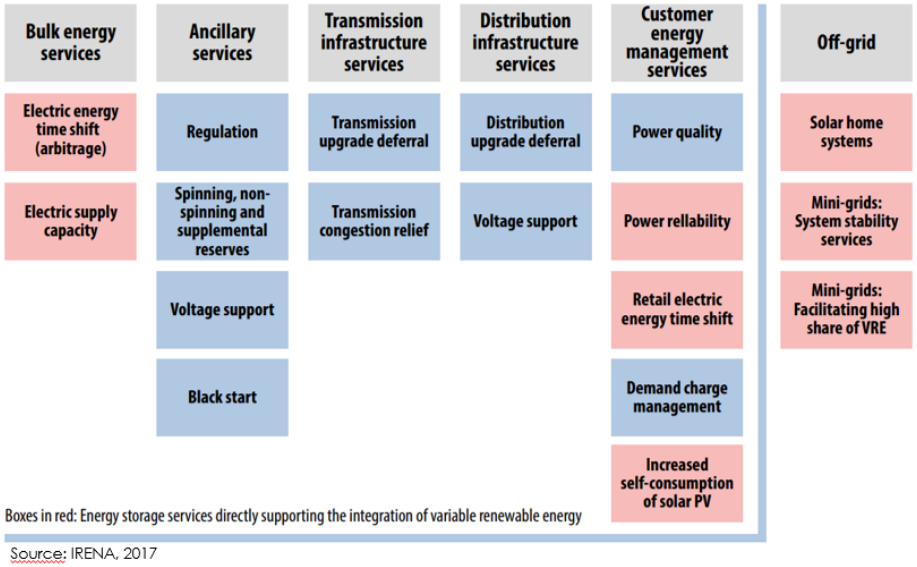
and industrial energy storage and second life. Higher integration of renewables sources (mainly wind and PV) does not provide flexibility and an attached energy storage will be able to provide it. High energy and power density are required to provide the needs of the installation. Companies and organizations will differentiate and innovate by software and algorithm optimization.

Several applications for stationary energy storage are presented in the image below:



Europe is growing and evolving but the US and Australia are the main markets of ancillary services. Energy storage and in particular battery energy storage can decrease costs in upgrading the transmission and distribution infrastructure. Storage can be closer to the end-user with customer energy management services, by reducing the cost of electricity. Off-grid can be applied in both geographical and electrical islands, for Europe or more remote as in some countries in Africa and other in developing countries.

Integration of renewables and continuous decarbonization, growing electrification and new market designs and business models will unlock the development and integration of energy storage. EU Green Deal and other European regulations are starting to recognize energy storage with a key role to achieve the sustainable goals for energy.

Stationary Energy Storages involves several components, although batteries are the centre and dictate the efficiency of the system. Competences can be found in the next image.

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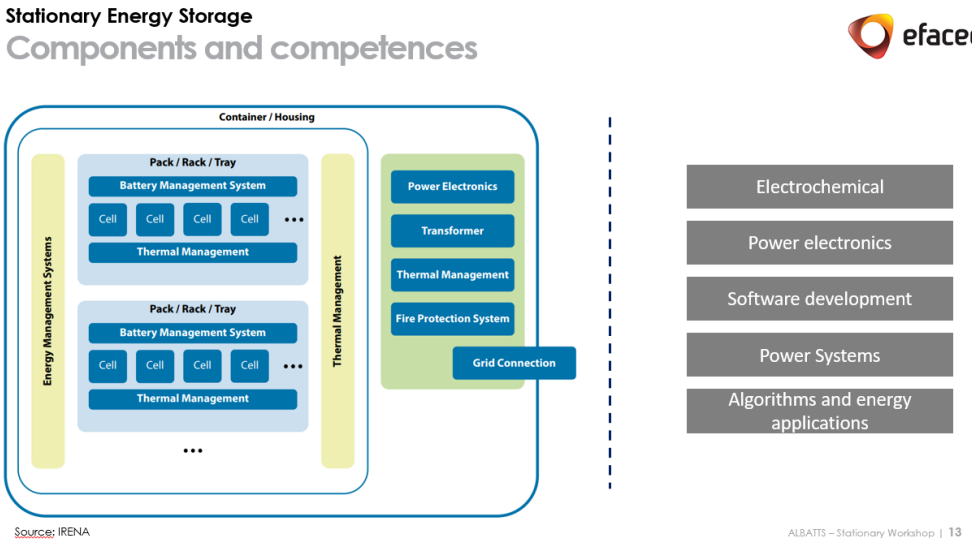
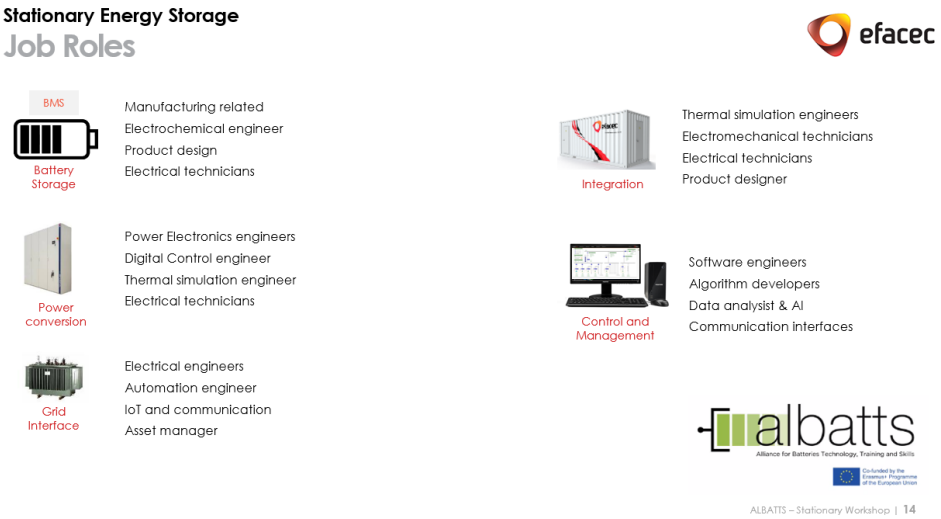


The development of each competence is interconnected between each other.

Identified Job roles are:



Stationary Energy storage involves multiple complex components that require adequate expertise which are key for storage development.

Knowledge sharing is crucial for the technology development.

5G Stations: Jussi Havela – Production Manager at Telia Towers

Drives of the Change are – energy consumption is increasing due to the 5G and mobile network needs to be batteries which are backing up if the grid power is lost.

Mobile base stations are near every mast they are non-manned are operated around a year and we want to avoid the outages in the telecom operators.

Telia Towers have a site visit at least once a year usually often because there are some preparations or customer changes, but in this check, we also check the batteries and sometimes they can faultier and then we replace them.

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As a business environment telecom is heavily regulated by authorities. Towers has a certain back up requirements speaking of time wise depending how many customers the current base station is serving it needs to be up 3,6 or even 12 hours.

5G is heavily increasing the power consumption in telecom networks and it needs new solutions. The same equipment, that was used with 4G. The sustainable targets are ambitious to provide clean energy for customers. Sustainably targets are part in the recycling material.

A wide mix of different kind of setup, not only buying the energy from the grid and consumption it, but also producing it locally. We have had this traditional setup battery but now we need to search new alternatives to embrace new options like probably joining to the grid and creating some energy with solar panel.

- Transformation of energy market
- Emerging technologies
- Price pressure

Competences and skills are: Manufacturing needed to leverage R&D, to improve the product further and simultaneously to keep the pricing in a modest level. Development of a good product and to be capable to sell it to the market and understand the market.

For telecom tower operators' service partners, who do the actual maintenance, it is important to understand the new technologies such as improving batteries and their monitoring. That forces a shift from a traditional maintenance perspective to more holistic service approach, in which the maintenance staff has to know extensively the technologies applied in base stations in order to provide the best support to a customer.

In the future is needed to get multiskilled employees, that traditionally have had an electrical qualification, but in the future, they need to have IT skills also to be able to maintenance the whole site, is important.

Owners have to be alert for new emerging technologies, to understanding of legislation and simultaneously key competitiveness.

In the telecom operator's side preferably postdoctoral / graduated roles, the service side formal qualification because work is regulated, owner side is beneficial to understand what the demands are.

The basic electrical installers or -foremen roles will not disappear but adapt some needed skills to provide the best possibly end-users and the whole value chain.

Qualifications and S1, S2 or s3:

1 Scope of electrical qualification 3

Category S3 certificate of qualification is an **installation repair qualification** and does not entitle the holder to carry out extensive electrical installation work.

- **There are a few exceptions when the electrical works authorisation is not needed:**
- everyman work (Do-it-yourself electrical work on tukes.fi)
- a couple of other exceptions under certain conditions (Electrical Safety Act 1135/2016, Section 56):

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- electrical work on the power system of electric vehicles: the person carrying out the work should be adequately familiar with the electrical system of the vehicle model in question and the dangers related to electricity.

Q&A Panel

Question to Mikko Saastamoinen: Is there any specific training for battery firefighting?

There is specific training, although it is at a minimum level. French Firefighters created a database on how to deal with incidents with electric vehicles and batteries (http://ctif.org/training-and-tools/emergency-response-vehicles). It is a very new topic in need of big development.

Question to Ismael Miranda: It is a challenge to find master thesis positions in companies. What would you recommend to maximize the chances? What skills are top priority in cell manufacturing and energy storage fields?

In terms of battery manufacturing, a strong background on electrochemistry is recommended.

It is useful to know how to use modelling tools for thermal and electrical simulation. People need to be more aware of these tools and know how to use them in order to give the company some valuable work. EFACEC has been receiving master thesis students, which are publicly available. Those can be viewed and used as inspiration to know what companies are looking for in terms of a master thesis.

Johan Soderbom added that a master thesis can be done with the goal of improving the manufacturing quality.

Question to Jussi Havela: What kind of qualification (S1, S2 or S3) do you have to have to work at a base station?

It depends on the type of work. For antenna work, there is no need for qualification. For most of the cases, S3 is enough. As some higher voltage is involved, a S2 may be required, both for a technician or for a more formal position as a team leader for example. S1 is not as required as the voltage is not high enough.

Question to Karoliina Meurman: Have you adopted any restrictions or regulations in Finland for parking lots in relation to electric vehicles?

In Finland there is no restrictions, as the building itself should hold the fire event, whether it is from an electric or regular vehicle. The main constriction is related to the rescue service, how they should act. There is a question if charging stations should be installed, but nothing in the law yet.

History of Webex Chat Box:

from Eupportunity Brussels to everyone: 3:02 PM

Hello everyone. We are inviting all stakeholders to take our Battery Sector Intelligence Survey. The aim is to collect information about job roles and skills needed to build a complete battery value chain in Europe - https://stakeholders.project-albatts.eu/s/survey2020

from Eupportunity Brussels to everyone: 3:07 PM

If you have questions, please send them in through here. We will try to answer them at the end of each panel.

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from Eupportunity Brussels to everyone: 3:12 PM

www.menti.com

from Eupportunity Brussels to everyone: 3:12 PM

8516580

from Marius Tudor to everyone: 3:17 PM

Hi to everyone!

from Ms Sari Rintakoski Merinova Finland to everyone: 3:36 PM

Is there any difference between different batteries in fire situation?

from José to everyone: 3:39 PM

Is there any specific training for battery firefighting?

Yes, minimum, French firefighter created database – lot information how to mitigate.

from Mateusz Sierakowski to everyone: 3:40 PM

It is said that both internal combustion engines and electric engines catch fire. Which ones are more frequent and more dangerous?

from Lucie Krcmarova to everyone: 3:45 PM

How does the training for extinguishing electrified vehicles look like? What is the most important knowledge to get there?

from Helena Almeida to everyone: 3:46 PM

What training does someone need in order to understand the standards on battery safety?

from Mikko Saastamoinen to everyone: 3:46 PM

Firefighters around the world have now opportunity to use database, which French Firefighters have created. Thanks to MIchel Gentilleau, SDIS86. You will find it from CTIF.org

from Mikko Saastamoinen to everyone: 3:46 PM

http://ctif.org/training-and-tools/emergency-response-vehicles

from Antonio Martins to everyone: 3:46 PM

will a webinar recording and a copy of the presentations be made available to the participants~'

from Mikko Saastamoinen to everyone: 3:47 PM

it´s been translated to several languages and you can use it also

from Kari Valkama to everyone: 3:47 PM

@Antonio Martins: yes. Videos on-demand from ALBATTS Facebook site.

from Mikko Saastamoinen to everyone: 3:49 PM

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It is said that both internal combustion engines and electric engines catch fire. Which ones are more frequent and more dangerous?..... Both are dangerous, but EV is more dangerous and difficult, because it can start to burn again and again.

from Mikko Saastamoinen to everyone: 3:51 PM

and all alternative propulsion, CNG, LPR, hydrogen, etc... are very dangerous, because fire behaves in different way than "traditional car fire"

from Mikko Saastamoinen to everyone: 3:52 PM

Is there any specific training for battery firefighting? In some countries-yes.

from Lucie Krcmarova to everyone: 3:52 PM

Have you adopted any restrictions or safety measures in Finland regarding parking lots in relation to EVs?

from Mikko Saastamoinen to everyone: 3:55 PM

How does the training for extinguishing electrified vehicles look like? What is the most important knowledge to get there? Every intervention is "premiere". you will find more information from CTIF.org

from Karoliina Meurman to everyone: 3:55 PM

No restrictions for building requirements etc. We have recommendations for the placing of charging stations, but they are not compulsory.

from Karoliina Meurman to everyone: 3:56 PM

Of course, charging stations have to be installed safely and according legislation.

from Mikko Saastamoinen to everyone: 3:56 PM

https://godr.sdis86.net/godr/godr-sr-en/index.html

from Helena Almeida to everyone: 4:00 PM

Would a masters in energy storage with dedicated courses be a sustainable idea?

from Johan Soderbom to everyone: 4:03 PM

https://apply.innoenergy.com/courses/course/24-masters-energy-storage?search=11600

from Mateusz Sierakowski to everyone: 4:05 PM

Nowadays it is a challenge to find a Master's Thesis position in energy storage companies. What would you recommend doing to maximize chances? What skills are top priority in cell manufacturing and energy storage modelling fields?

Electrochemistry, modelling tools – thermal simulation, electrical simulation, tools for general modelling

What kind of qualification (S1, S2 or S3) do you have to had to work at a base station?

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Feedback from the audience and organization:

Post-Workshop Survey

After the workshop, a satisfaction mini survey was sent to the participants. The response rate was very low, with only 7 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	1	14%
5=Excellent	6	86%
Total	7	100%

The main topic that got the audience most interested was battery safety. One person selected all the topics.

Which topic or aspect of the webinar did you find most interesting or useful?		
Choice	**Answer**	**%**
Battery safety	7	100%
On-Off Grid Applications	1	14%
Telecom applications	1	14%
Total	7	129%

Half the participants claim they learned something with the workshop. The other half claims they somehow learned something.

Knowledge and information gained from participation at this event?		
Choice	**Answer**	**%**
Yes	4	57%
Somehow	3	43%
No	0	0%
Total	7	100%

Written feedback:

- How do you think the webinar could have been made more effective?
  "Good as it is, I count the picture on what competence is needed will become clearer in the continuation of the project."

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- In your opinion, what are the battery relevant future jobs and skills needed in the battery production sector and why?
  "electronics, electric specialist"
  "Quality, safety and security staff. Emergency handling experts. Installers of Stationary battery applications"
- Comments and suggestions (including activities or initiatives you think would be useful for the future).
  "EU Projects (Erasmus+ or other Program) for new job development knowledge"
  "I think that more on how battery parks (like in Hornsdale, Australia) can help power grid owners and electricity producers to get rid of dirty oil- and coal-driven peaker plants. This especially if hydropower production cannot be used for balancing the grid."

Lessons Learned and points to be improved:

- Time management of the speakers during presentation.
- Explaining better to speakers how the interaction with the audience (Mentimeter) works.
- Learn how to incentive the audience to ask more questions and related to the topic of the workshop.

Mentimeter Answers:

1) Where are you located (Country)?

Most people that answered were located in Portugal, followed by Sweden, Czech Republic and Finland.

Portugal	Sweden	Czech Republic	Finland	Spain	Austria	Romania	Netherlands
17	5	5	4	2	2	2	1
Norway	**Italy**	**Philippines**	**Germany**	**France**	**Bulgaria**	**Belgium**	**Total**
1	1	1	1	1	1	1	**45**

2) Where is your company located in the Battery Value-Chain?

A big portion of the participants (64%) claims to be part of the R&D and Education segment. The other segments were equally balanced. It is possible that some of those who participated and did not actually belong to any of the value chain steps chose "R&D/Education", as it is the most generic answer of them all.

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Value-chain	Answers	%
Raw Materials and Processing	3	6 %
Cell Components and Manufacturing	4	9 %
Battery and Battery Pack manufacturing	6	13 %
2nd Use or Recycling	4	9 %
Research and Development / Education	30	64 %
Total	**47**	**100 %**

3) How did you hear about the workshop?

Mouth-to-mouth and LinkedIn proved to be the most efficient methods for dissemination of the workshop, which may suggest the audience was mainly reached from people close to the organization of the event or who already follow the project. In the future, other methods should be tried in order to reach more people other than the circle around the organization. More aggressive methods such as direct marketing kind of an approach that would target certain specific entities and individuals of special interest could be option.

4) Does your company have at least one battery fire specialist?

The responses to question 2 reflect the answers to this question in such a way that the total count of those who belong to any of the listed value chain stages, other than R&D/Education, equals exactly the count of those who responded “yes” to this question. With regards to R&D/education category it is potentially diversified from those who physically deal with batteries to those who do not deal with batteries directly at all. Additionally, as the most generic category it was a choice for those who do not actually belong to any of the category options.

Based on this we can assume that those in the battery value chain do have a need to have a battery fire or safety specialist among the staff many of them have also hired a person/people to such a position.

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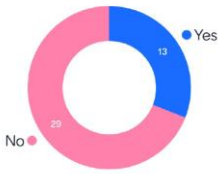
Choice	Votes	Percentage
Yes	13	31 %
No	29	69 %
Total	**42**	**100 %**

Does your company have at least one battery fire safety specialist?

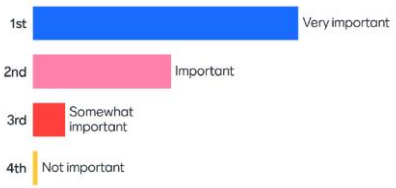


5) How important is it for a company to invest in people skilled in general knowledge of regulations and standards regarding batteries?

Most of the audience (90 %) believes that companies should have people with knowledge on regulations and standards. It is an important skill that must be addressed, since they create the framework for the whole battery ecosystem.

Choice	Answer	Percentage
Very important	28	67%
Important	12	29%
Somewhat important	2	5%
Not important	0	0%
Total	**42**	**100%**

How important is it for a company to invest in people skilled in general knowledge of regulations and standards regarding batteries?



6) Which BESS application do you consider to be more relevant in the future?

For this question the audience was allowed to choose two options. Only half of the participants decided to answer a second time.

It is consensual that the applications that were on the birth of the energy storage technology (ancillary services and transmission energy services) are no longer viewed as the ones with more relevance for the future, but instead applications which require more detail in designing and more skilled people, as distribution infrastructure, bulk energy services and customer energy management.

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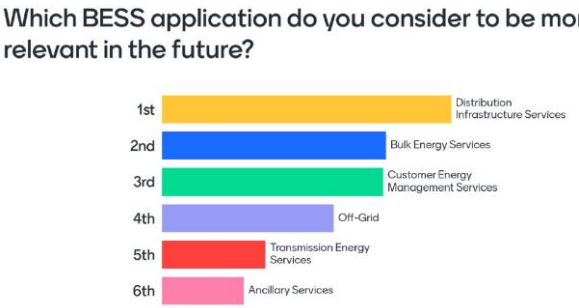
Choice	Answer 1	Percentage	Answer 2	Percentage
Bulk Energy Services	7	19%	4	11%
Ancillary Services	2	5%	0	0%
Transmission Energy Services	2	5%	3	8%
Distribution Infrastructure Services	13	35%	4	11%
Customer Energy Management Services	9	24%	4	11%
Off-Grid	4	11%	3	8%
Total	**37**	**100%**	**18**	**49%**

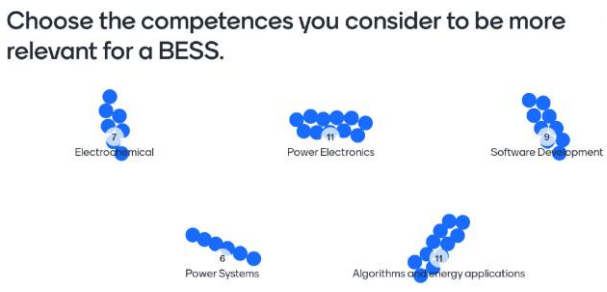


7) Choose the competences you consider to be more relevant for a BESS.

This question was skipped during the presentation due to time management, nevertheless it was online during Jussi's presentation and people still answered. The perception of relevance is equally distributed. It can possibly be because people's perception on importance varies accordingly to what they are exposed. People from the electrochemical area will not think of power electronics as relevant as electrochemistry and vice versa. Concluding, all areas will have the same level of relevance.

Additionally, it should be noted that "Software Development" and "Algorithms and energy applications" are partly overlapping due to algorithm design and programming being a part of advanced software development. This appears to indicate to the direction of importance of advanced software skills in various stages of the value chain, which is interesting, since there is already a high demand for IT people, namely coders in the job market and adding battery business to that is making the competition for skilled programmers even fiercer in the future.

Choices	Votes	Percentage
Electrochemical	7	16%
Power Electronics	11	25%
Software Development	9	20%
Power Systems	6	14%
Algorithms and energy applications	11	25%
Total	**44**	**100%**



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8) What area your organization needs to focus the most to fully utilize future Battery Energy Storage Systems?

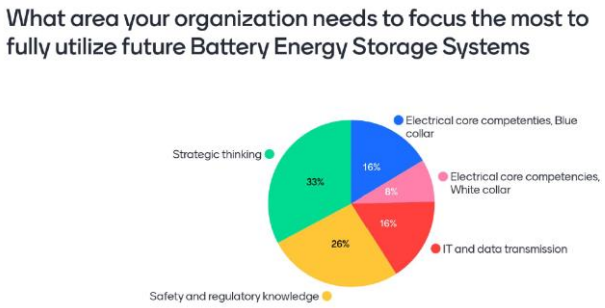
According to the answers, jobs from electrical engineering are already well developed in the industry. Safety and regulatory knowledge together with strategic thinking appear to be the competences that need further development.

Taking the answers in question 4), where it was concluded that probably most companies already have a battery fire specialist, it is still seen as a competence that needs further development and training.

“Strategic thinking” scoring high is an indication of companies potentially still being in the stage in which they need to understand how batteries will help their future business to perform in the most efficient way considering how they strengthen the foundation of the service and added value they provide to their customers. And the plans and strategies they come up with regards to using BESS solutions need to happen within the framework provided by the regulations and safety. After the companies know to which direction they are heading and how the BESS application strengthens that course, the actual skills need will follow and hence there were less votes for actual core electric competences plus IT skills.

And the above assessment (naturally based on the limited info) indicates an opportunity for management consultant kind of job roles in which individuals and agencies providing consulting services are expected to rise.

Choices	Votes	Percentage
Electrical core competencies, Blue collar	10	16%
Electrical core competencies, White collar	5	8%
IT and data transmission	10	16%
Safety and regulatory knowledge	16	26%
Strategic thinking	20	33%
Total	**61**	**100%**



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Evaluation – Mapping to Topics of Intelligence

Stakeholders Identified:

Name	Specialization	Importance	Contacts/Links
TUKES Finnish Safety and chemicals Agency	Safety and regulation for chemicals. Tukes promote the safety and reliability of products, services and industrial activities in Finland.	Regulation and standards for battery storage A register of authorised to perform electrical works in Finland.	Link
Telia Towers	Operator and provider of Telecom stations	Operator and user of battery storage	Link
EIT InnoEnergy			Link
EFACEC	Product and systems for electric grid equipment's	Battery Storage integrator	Link
CTIF International Association of Fire and Rescue Services	Association for fire and rescue	Expertise in battery fire mitigation	Link

Technologies Identified:

Name	Description	Comment	Links
Controlled burn of batteries	Control the spread of the fire until all fuel is burned to prevent re-ignition	May not be possible	
Fire control blanket	Cover the vehicle with a Fire blanket	Less or no maintenance – Only for EVs	
Water usage for stopping thermal propagation	Use of water to stop Li-batteries fire	Can damage the components	
Inert gasses for stopping thermal propagation	Use of inert gasses for Li-batteries fire	It is not effective if battery modules are not separated enough	
Optimization by software	Market differentiation between competition by software and algorithm improvement	Software development is what can be most improved to differentiate solutions and problem solving	
A holistic way of maintenance and service	Wider competence to work at base station		

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Job Roles Identified:

Name	Value Chain	Comment	Links
Data Analyst and AI	All Value-Chain	Focus on system integration and 2nd use	
Algorithm developers	Module Manufacture, System integration, 2nd use	For BMS, Scada and control systems	
Software Engineers	Module Manufacture, System integration, 2nd use	For BMS, Scada and control systems	
Thermal Engineers	Cell and module manufacture, system integration	Ensure batteries work in the correct temperature range	
Electrochemical technicians and engineers	Cell and module manufacture	Ensure batteries correct manufacture. Improve and develop new battery technology	
Product designer	Cell and module manufacture, system integration and recycling	Design a product accordingly to the customer needs	
Asset manager	System integration and O&M	Project management	
Communication operational and developers	System integration	Guarantee automated communication with the system assets	
Automation engineers	System integration	Autonomy of the battery storage functioning	
Electrical engineers	Module manufacture, System integration and O&M	Functionalities, system design, automation, project management, etc.	
Power Electronics engineer	System integration and O&M	Develop and maintenance of power conversion systems	
Digital Control engineer	Module Manufacture, System integration, 2nd use	For BMS, Scada and control systems	
Manufacturing	Cell and Module manufacture	Manufacturing of batteries and other equipment's	
Electricians (S1) qualification	All value chain		
Electricians (S2) qualification	All value chain		

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Electricians (S3) qualification	All value chain	
Sales personal	All value chain	
Economist	All value chain	
Chemist	All value chain	
Electrical work supervisor	All value chain	guiding the work, ensuring the competence of and instructing the employees, providing tools, managing the external framework of the work
Management consultants	Operation	Support for corporate strategic management

Skills/Competence or Knowledge Identified:

Name	Job Roles	Comment	Links
Electrical hazards	Safety for electrical equipment expert		
Contamination control of batteries	Safety professionals / Environmental		
Safety of the product	Testing engineers / Regulatory Consultants		
Legislation and standards	Consultants		
Market surveillance	Business Developer / Sales department/Inspector		
Safe working methods	Risk assessment consultants		
Electrical works	Electrician		
Chemistry	Chemists/Chemical Engineers		
Electrochemistry	Chemists/Chemical Engineers		
Modelling tools	Simulation Engineers		
Thermal simulation	Simulation Engineers		
Software development	IT developers		
Power Electronics and systems	Electrical Engineers		
R&D	Investigation	R&D in general for every fields	
Service and Maintenance	Maintenance leaders and operators		
Sharing of information		Promoted in all job roles, with resource	

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		to more events, associations, and co-organized projects
Testing	Testing experts	Testing methods for battery fire mitigation
Training	Educators	Increase the number of people skilled in battery fire mitigation

Drivers of Change Identified:

Name	Influence	Comment	Links
Incidents with batteries	Increase in number of registered incidents	Mitigation of the hazard becomes necessary	
New battery technologies	R&D in batteries with different properties	It is possible to discover new applications and improve the old ones	
EV revolution	Prices of lithium-ion batteries -> profitable for stationary apps	-87 %	
5G	Energy consumption increase Sustainably demands	Batteries will ensure the energy requirements for the stations during off-grids	
Sustainability	Transformation of energy market	Carbon fuels usage can be shorted with battery storage	
Price pressure	Transformation of energy market	Battery storage allows the usage of low-price energy	
Emerging technologies	Transformation of energy market	New technologies make the storage business profitable	
Renewable Energy	Integration of BESS due to the need for flexibility	Battery storage allows flexibility to use energy from renewable sources	
High Energy to power ratio	Li-ion BESS have higher E/P densities	Ability to provide to the needs of the customers	
Increase in power consumption for telecom base stations	Power Consumption increase	Batteries will ensure the power requirements for the stations	

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Sector Attractiveness Factors Identified:

Name	Influence	Comment	Links
New regulations towards green energy	Environmental policies require a new approach to energy generation	Energy storage is one very efficient method to help the integration of renewable energy sources	
New market designs and business models	Opportunity for new business and companies	Attractive business models and market design contribute to the development of the sector	
Growing Electrification	Demand of energy and power of good quality increase	Energy storage allows the utilization of stored energy and power when it is more required and less available	

Trainings/Courses and Education Identified:

Name	Focus	Type	Links
Risk mitigation Database			
Master thesis done in collaboration with the Energy Storage companies	Solving company's issue + developing student's skills and competences related to energy storage	Master thesis	
Master's degree targeted to battery storage	Development of specific skills related to battery storage	Master's degree	Link
Modelling of batteries	Creating, developing and improve models for batteries and battery systems	Post-grad, PhD, small and medium courses	
Strategic thinking	Develop methodologies for storage business and storage development	Workshops, small and medium courses	
Safety and regulations	Increase knowledge in safety issues and	Workshops, small courses	

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	existing and in development regulations		
Software development and algorithms for battery storage	Software & algorithms used to improve the functionalities of energy storage	Workshops, small courses	
Battery Firefighting	Methods and protocols for battery fire prevention and mitigation	Workshops, small and medium courses	Link

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