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Alliance for Batteries Technology, Training and Skills

2019-2023

D4.5 Sectoral Intelligence definition for sub-sector ISIBA - Release 1

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Job roles & skills relevant to the operation, repair and maintenance of stationary batteries

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List of Abbreviations

BESS	…	Battery Energy Storage System
BMS	…	Battery Management System
EPC	…	Engineering Procurement and Construction
ESS	…	Energy Storage Systems
EU	…	European Union
EV	…	Electric Vehicle
GW	…	Giga Watt
ISS	…	Industrial Storage System
LiB	…	Lithium-ion Batteries
PCS	…	Power Conversion System
PV	…	Photovoltaic
R&D	…	Research and Development
RES	…	Renewable Energy Sources
RSS	…	Residential Storage System
USD	…	US Dollar
VRE	…	Variable Renewable Energy Systems

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Executive Summary

The elements covered in this report involve trends that have been identified in the previous research conducted in the ALBATTS project. These main trends with their sub trends are further analysed and discussed in this document to provide recommendations on how to further boost the development and availability of the skills and competences. This is conducted on the basis of the job roles, skills, and competences that were also identified in our previous research.

In this report we cover the following main trend categories with the job roles and skills as well as related recommendations:

1. General Stationary Applications
2. Cost-efficiency
3. Safety
4. Resiliency and/or Self-sufficiency
5. Sustainability

With **General Stationary Applications,** we cover the trends related to the use of BESS and the implications in terms of what can be recommended as further actions. For example, the increasing use of battery energy storage systems (BESS) with heavy-duty, grid/off-grid and telecom applications is a result of various needs and benefits. These include supporting the process of reaching sustainability goals by combining BESS with variable renewable energy (VRE) systems, as well as bringing resiliency and reliability with backup systems. What we recommend is further training on understanding not only the energy storage technologies of them, but their areas of applications and system integration and management skills. The so-called heavy duty use in the context of our research is often associated with the areas of application that have placed the reliability of the power supply to a high importance level which then emphasizes the need for skills related to the maintenance and repair. The main job roles supported by the trends range from application engineers to energy storage project engineers and those responsible for the maintenance such as field service engineers and beyond.

Cost-efficiency is a common driver of development from throughout industries and markets. This is also the case with battery energy storages. Decreasing electricity costs by placing

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stationary battery systems is an objective that boosts the deployment of stationary batteries. Batteries can be used together for example with intermittent PV and wind power systems. Additionally, batteries can save energy when electricity prices are lower in order to be used during the time of higher rates. Those working in this area include not only technical staff but also personnel who needs to ensure the business side and smooth customer interaction from consultants to sales related roles. Recommendations on education and training do not only include such skills as understanding battery systems and electrical engineering but also for example project planning, ability to build models along with competence to perform energy related cost calculations.

In the **Safety** chapter, we look into the importance of creating regulations and legislation on the topics of battery safety. In our previous research, we have learned about the risks related to battery fires. We have identified such job roles as safety managers and specialists. There are also other significant roles that support the safety such as test engineers, inspection technicians, auditors, and others. In our recommendations, we emphasize the need to create and update electrical equipment regulations and legislation accordingly to ensure the safety of users. We also address the skills that are needed when disaster strikes such as ensuring re-skilling of firefighters with adequate skills and beyond.

Resiliency and self-sufficiency are the factors that are required from systems that have some type of critical role whose functionality has to be ensured. In the context of BESS, it is about enabling the availability of power in any circumstances. We look into such trends as military use, offshore oil and gas operations as well as telecom applications and beyond. Batteries provide resiliency by supplying power in blackout situations. Together with VRE, BESS ensures a self-sufficient, intermittent power source. In terms of job roles, we are talking about various engineer positions such as battery system, energy and application engineers that are needed there in consultant roles. Maintenance roles are emphasized due to the critical nature of batteries in the concerned application areas. Consequently, for example, maintenance and repair related skills are recommended in addition to the skills associated with understanding battery technologies to the integration of BESS with renewable systems.

Finally, we address the **Sustainability** element of batteries through second life application, integration of battery systems with renewable energy sources and the need for sustainable and resilient base stations. While batteries support sustainability related goals at the same

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time the sustainability of the batteries themselves requires to be addressed. In terms of second life application, we have discovered job roles from cell test engineers to various other engineer positions and beyond. Recommended skills include testing and quality inspection as well as repairing. With the integration of renewables, we are talking about engineers with various skills from battery systems to algorithms. Regarding the base stations, there is a development taking the shape of moving to increased sustainability and resiliency by, for example, shifting from diesel generators to batteries with backup systems. There is a variety of technical positions related to this area, from battery maintenance to inspectors, as well as those dealing with the business development side, all the way to the safety specialists. The needed skills include the ability to manage projects involving the sustainability of base stations along with the engineering competences related to such projects concerning batteries and their integration.

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Introduction

Proliferation of batteries in various stationary applications from backup power systems to battery energy storage systems (BESS) is occurring in Europe and beyond. The global market for energy storage is forecasted to grow significantly. According to the forecasts installed capacity is expected to reach over 100 GW by 2030 Figure 1. While there are different estimations on the pace of the growth P&S Market Research forecasts that the market could reach 26 billion USD by 2022.[1]

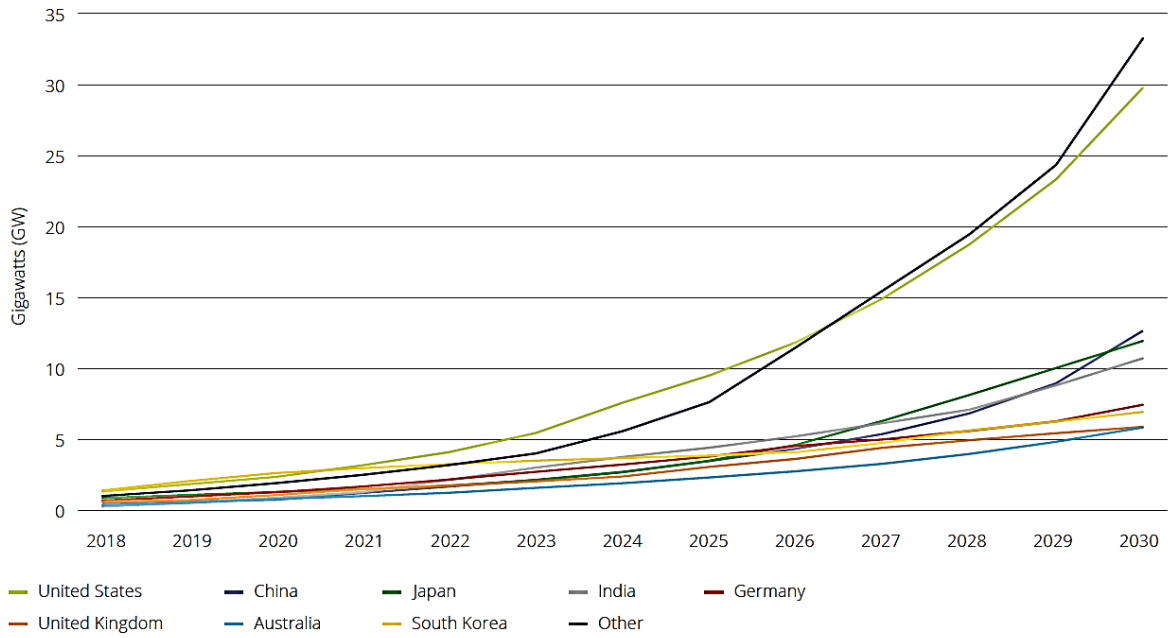

Figure 1. Projected global cumulative storage deployment by country 2018-2030[2]. Deloitte, Supercharged: Challenges and opportunities in global battery storage markets

We are experiencing such trends[1] as increasing need for energy storages in heavy-duty applications such as in public places to various applications from hospitals to airports and stadiums. The reliability of our mobile communications is also dependent on battery backup systems that are emphasized by the global deployment of energy-thirsty 5G networks[3].

[1] ALBATTS - D4.1 Desk Research Data Analysis ISIBA1), ALBATTS project, 2020
[2] Bloomberg New Energy Finance. Deloitte. lobal energy storage Digitization and market innovation accelerate battery storage deployment. Retrieved July 22. 2020, from https://www2.deloitte.com/us/en/pages/energy-and-resources/articles/global-energy-storage-renewable-energy-storage.html
[3] ALBATTS - Deliverable 4.3 - Future Needs Definition for sub-sector ISIBA - Release 1

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Figure 2 Furthermore, there are grid and off grid applications that are more and more supported with ESS. Figure 3

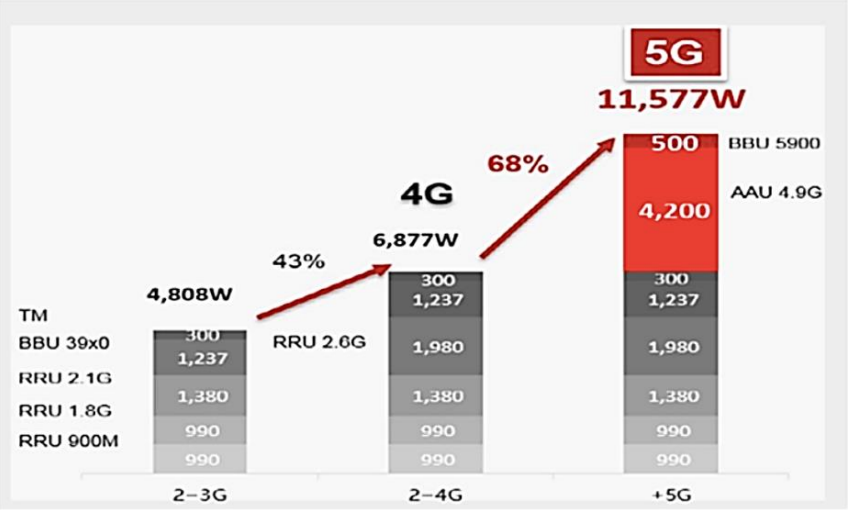

Figure 2. Base station power requirements 2G, 2-4G and 5G.[4]

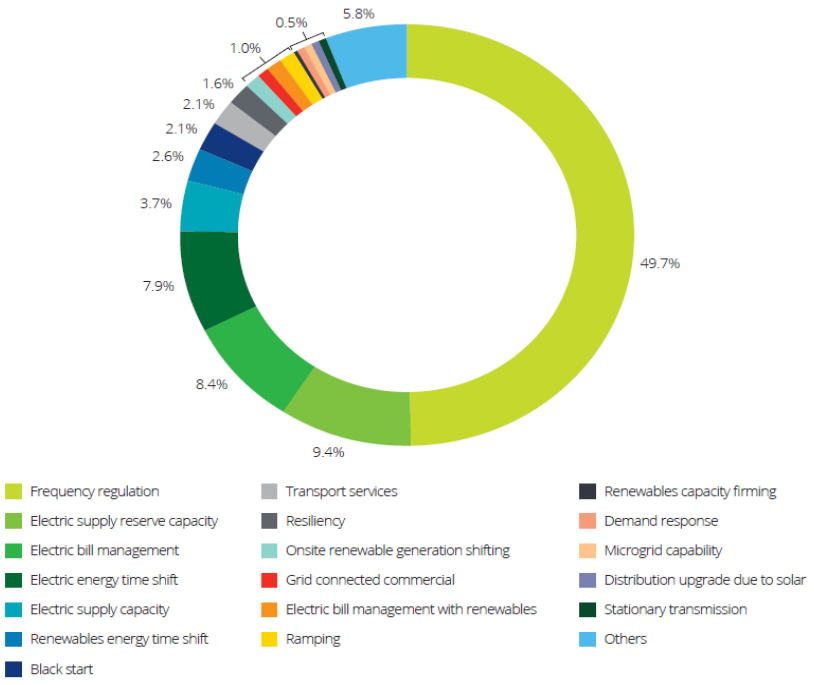

Figure 3. Global battery storage capacity by primary use case.[5]

[4] Fierce Wireless, 5G base stations use a lot more energy than 4G base stations: MTN by Linda Hadestry, Apr 3, 2020. Huawei. Retrieved August 28, 2021 from https://www.fiercewireless.com/tech/5g-base-stations-use-a-lot-more-energy-than-4g-base-stations-says-mtn

[5] Electricity Storage and Renewables: Costs and markets to 2030, International Renewable Energy Agency (IRENA), October 2017, p. 33, http://www.climateactionprogramme.org/images/uploads/documents/IRENA_Electricity_Storage_Costs_2017.pd

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The drivers for the forecasted development are numerous. They are guided and supported with policies, directives and regulations that push the industries towards sustainability with the application and integration of variable renewable energy systems (VRE). Then there is the cost-efficiency factor that BESS application can provide as well as technical aspects[6] that may involve things for enabling resiliency and self-sufficiency of systems. Additionally, this is also supported by the decreasing prices Li-ion batteries. Figure 4

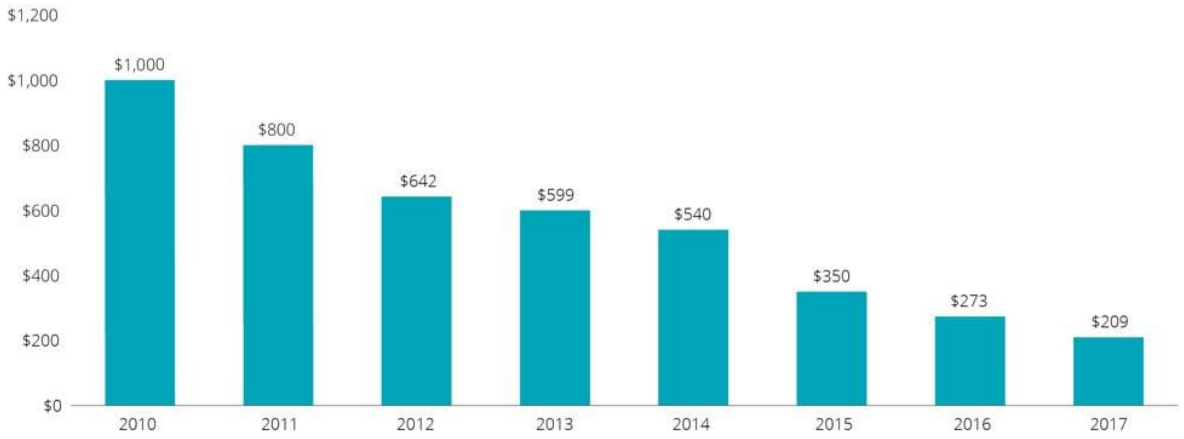

Figure 4. Declining costs of lithium-ion batteries from 2010 to 2017[7]

Along with the deployment of stationary batteries that coexist with the battery application in the traffic with various EVs the safety aspect of the batteries is becoming more and more important. Figure 5 Battery fires are difficult to extinguish, and the risk of re-ignition is very high. This has generated a need for new methods and tactics for fire and rescue departments. This, again, needs encouraging collaboration between fire and emergency services globally. What is needed to improve the situation from the safety perspective includes education, innovation, information, installation, and regulation. Each stakeholder, such as manufacturers, have their role in ensuring the safety. Authorities are responsible for the legislation and surveillance. Currently, energy storage systems are not covered well by EU legislation.[8] There are aspects that could use improvement from the safety point of view.

[6] ALBATTS - D4.1 Desk Research Data Analysis ISIBA1), ALBATTS project, 2020
[7] https://www2.deloitte.com/kz/en/pages/energy-and-resources/articles/gx-global-energy-storage-renewable-energy-storage.html last accessed 28.8.2021
[8] ALBATTS - Deliverable 4.3 - Future Needs Definition for sub-sector ISIBA - Release 1

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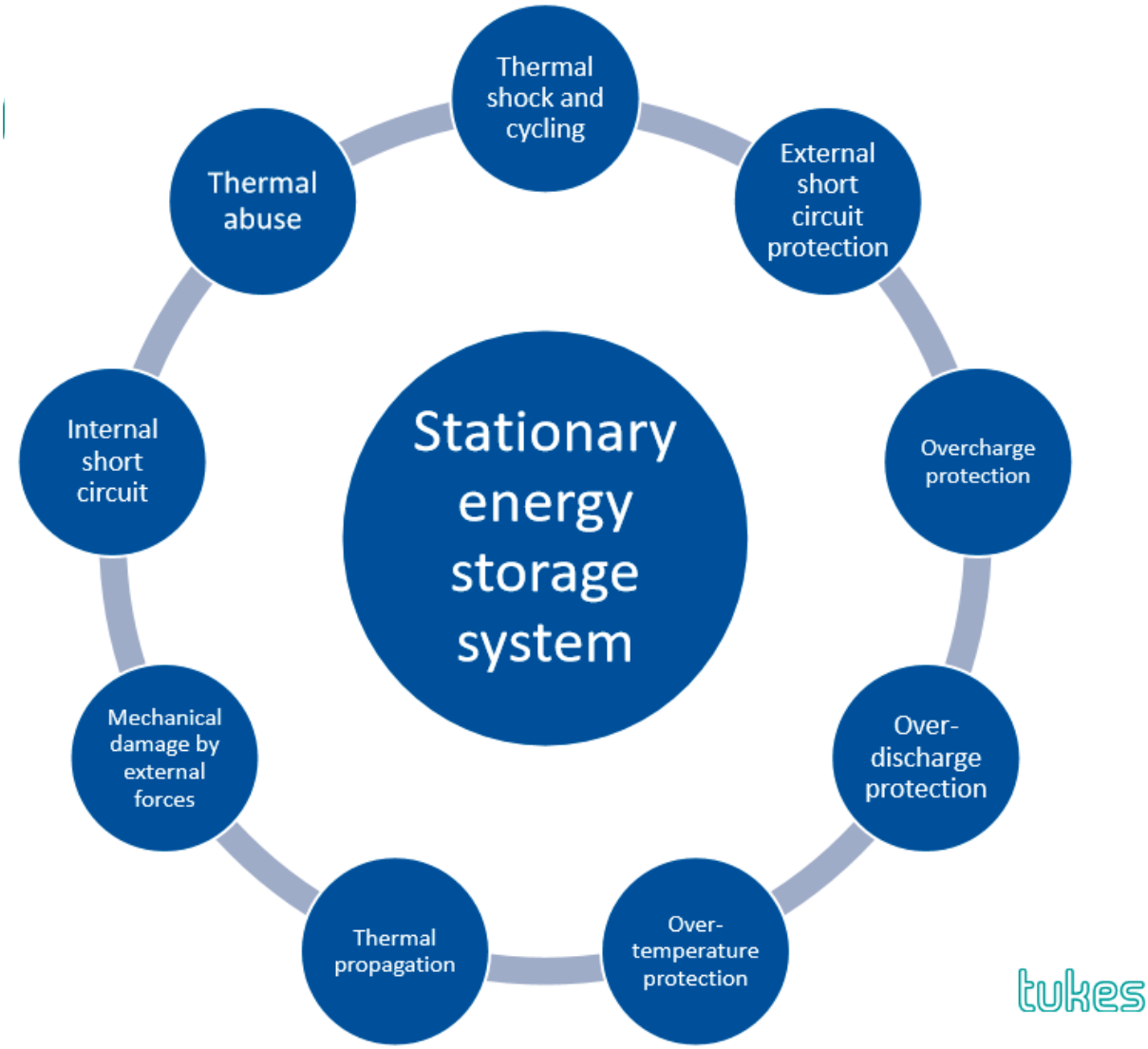

Figure 5. Risks involved with stationary energy storage systems[9]

[9] Karoliina Meurman, Tukes, 29.1.2021

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Methodology

This report covers the **operation, repair, and maintenance** (with some outreach into battery second life or recycling), including the battery value chain stage of applications in **stationary applications of batteries** (including heavy duty applications; telecommunications – mainly 5G, grid and off-grid applications; military applications; base stations)**.** Analysis of other stationary battery applications is expected to be included in future ALBATTS reports.

The report contains a set of **trends** that were identified within the ALBATTS project. Trends related to the aforementioned stationary applications of batteries are structured according to their characteristics and their scope is described in individual sections. Trends as such were used for further mapping of skills/competences that are making up different job roles.

This mapping and composition are possible due to the extensive research (continuous desk research, survey, interviews, or workshops) that has been done in the ALBATTS project, where all relevant skills and job roles were stored in the **"competence matrix"** which represents the relation of skills concepts to the occupation profiles (job roles).

Thanks to this **mapping process**, where multiple skills were mapped to multiple trends, it was possible to see a link between trends and available skills/competences and thus job roles in the database and see which job roles or skills/competences were influenced or were related to different trends.

This is visualised in two different ways:
(1) **tree map** showing a set of skills, their occurrence number corresponds to the area, which is covered by the skills within the tree map. The more occurring skills, the more area it covers. This was done for the sector-specific and cross-sectoral skills/competences concerning each individual trend. Occurrence is calculated based on the significance of the job roles, which is described in the next point. In a few cases, not sufficient data was found and, therefore, only sector-specific or cross-sectoral competence mapping was possible.
(2) **word cloud** visualisation is used for the significance of the job roles, while more significant job roles are showcased with a bigger font size. This significance rating is done by analysing

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the skills/competence to trend mapping and selecting all job roles that are relevant for the trend scope and are composed of this skill. This enables us to see how many times different job roles will occur per trend.

Recommendations and **target groups** are identified as a last part of the trend description. Actions that are recommended to be partaken are targeting relevant EU institutions, Governmental bodies (Ministries of Education, Labour, etc.,) and the industry sector/business area involved in education, training, reskilling, and upskilling of the workforce.

The main sources used for trends, sub trends, and recommendations are the previous **project ALBATTS reports** – desk research, webinars, and survey[10] but it was also based on specific **knowledge** of involved project partners.

This is the **first in a series of three** ALBATTS sectoral intelligence reports for stationary applications. The findings and recommendations need further **verification and specification** within upcoming ALBATTS project rounds of activities, such as the next desk research works, webinars, and other activities. In the next reports, we plan to update findings and expand the scope to other applications or other battery value chain steps.

The report will be used as a **partial input** to the first overall report under the ALBATTS WP3 – Sectoral Intelligence working group due by the end of November 2021, which will also cover **other parts of the battery value chain,** from the extraction and processing of minerals to the secondary use or recycling of batteries. **WP3 report will constitute the main sectoral intelligence deliverable.**

[10] Deliveries D5.1, D5.2 and D5.3 available at https://www.project-albatts.eu/en/results (last accessed on 24/08/2021)

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1 General Stationary Applications

This chapter discusses the trends concerning the various stationary applications[11] of batteries. While batteries are often associated more with the electrification of traffic, there are a number of uses that are far less obvious for regular citizens and consumers even though they are using systems and relying on power grids that are often critical and consequently backed up with battery systems on the daily basis. Additionally, they play a significant role in the process in which, for example, Europe is pursuing its goals on sustainability. Planning, building, maintaining, servicing, selling, etc. these battery-supported systems will require actions in terms of education, skills, and competences of those who interact with them.

In this chapter, we cover the following trends:

Increased need for energy storages with heavy-duty applications

- Proliferation of battery energy storages commercially in public places
- Growing competition in the energy storage market
- 5G cellular network deployment, batteries in telecommunications
- Commoditization of base stations
- grid and off grid systems and applications
- Removal of barriers for a widespread implementation of battery storage
- Smart Grid

[11] ALBATTS - D4.1 Desk Research Data Analysis ISIBA1), ALBATTS project, 2020

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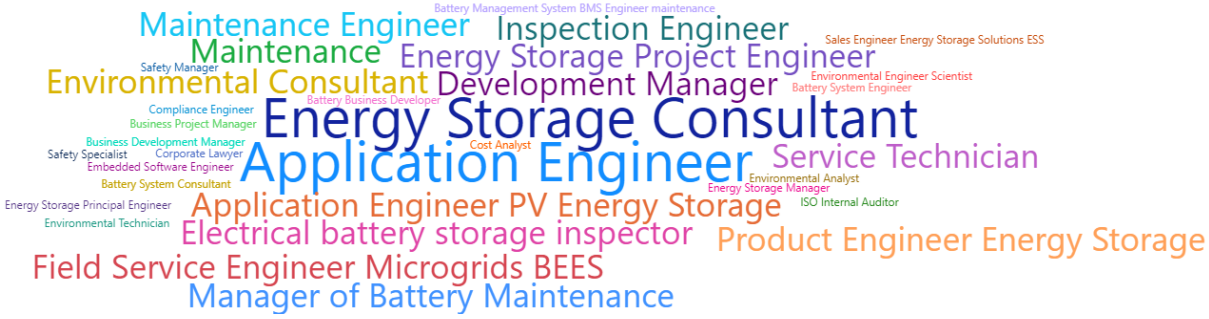
1.1 INCREASED NEED FOR ENERGY STORAGES WITH HEAVY-DUTY APPLICATIONS[12]

Energy storage can be regarded as a promising technology, when coupled with a variety of heavy-duty applications, and this has resulted in an increased use of it worldwide. The areas of applications considered as heavy-duty include use of energy storages, for example, in hospitals, stadiums, data centres, airports, military applications, maritime on-/offshore and beyond. The reasons for increased need and benefits include:

- support in meeting sustainability goals;
- combining energy storages with VRE systems;
- cost savings, for example, by storing the energy when the prices are the lowest;
- resilience and safety with backup power systems - reduce the need for diesel generated energy as a backup;
- energy independency.

Geographically, this development is likely to occur earlier in Europe and North America followed by other areas, but this will eventually be a global development.

1.1.1 Skills Agenda



[12] ALBATTS - D4.1 Desk Research Data Analysis ISIBA1), ALBATTS project, 2020

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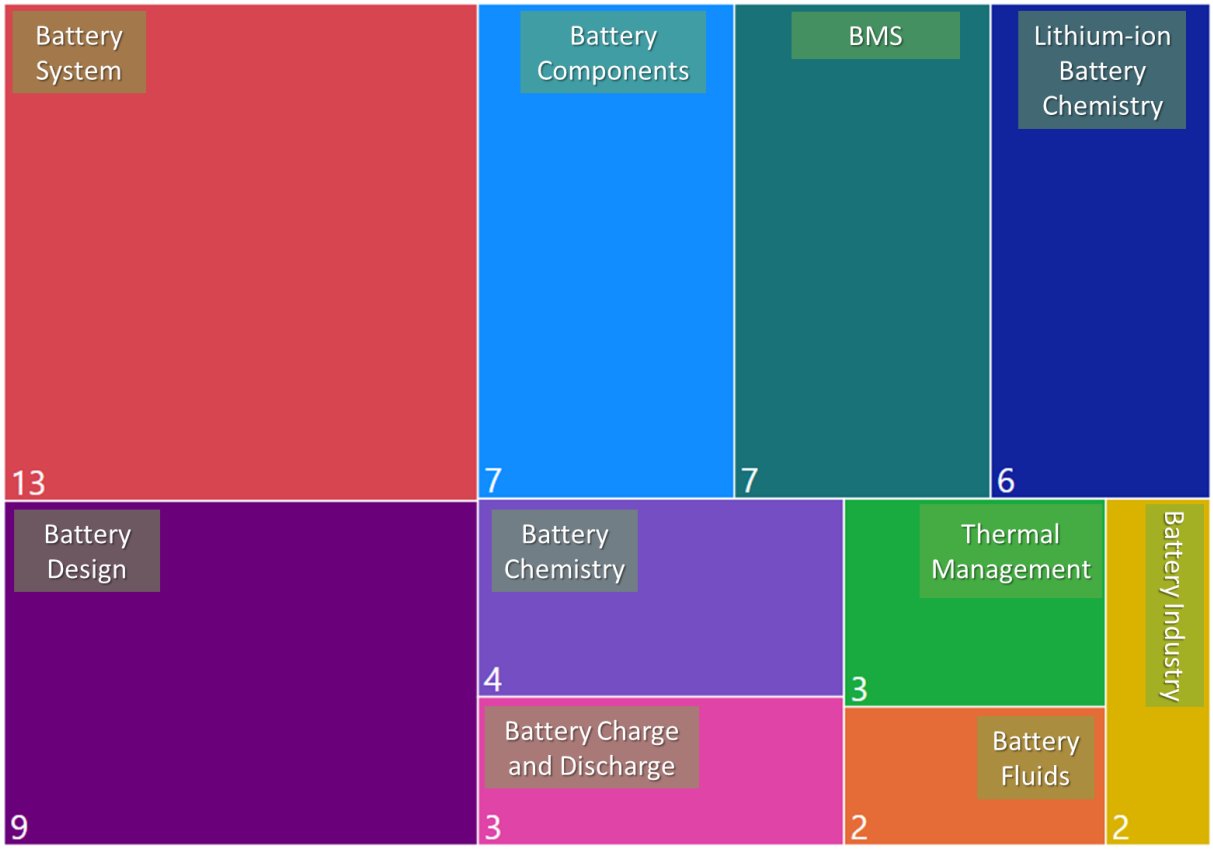

Figure 6. Sector Specific Competence

Figure 7. Cross-sectoral Competence

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1.1.2 Recommendations and Actions

When providing the training on energy storage, it is needed that the trainees understand the following:

- energy storage technologies;
- areas of energy storage application;
- energy storage installation, with functional testing and charge/discharge;
- energy storage integration to different VRE and other systems;
- management of energy storage systems;
- power management - requirements in context of battery management systems and their effects on operation of the overall battery stack, safety, and cost
- the related maintenance including:
  - preventive/predictive maintenance;
  - battery repair;
    - safety and maintenance aspect - different cell chemistries within the application and risk controlling – overcharging, short-circuiting

In terms of general maintenance and repair of battery systems the following are important skills:

- battery rundown testing – determination of battery capacity;
- inspection of battery, rack/cabinet, or chassis for defects (corrosion, leakage);
- measurement and recording - float voltage and current of the bank and terminal voltage of selected batteries;
- checking of: (1) electrolyte levels in each cell, visual inspection where applicable; (2) identification of weakened or damaged cells or components (3) terminal voltage of selected batteries; (4) loose connections;
- keeping record of the ambient temperature;
- comparison of the collected data to the previous inspection;
- removing/preventing corrosion.

It is also important to provide training to understand the following in the energy storage context:

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- sustainability;
- environment and environmental permits;
- cost estimates;
- legislative framework;
- standards (ISO 17840, EN 50110-1, IEC 60364, NFPA 855);

1.1.3 Target Groups

This development is currently in progress, and it is going to grow. By 2025 and beyond, it can be expected to become more and more significantly developed. The target groups, heavy-duty users of energy storages include, for example:

- Airports
- Aviation authorities
- Battery manufacturers
- Battery management system (BMS) providers
- Citizens/ end-users in hospitals, stadiums etc.
- Commercial organizations
- Electric utilities companies
- Environmental protection agencies / associations
- Local authorities/municipalities, governments
- Marine electrical engineering servicing providers
- Maritime ESS suppliers
- Maritime industry advisors
- Military bases
- Oil drilling companies/ Oil groups
- Power management companies
- Project developers and investors
- Regulators

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- Solar panels manufacturers
- Specialist battery storage integrators

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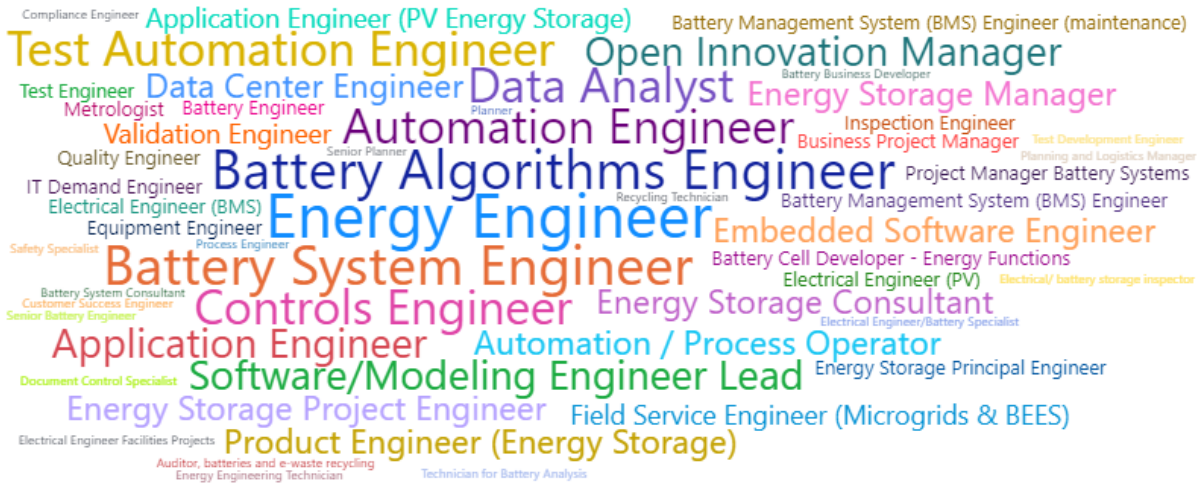
1.2 PROLIFERATION OF BATTERY ENERGY STORAGES COMMERCIALLY IN PUBLIC PLACES

Using battery energy storages coupled with various renewable energy systems with public buildings and facilities such as hospitals, airports, stadiums etc. is increasing.[13] An example of this is the application of renewable energy generating infrastructure with buildings in the form of PV systems on the roof and combining them with a battery energy storage system. The benefits include, for example, balancing the peak hours energy consumption and reducing overall electricity costs.

Geographically, this a process expected to occur Europe-wide (and potentially beyond).

1.2.1 Skills Agenda

Information, metrics on the skills and job roles mapping, qualitative/quantitative summary, few charts, will have to develop



[13] ALBATTS - D4.1 Desk Research Data Analysis ISIBA1), ALBATTS project, 2020

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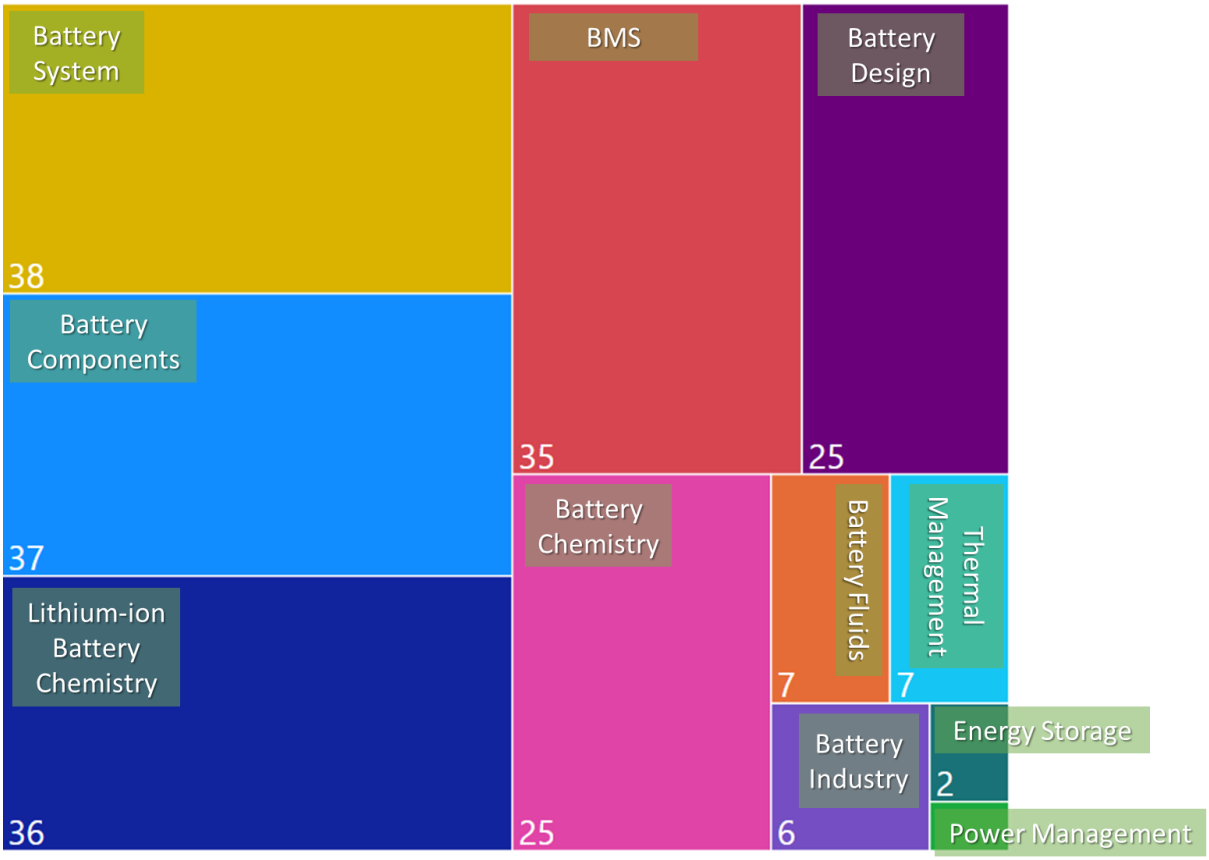

Figure 8. Sector Specific Competence

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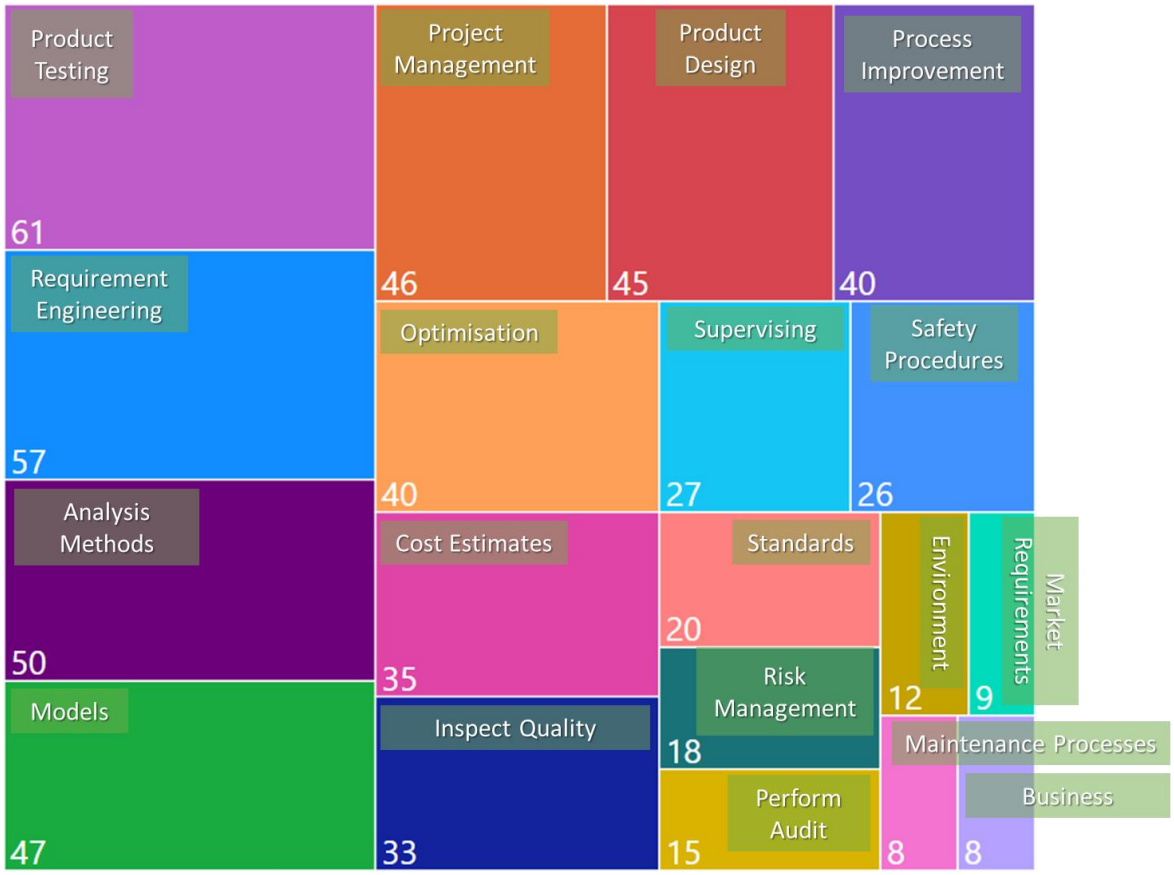

Figure 9. Cross-sectoral Competence

1.2.2 Recommendations and Actions

- Proliferation of battery energy storages in public places requires different job roles and skills ranging from technology related skills to understanding legislation associated with pursuing this sort of venture.
- The range of job roles is tremendous since there are so many things associated from R&D to planning, implementation to understanding the provision of such solutions from the business point of view.
- The identified skills associated and emphasized in this context include the following areas: algorithms; (2) project planning; (3) models; (4) business; (5) energy and costing; (6) electrical engineering; (7) legislative; (8) battery systems; (9) cooling systems; or (10) thermal analysis.

1.2.3 Target Groups

In terms of the timeframe for this development, we are in a stage in which, most likely, modelling, cost analysis, business cases and R&D are being conducted to lay a foundation for the actual deployment (while already in potential progress, for example, in the EU) of battery energy storages to public places

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more widely. Broad implementation of such projects can be estimated to occur more intensively by 2030 and beyond. The target groups include, practically, the same as mentioned in the context of 1.1 - Increased Need for Energy Storages with Heavy-Duty Applications.

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1.3 GROWING COMPETITION IN THE ENERGY STORAGE MARKET

The growing interest in energy storage in recent years has also led to new players coming into the market competing against very well-established players of the energy sector.[14] These new players range from new battery manufacturers that put forward new battery chemistries or technologies that can have advantages in some applications. The newcomers and traditional actors of the electric sector have a different positioning in the market and may address different segments, from the residential segment to the utility-scale segment.

Geographically, this development is occurring in Europe, and worldwide to various extents.

1.3.1 Skills Agenda

[14] ALBATTS - D4.1 Desk Research Data Analysis ISIBA1), ALBATTS project, 2020

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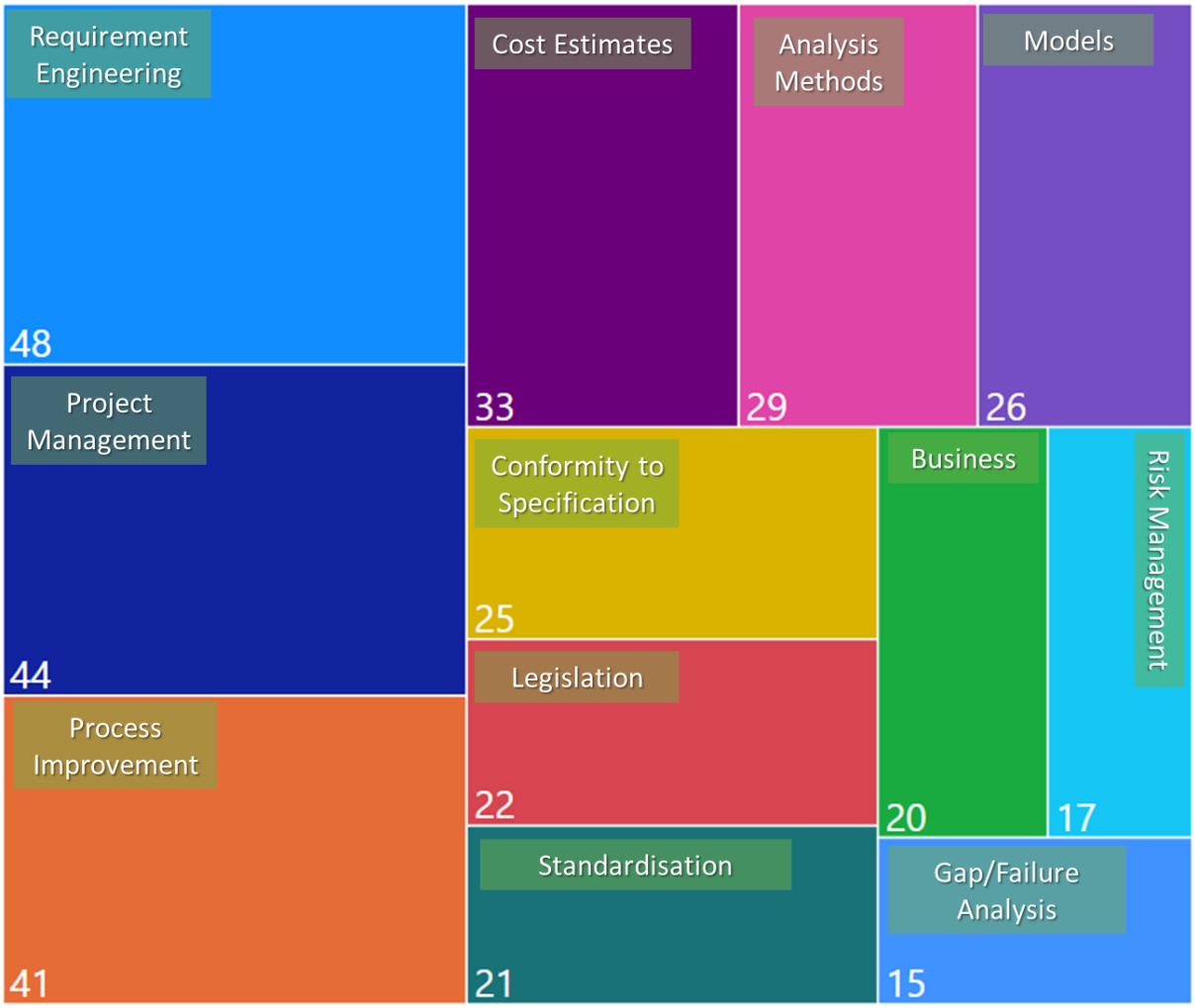

Figure 10. Cross-sectoral Competence

1.3.2 Recommendations and Actions

- Business and marketing related training programmes for BESS experts, who function in management, consultancy, and sales roles (in addition to the technical expertise), are needed to enhance the abilities to understand for example:
  - the BESS business and development of strategies on how to operate in it;
  - the market (customers, competitors etc.) and the market requirements;
  - BESS sales skills;
  - benchmarking;
  - cost estimates;
- Additionally, people with business degree backgrounds (without technical battery related educational etc. background) should be provided training on the basics of BESS technology to enable them to function effectively for example in the marketing and sales roles.

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1.3.3 Target Groups

The competition is occurring already and likely to expand geographically to new areas. The future is not about competition among different companies, but also potentially about new batteries vs. second life ones and different battery technologies. The entities that are most likely to be affected are various providers of battery energy storage solutions as well as the customers who are supposed to benefit from the competition.

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1.4 5G CELLULAR NETWORK DEPLOYMENT, BATTERIES IN TELECOMMUNICATIONS

Worldwide application of 5G technology presents two main challenges and thus opportunities for battery suppliers having to do with the designing or refurbishing of the base stations. 5G networks will demand more energy[15] than previous technologies which means more local generation and battery storage. Additionally, 5G networks need higher density of base stations than 4G networks meaning that new base stations need to be built, considering sustainability and environmental goals, nonetheless. This is a great opportunity for battery storage and, particularly, lithium-ion battery storage as it is deemed as a better technical and economical solution than conventional lead-acid batteries.[16]

1.4.1 Skills Agenda

[15] ALBATTS - Deliverable 4.3 - Future Needs Definition for sub-sector ISIBA - Release 1
[16] ALBATTS - D4.1 Desk Research Data Analysis ISIBA1), ALBATTS project, 2020

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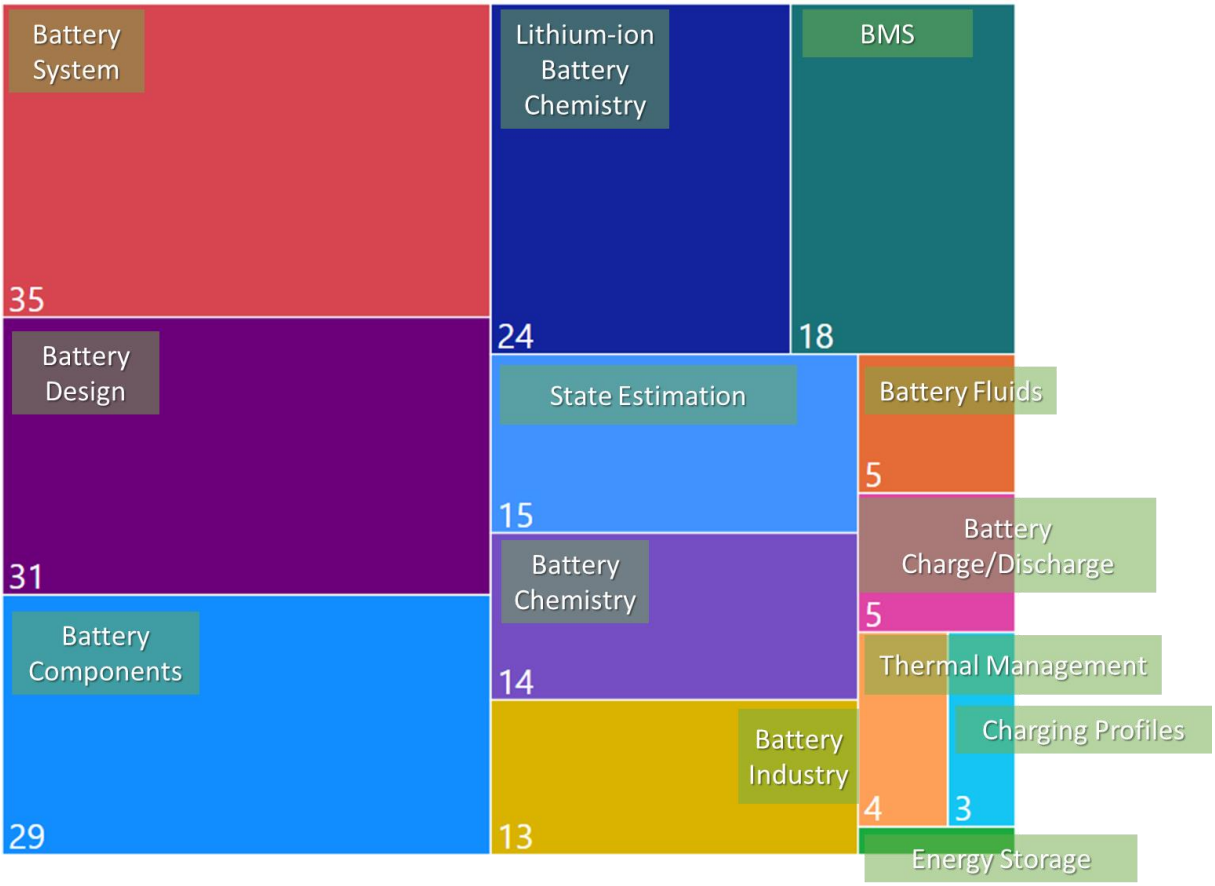

Figure 11. Sector Specific Competence

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Figure 12. Cross-sectoral Competence

1.4.2 Recommendations and Actions

- Global deployment of 5G networks presents a significant business opportunity for the providers of Li-ion batteries for base station applications, but, as mentioned in section 1.3, there is a competition. Consequently, this emphasizes the need to provide business and strategic development related training to battery experts and executives to exploit the opportunities fostered by this expanding market.
- With the number of base stations increasing and battery energy storage being recognized as a crucial help in deploying the needed power and energy to feed the antennas, owners of the base stations should dispose of teams with operating and repairing competences and perform maintenance protocols on the battery systems.
- Workforce and competences needed to install, service and maintain base station batteries should be acknowledged, and the requirements and benchmarking of different solutions for energy storage should be known.

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1.4.3 Target Groups

In terms of timeframe, 5G deployment is currently in progress globally. Those that are affected by the development include, for example: (1) battery manufacturers; (2) citizens/telecom users in general; (3) electric utilities providers; (4) energy management system (EMS) providers; (5) environmental protection agencies / associations; (6) 5G telecom base station; (7) equipment providers; (8) integrated base station providers; (9) integrated storage technology vendors; (10) local authorities/municipalities, governments; (11) Power Conversion System (PCS) manufacturers; (12) research institutes; (13) solar panels manufacturers; (14) telecommunication technology providers; (15) telecom operators; and (16) telecom regulators.

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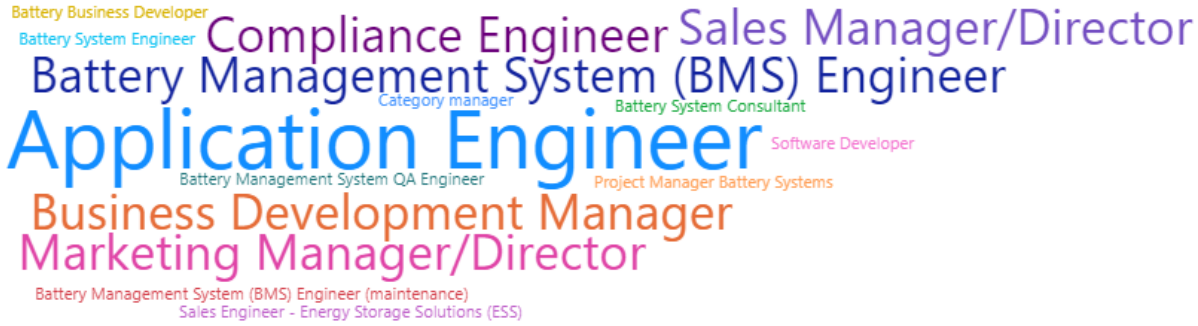
1.5 COMMODITIZATION OF BASE STATIONS[17]

Regarding cellular networks, along with 5G deployment, there is a shift in the industry to general purpose equipment instead of the dedicated equipment approach. This commoditization of base stations is allowing a faster growth of 5G networks but, moreover, the apparition of new actors. This is also relevant for battery storage, particularly manufacturers and integrators, as it should follow this trend for standard products with large life cycle.

1.5.1 Skills Agenda



[17] ALBATTS - D4.1 Desk Research Data Analysis ISIBA1), ALBATTS project, 2020

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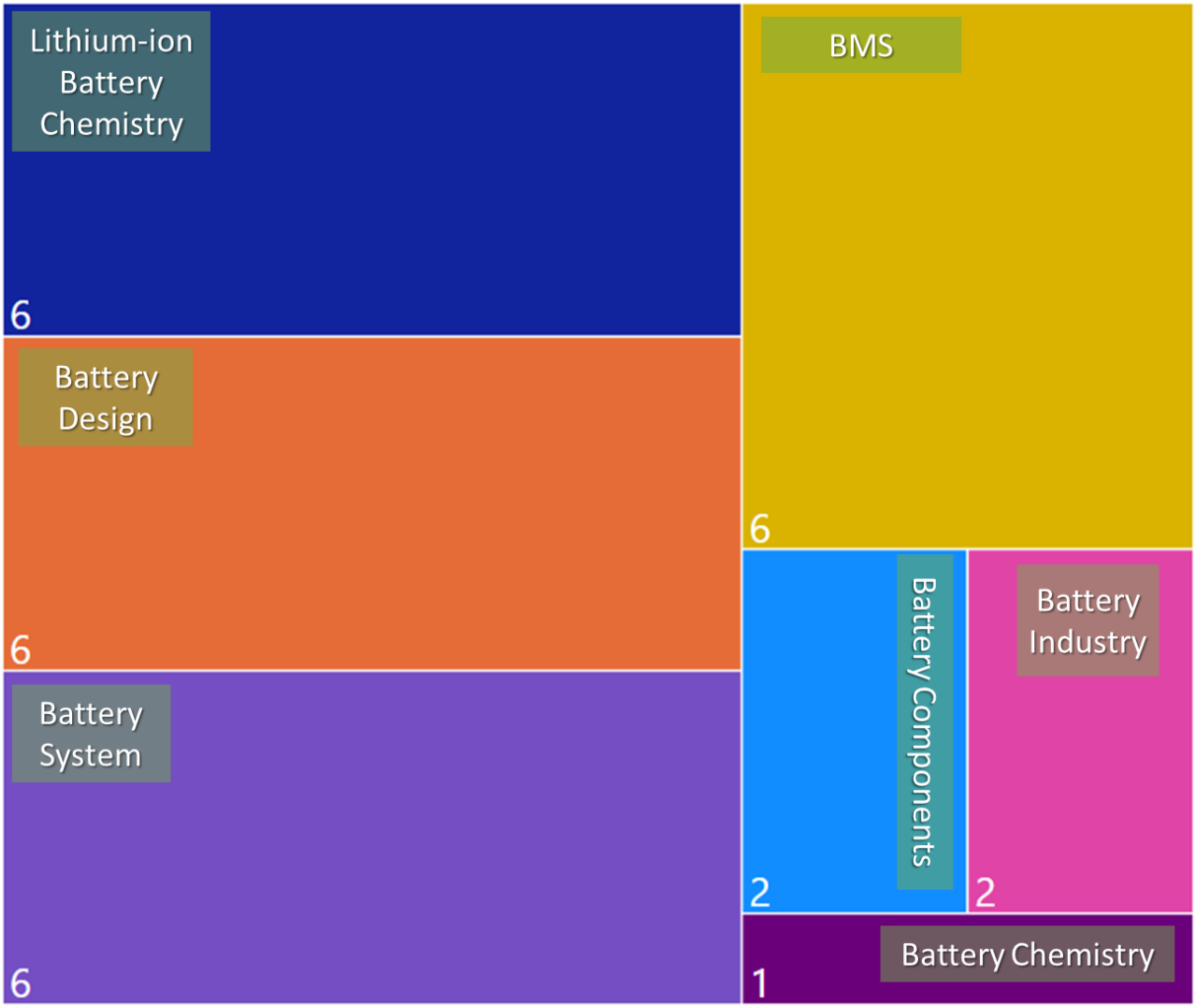

Figure 13. Sector Specific Competence

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Figure 14. Cross-sectoral Competence

1.5.2 Recommendations and Actions

- Commoditizing of base stations provide another business opportunity within the 5G technology deployment process. Developers and sellers of battery systems need to be skilled and appropriately trained in battery system integration with these base station "packages" and related software development.
- Understanding the customer requirements concerning the batteries needed with the given base station equipment requires adequate marketing and business skills for the developers of value-adding solutions for 5G technology providers.
- Requirements to be met when designing the 5G base station power source:
  - Integration of multiple energy sources to improve reliability to produce stable electricity is also recommended.
  - Intelligence for operation and maintenance to increase efficiency.
  - Digitalisation of power high density and efficiency.

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- Development of smart batteries to achieve maximum efficiency from the entire battery life cycle.

1.5.3 Target Groups

In terms of timeframe, 5G deployment is currently in progress globally. Those that are affected by the development include for example: (1) battery manufacturers; (2) citizens/telecom users in general; (3) electric utilities providers; (4) energy management system (EMS) providers; (5) environmental protection agencies / associations; (6) 5G telecom base station equipment providers; (7) integrated base station providers; (8) integrated storage technology vendors; (9) local authorities/municipalities, governments; (10) power conversion system (PCS) manufacturers; (11) research institutes; (12) solar panels manufacturers; (13) telecommunication technology providers; (14) telecom operators; and (15) telecom regulators.

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1.6 GRID AND OFFGRID SYSTEMS AND APPLICATIONS

The drivers of the growing interest in energy storage technologies for the energy sector have been multiple, ranging from environmental, economic, and to technical aspects. The electric sector presents a consistent need for energy storage, significantly related to the integration of significant shares of renewable sources. In the last two decades, a massive integration of Renewable Energy Sources (RES) in the power/energy distribution systems has been prompted by the global increasing climate awareness and various economic incentives.[18]

1.6.1 Skills Agenda

[18] ALBATTS - D4.1 Desk Research Data Analysis ISIBA1), ALBATTS project, 2020

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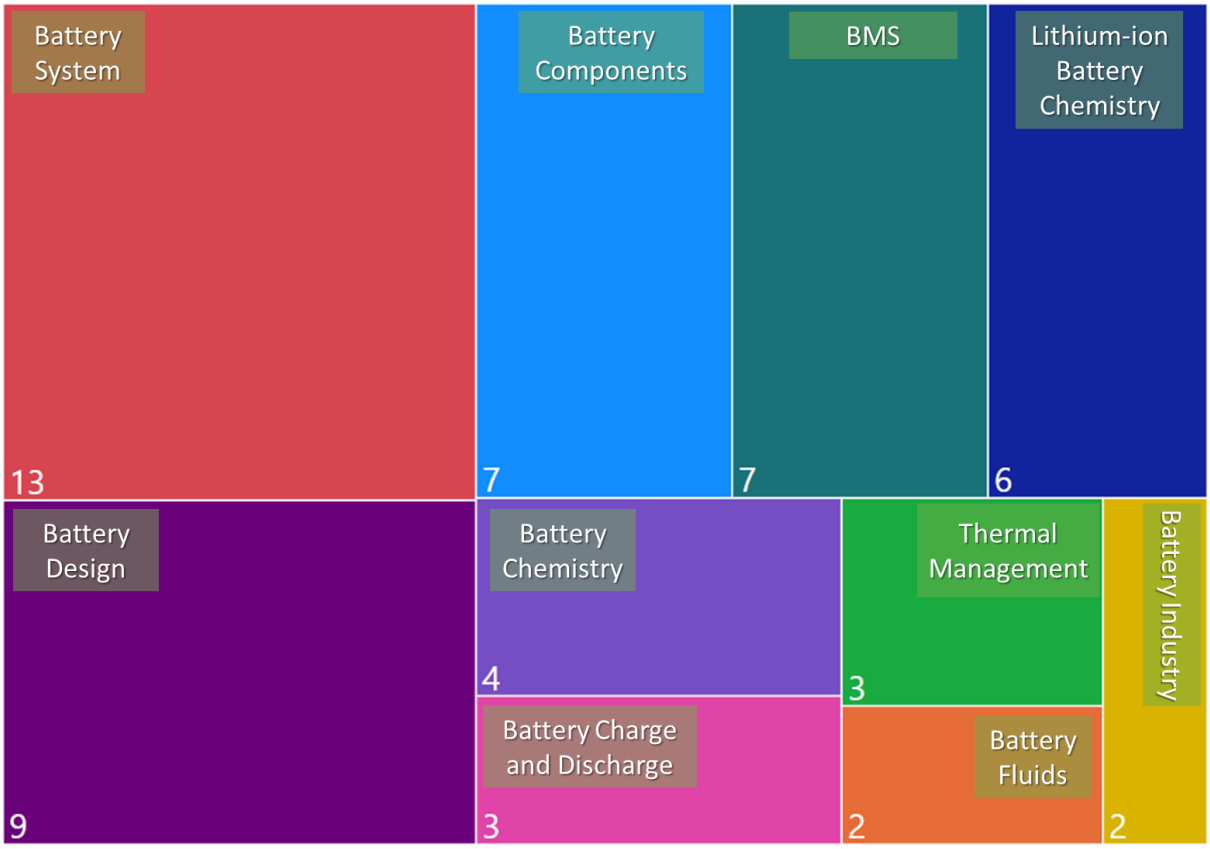

Figure 15. Sector Specific Competence

Figure 16. Cross-sectoral Competence

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1.6.2 Recommendations and Actions

- Overall competence development within renewable energy sources:
  - experts on applications such as photovoltaic panels.
- Development of competence and qualification related to grid balancing.

Strengthening the competence regarding the behind the meter battery services, namely the:

- Electricity consumers:
  - Increased self-consumption
  - Backup power
  - Savings on electricity bills
  - Demand charge reduction
- System operation:
  - Frequency regulation
  - Network investment deferral
  - Peak capacity investment deferral
- Mini grids:
  - Replacing diesel generators
  - Backup power
  - Smoothening of VRE

Application of battery energy storage in grid and off-grid applications requires training in a number of skill areas for the staff, such as: (1) battery repair; (2) battery systems; (3) energy storage; (4) high voltage skills; (5) preventive/predictive maintenance; (6) maintenance management; (7) risk management; (8) customers; (9) cost estimates; and (10) business and marketing for those dealing with business planning of providing batteries to grid and off-grid applications .

1.6.3 Target Groups

As described in chapter 1.4 5G Cellular Network Deployment, Batteries in Telecommunications this development is in progress at the moment. Those target groups are also the same as in chapter 1.4.

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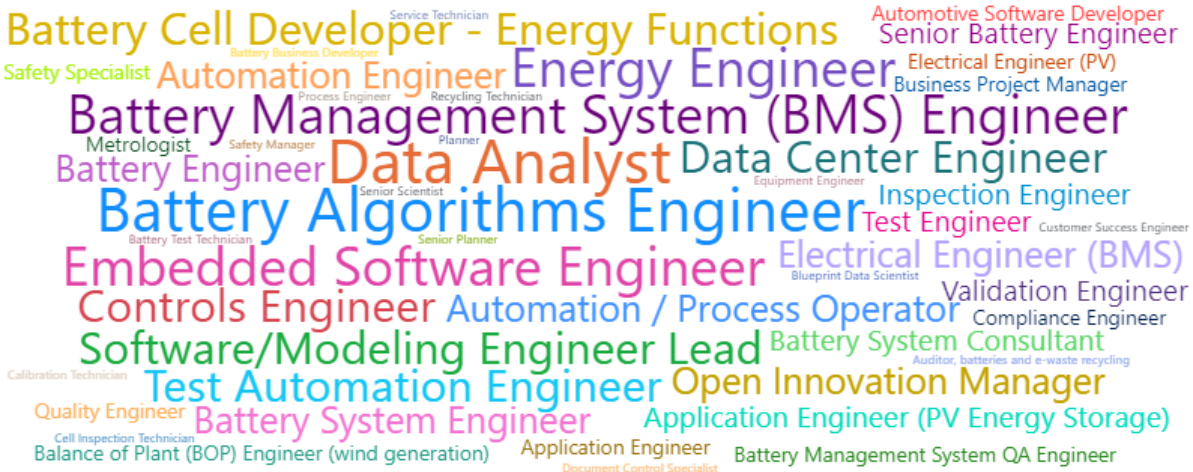
1.7 SMART GRID

Energy storage is one of the most important smart grid components due to its key role in complementing renewable energy generation. With the proper amount and type of storage broadly deployed and optimally controlled, renewable generation can be transformed from an energy source into a dispatchable generation source. The smart grid, with its many advanced communications and control features, will make it possible to integrate the application of widely dispersed battery storage systems. Vehicles (vehicle-to-grid applications), houses and electrical devices will be connected, with digital technologies changing the way data is transferred and utilised. These new communication technologies have a key strategic importance in relation to changes in the sector.[19]

1.7.1 Skills Agenda



[19] ALBATTS - D4.1 Desk Research Data Analysis ISIBA1), ALBATTS project, 2020

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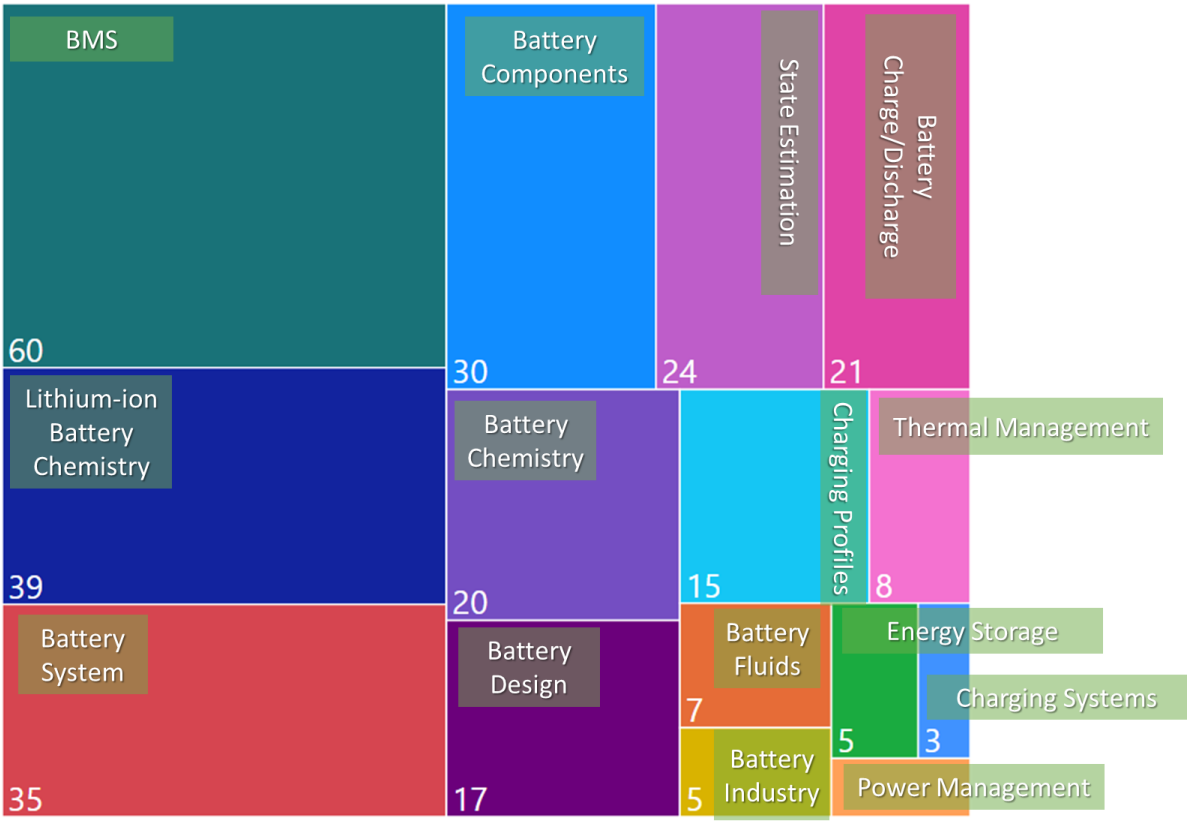

Figure 17. Sector Specific Competence

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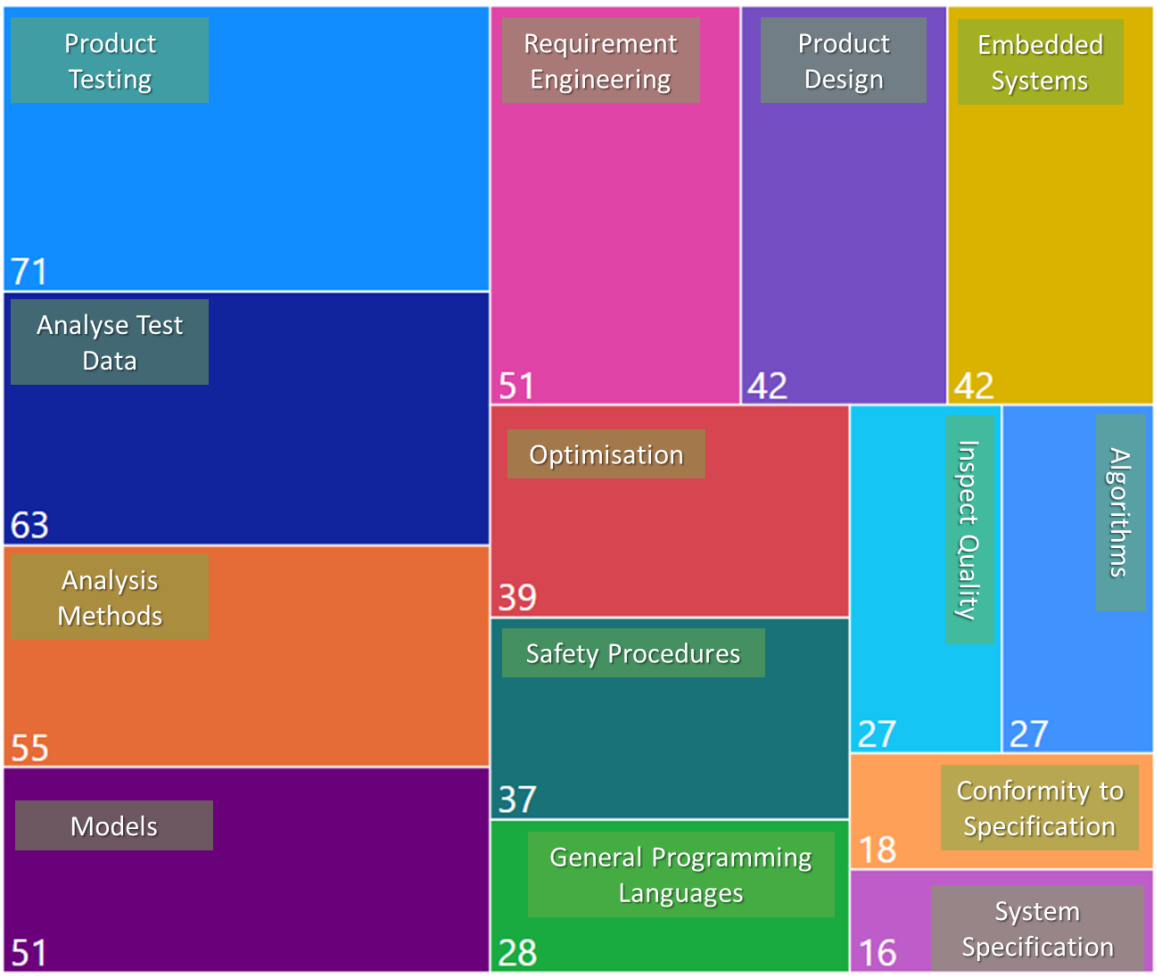

Figure 18. Cross-sectoral Competence

1.7.2 Recommendations and Actions

- The skills needed with battery energy storage application with smart grids that need to be provided in training and education to energy storage related workers include: (1) algorithms; (2) project planning; (3) models; (4) business; (5) general programming languages; (6) electrical engineering; (7) legislative; (8) battery systems and (9) R&D.

1.7.3 Target Groups

The timeframe for the recommendations above ranges from the present day until 2030. In the nearer future for example R&D and related processes will be in place with expectation for wider deployment of smart grids closer to 2030-35. The target groups include those involved with grid development such as for example: (1) battery modules producers; (2) battery manufacturers; (3) environmental protection authorities / associations; (4) citizens/battery users in general; (5) commercial and industrial prosumers; (6) electric utilities companies; (7) Engineering Procurement and Construction (EPC) companies;

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(8) energy management system (EMS) providers; (9) integrated storage technology vendors; (10) local authorities/municipalities; (11) market operators and aggregators; (12) Power Conversion System (PCS) manufacturers; (13) project developers and investors; (14) regulators; (15) renewable energy promoters; (16) research institutes; (17) specialist battery storage integrators; and (18) transmission and distribution system operators.

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2 Cost-efficiency

One of the significant drivers to stimulate investments in batteries is their potential to help decreasing electricity costs when applied in energy storage applications.[20] From the sustainability point of view this is also beneficial since sustainability and cost-saving often go together as is the case with the integration of battery energy storage systems (BESS) with variable renewable energy (VRE) sources. Application of BESS enables also saving energy at times when the electricity is cheapest and using it when its price is highest. There are job roles with skills and competences related to the planning and execution of such products as well as to the practical implementation of such as system integration and beyond.

We will study these areas deeper with the following trends:

- Decrease electricity costs by placing stationary battery systems

[20] ALBATTS - D4.1 Desk Research Data Analysis ISIBA1), ALBATTS project, 2020

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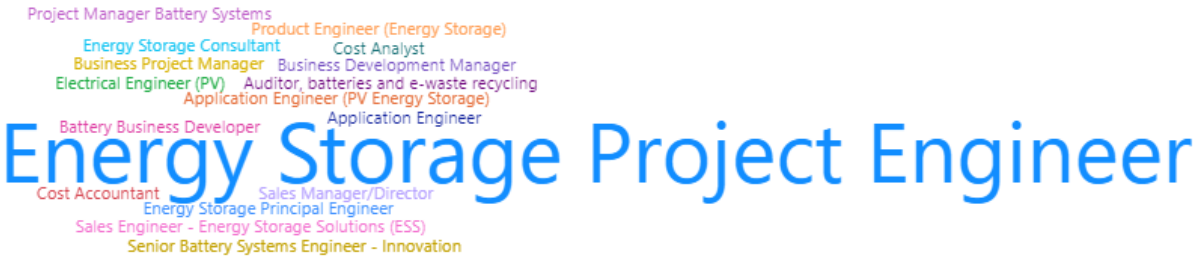
2.1 DECREASE ELECTRICITY COSTS BY PLACING STATIONARY BATTERY SYSTEMS

Customers for energy storages include for example power generation unit owners, grid operators and residential consumers and prosumers, who are seeking ways to reduce the electricity costs. Battery energy storage systems can be combined with variable renewable energy sources like for example with on-site solar panel power systems to reduce electricity costs and also, at the same time, decrease the impact on the environment. Energy storage can also assist in decreasing electricity expenses by allowing customers to charge batteries during off-peak hours and to release power during peak times to reduce energy costs. Consequently, customers can avoid spikes in energy use and high demand charges and thus pay less for energy. The generated excess electricity can be sold on wholesale energy market when and where applicable.[21]

2.1.1 Skills Agenda



[21] ALBATTS - D4.1 Desk Research Data Analysis ISIBA1), ALBATTS project, 2020

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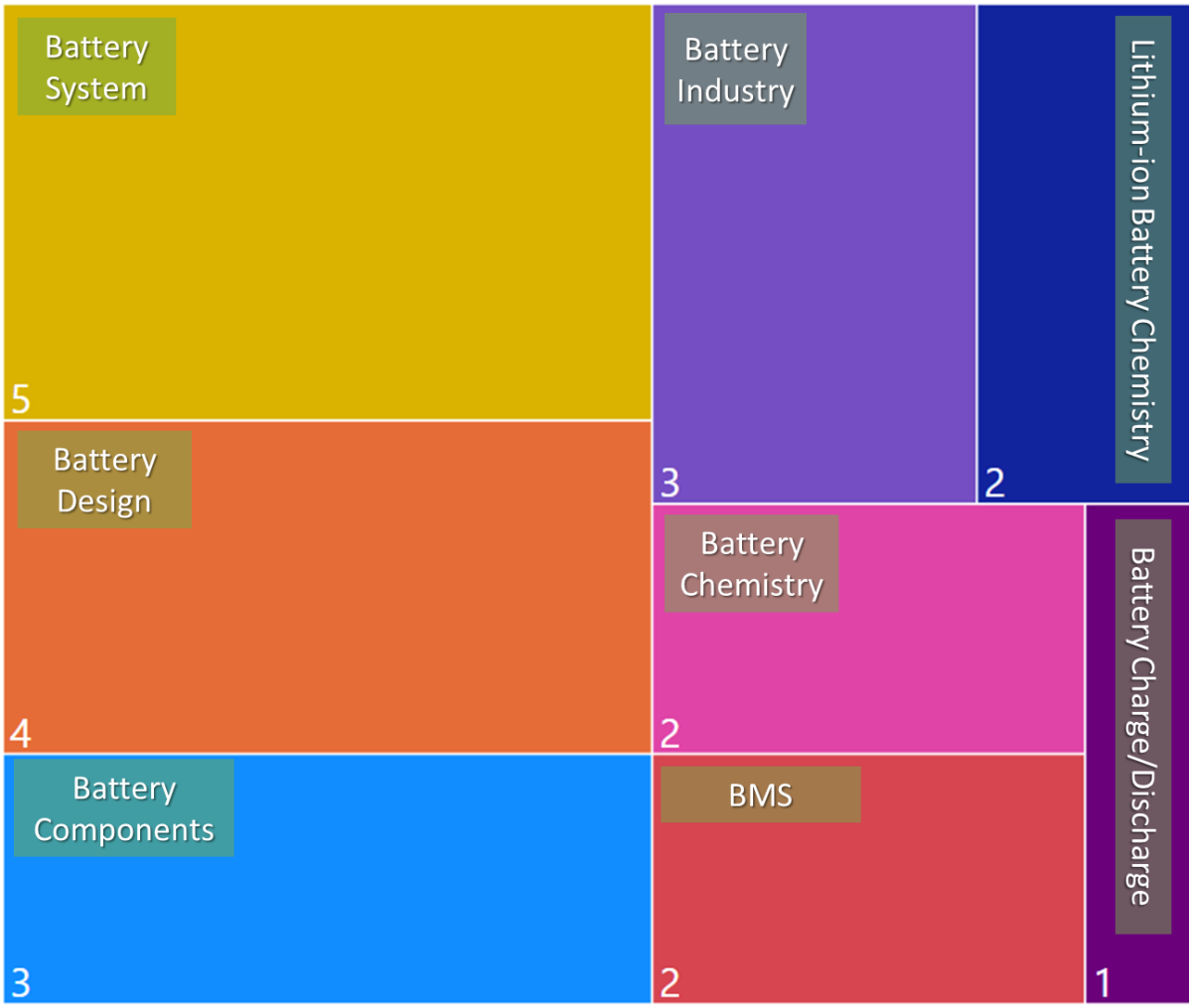

Figure 19. Sector Specific Competence

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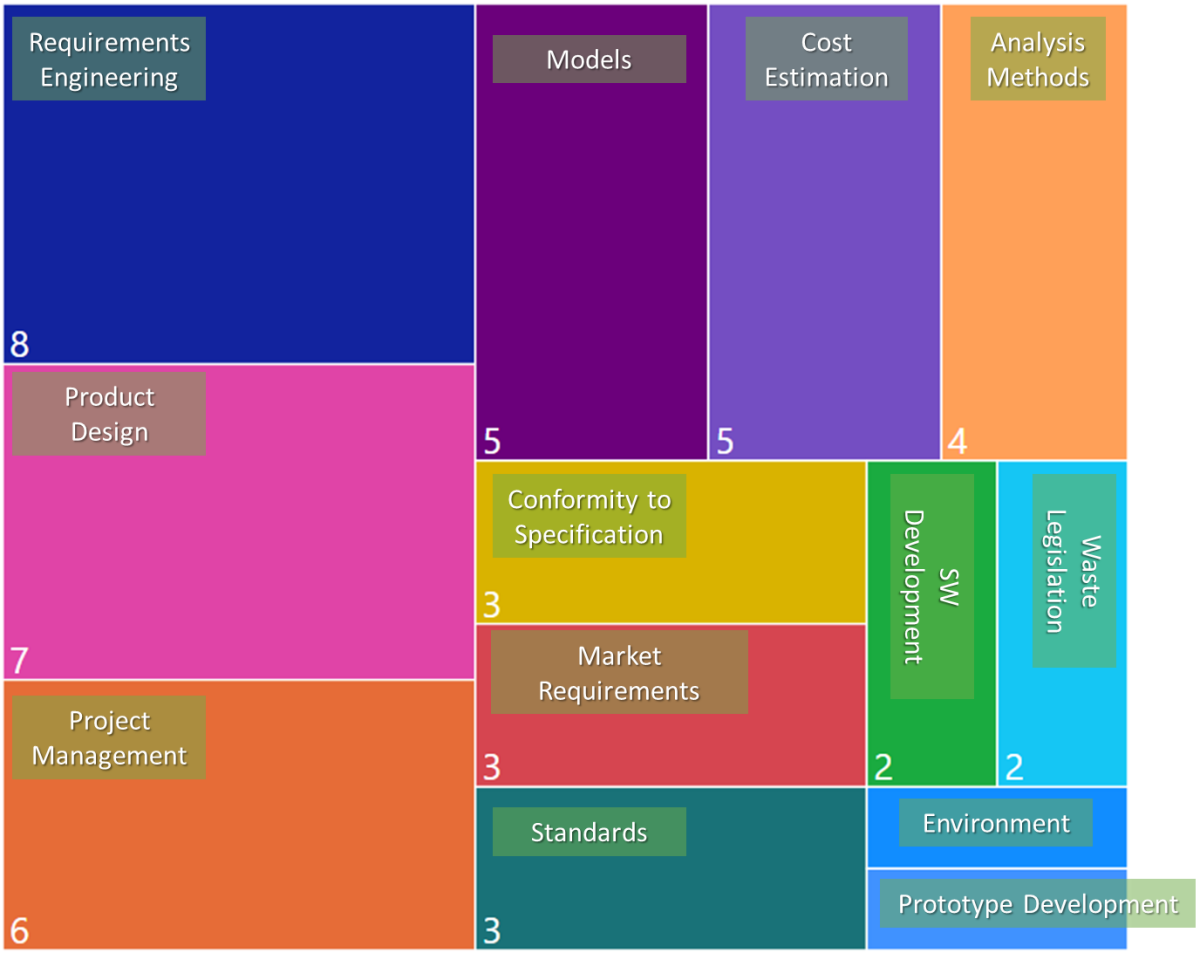

Figure 20. Cross-sectoral Competence

2.1.2 Recommendations and Actions

The associated job roles include a number of different kinds of engineer positions all the way from R&D and electrical engineering to battery systems, project planning and pricing. The following skills will be required and thus taught along with this trend and consequent development:

- Algorithms
- Project Planning
- Models
- Energy and Costing
- Simulation Methods
- Electrical Engineering
- Environment
- Battery System
- R&D

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2.1.3 Target Groups

Proceeding with the recommendations is acute with expected timeframe ranging from this year to the middle of the decade. The target groups include, for example:

- power generation unit owners, grid operators and residential consumers and prosumers, who are seeking ways to reduce the electricity costs
- various customers with other heavy-duty applications of battery energy storages such as, for example hospitals, airports, military bases, offshore operators (oil & gas etc.)

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3 Safety[22][23]

Increasing use and deployment of batteries in different areas of application has generated safety related concerns. Battery fires can be devastating due to their nature of being challenging to extinguish. Battery fires can continue for days, as has been witnessed in the case of EV accidents, for instance. Consequently, creating regulations and legislation that ensure battery safety and actions that sustain safety in disaster situations is essential development. The pursuit for this requires understanding of skills, competences related to enhancing pre-emptive measures to improve safety as well as how to execute right measures to mitigate damages when disaster strikes

We examine this trend in the following subchapter:

- Create Regulation and Legislation on The Topics of Battery Safety

[22] ALBATTS - D4.1 Desk Research Data Analysis ISIBA1), ALBATTS project, 2020
[23] ALBATTS - Deliverable 4.3 - Future Needs Definition for sub-sector ISIBA - Release 1

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3.1 CREATE REGULATION AND LEGISLATION ON THE TOPICS OF BATTERY SAFETY[24]

Although batteries are recognized as a safe system, the fire hazard is present when a battery system is installed. The readily available information on the topic of battery safety is still scarce and there is not enough regulation addressing the topic. The creation of regulatory protocols and legislation allows not only for easier dissemination of information regarding battery safety as well as it creates a guide for battery manufacturers and users to follow in order to increase the safety in battery energy storage systems.

3.1.1 Skills Agenda

[24] ALBATTS - Deliverable 4.3 - Future Needs Definition for sub-sector ISIBA - Release 1

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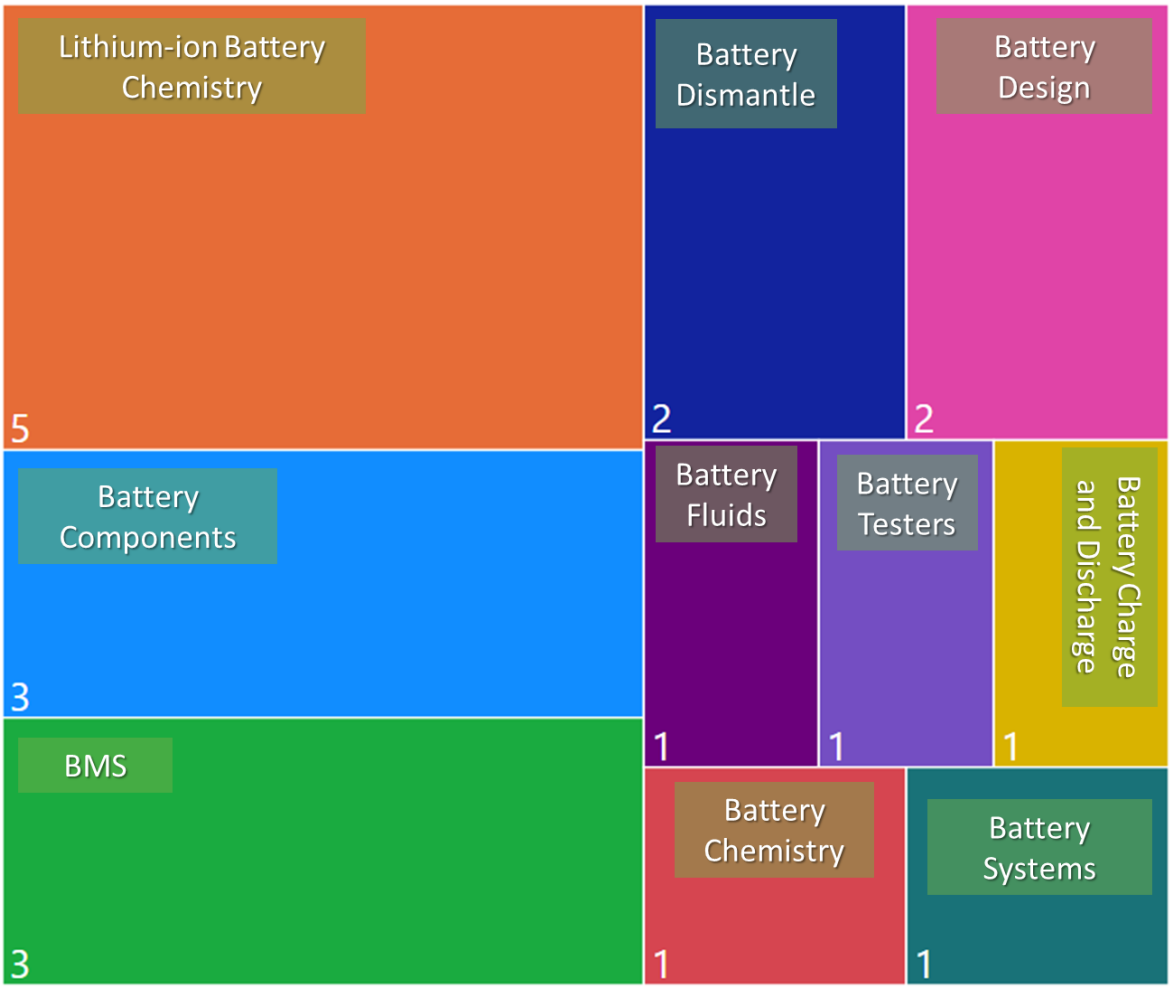

Figure 21. Sector Specific Competence

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Figure 22. Cross-sectoral Competence

3.1.2 Recommendations and Actions

- It is essential to create and update electrical equipment regulations and legislation accordingly to ensure the safety of users with batteries in their different areas of application.
- Testers in the operation, repair and maintenance stages will be needed with adequate skills, since they have a role in ensuring that battery safety can be achieved. Related training and education will thus be needed.
- Later, around 2035, when there is expected to see batteries deployed in various areas of application and many of them in public locations, it is important to pay attention to elements with related skills and competences that ensure public safety, and that health and safety standards are being complied with.
- What will also be needed is that development of new fire safety, overall safety and rescue methods should be priority:
  - Re-skilling of firefighters and other personnel
  - Mastering new methods and techniques
  - New technologies – water blankets and tanks

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- Mechanisms to share information, test, and provide training is essential for supplying future firefighters with skills and competence

3.1.3 Target Groups

The envisaged timeframe for the recommendations to be properly embedded in regulations and legislation for electrical equipment, along with training battery testers, should be occurring already or in the near future (2021-2025) while eventual wider deployment will require more focus on skills and related training when it comes to ensuring public safety as well as health and safety standards.

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4 Resiliency and/or Self-sufficiency[25]

Resiliency and self-sufficiency belong also the drivers of batteries and BESS. Certain circumstances require backup systems to provide power to ensure nonstop functioning, resiliency of critical systems even in blackout situation. In other applications, various electricity consuming systems are required to be operational off-grid. These users that need to be self-sufficient in terms of electricity can be military bases, offshore systems as well as simply remote areas not linked to a national power grid. Self-sufficiency can be achieved, for example, by linking BESS with VRE which also supports potential sustainability goals. In critical applications, successful integration of BESS and batteries requires, for example, repair and maintenance skills. Installation and system integration are essential when implementing battery systems.

We study the associated trends in the following subchapters:

- Increasing BESS use in military applications
- Increasing use in offshore oil & gas applications + Vessels
- Base stations need batteries to support their power requirements
- Provide electricity in remote places where a centralized electricity is not sustainable
- Transfer from lead-acid batteries to li-ion batteries in cellular network base stations

[25] ALBATTS - D4.1 Desk Research Data Analysis ISIBA1), ALBATTS project, 2020

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4.1 INCREASING BESS USE IN MILITARY APPLICATIONS

The expending demand for microgrids in military applications increases the need for energy storages, as militaries are interested in off-grid systems to provide continuous power. Reliance on Diesel generators in remote locations is often found to be a security threat, as transporting fuel can be dangerous and costly, and the generators are loud in service.

Forward operating bases in remote locations can apply energy efficient technologies such as solar and wind and store that energy into battery storage systems. Li-ion battery enable storage of solar and/or wind energy in a system that is substantially lighter than a typical lead-acid battery. The Lithium-ion battery also features a life cycle that is over five times higher than the life cycle of lead-acid batteries. Consequently, lithium-ion batteries present a high potential for storing energy in military transportation and microgrid applications.

Battery storage technologies have advanced enabling large-scale systems that can provide in a cost-effective manner spontaneous and flexible power sources for military bases, etc. At the same time, battery-based systems help reducing carbon footprint and bring down the fuel consumption and costs related to existing backup Diesel generators.[26]

4.1.1 Skills Agenda

[26] ALBATTS - D4.1 Desk Research Data Analysis ISIBA1), ALBATTS project, 2020

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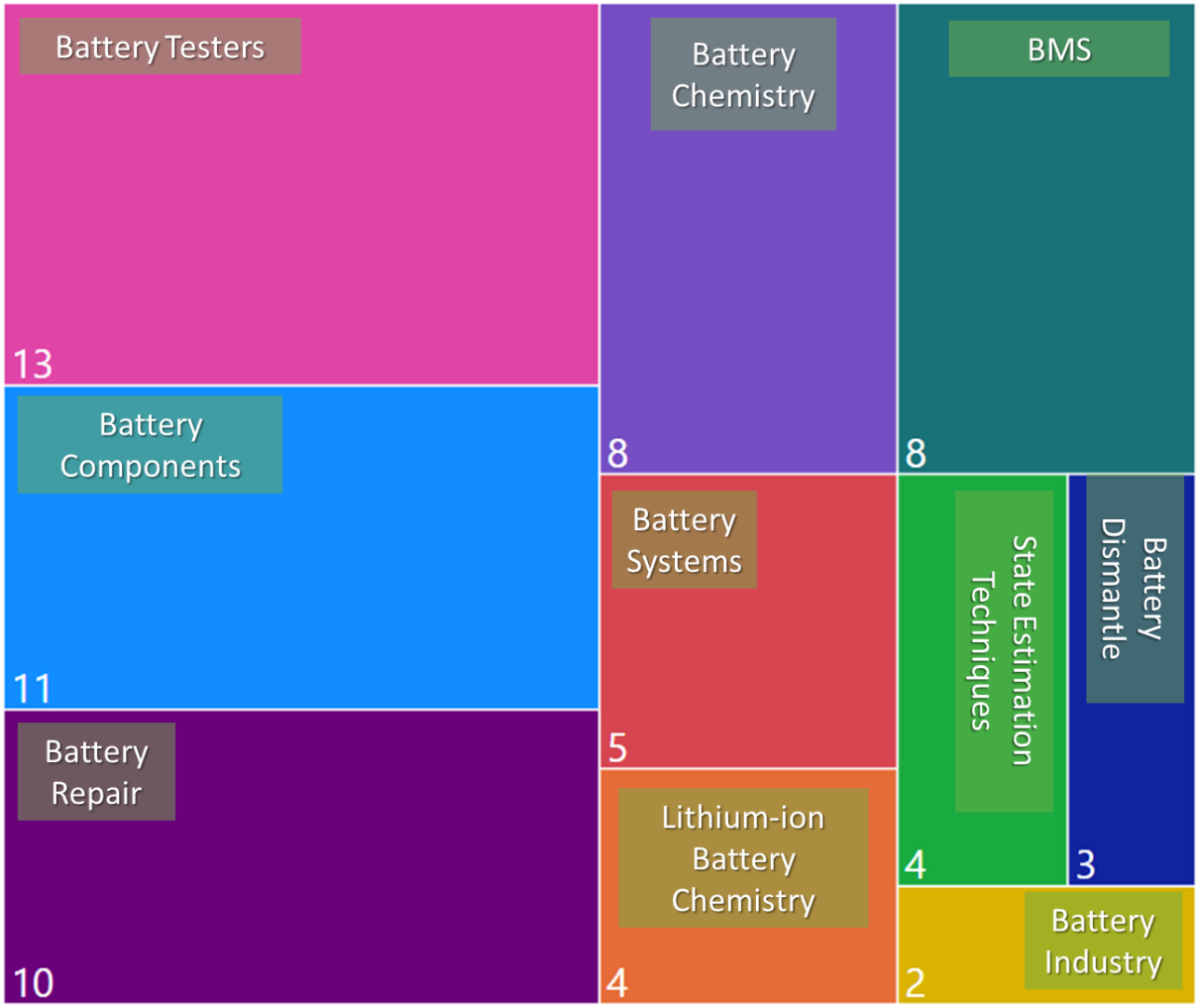

Figure 23. Sector Specific Competence

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Figure 24. Cross-sectoral Competence

4.1.2 Recommendations and Actions

- Microgrids and integration of renewable energy systems within operating bases and remote locations should be explored. Li-ion batteries can provide a lighter solution and are less prone to fail as a result of extreme temperatures and environmental conditions. Application of batteries also generate cost savings by mitigating the use of diesel generators, etc.
- Military and its specific application require ultimate reliability and usability from any systems in most conditions. Batteries and battery energy storages are not an exception. This will place an emphasis on repair and maintenance of batteries. Especially important is the ability to conduct preventive and predictive maintenance to avoid failures in critical conditions.
- Maintenance and repair are skills that are important to teach personnel that are involved with servicing systems that use batteries. This includes such roles as field service engineers that specialize in microgrids and battery energy storage systems.

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Integration of batteries into the existing military systems and equipment will require personnel trained in system integration and installation skills.

The following skills can be identified as essential when it comes to training personnel, mainly in various engineer positions, that deals with military applications of batteries:

- Battery Repair
- Battery Testers
- Electrical Testing Methods
- Maintenance Processes
- Preventive/Predictive Maintenance
- Equipment Maintenance
- Problem Solving/Troubleshooting
- Reporting
- System Integration
- Battery/Energy Storage Installing

4.1.3 Target Groups

The deployment of batteries for military applications is in progress and while, for example, the biggest military spender by far, USA, is in the forefront of the battery applications, other countries are close behind. Generally, the timeframe for the military application of battery related skills training and education is potentially around the mid-2020s.

The target groups include military forces and their contractors and equipment manufacturers.

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4.2 INCREASING USE IN OFFSHORE OIL & GAS APPLICATIONS + VESSELS

Li-ion batteries can also be used in offshore/marine applications. Batteries can act as peak-shavers, load-levellers etc. and provide fuel costs savings along with low maintenance expenses. This market is expected to grow in the future as there are clear benefits. The integration of energy storage with the power supply and distribution system of a drilling rig improves the environmental sustainability of the offshore oil and gas industry. The power consumption is steeply fluctuating in drilling and dynamic positioning processes. With energy storages, it is possible to decrease the use of Diesel engines (runtime) and optimize combustion level when operating them thus decreasing the emissions consequently. The batteries can be used for supplying power during peak load times and as a backup power system to prevent blackout situations and provide power to the thrusters, if needed. In addition to battery storage installation on a drilling rig power plant itself, there is also potential scope to replace Diesel generators or engines? with batteries in offshore supply vessels.[27]

4.2.1 Skills Agenda

[27] ALBATTS - D4.1 Desk Research Data Analysis ISIBA1), ALBATTS project, 2020

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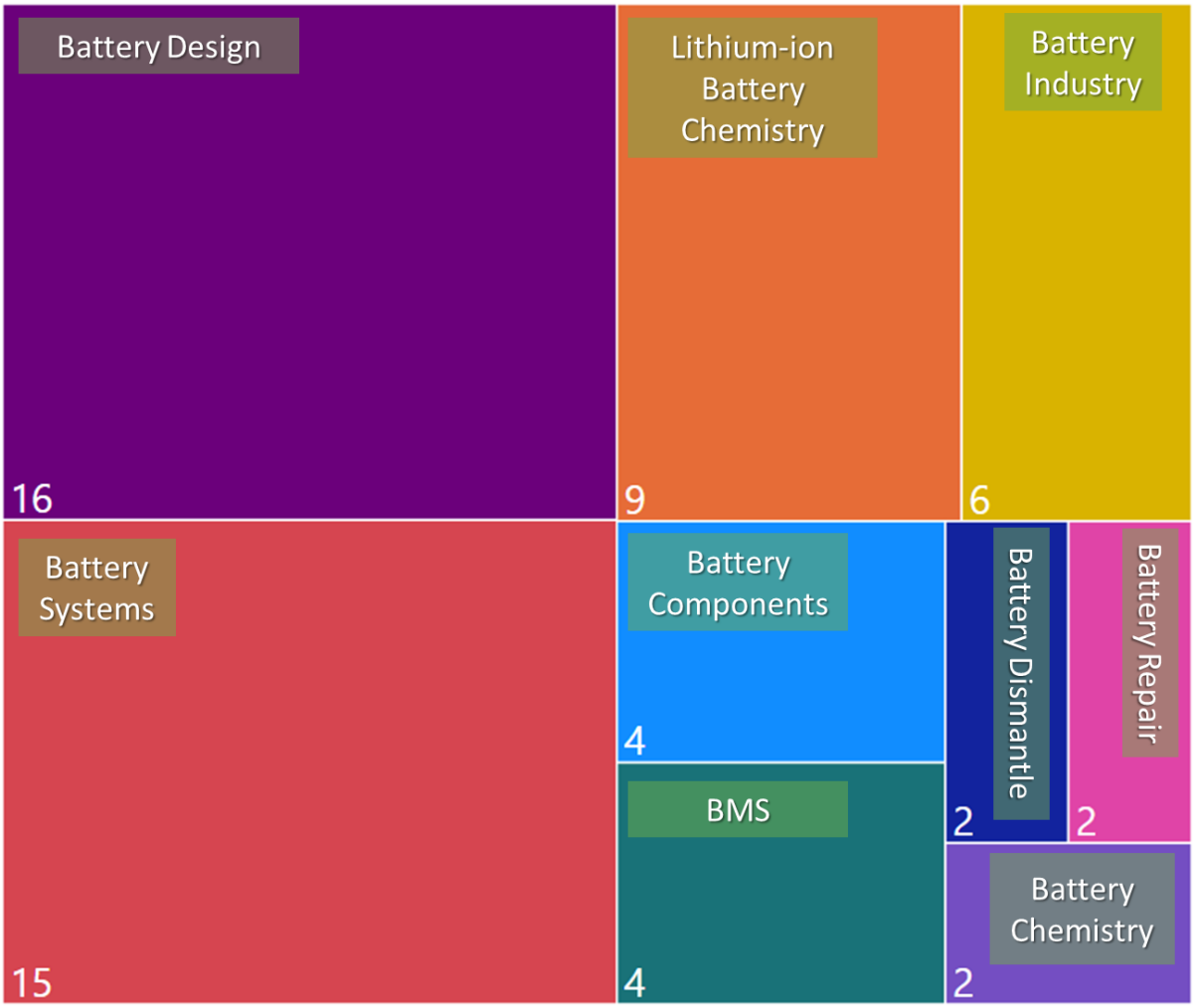

Figure 25. Sector Specific Competence

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Figure 26. Cross-sectoral Competence

4.2.2 Recommendations and Actions

Exploration and development of innovative lithium-ion battery applications such as naval power systems are needed.

Various skills concerning energy storages and batteries will be required for understanding the systems in and of themselves, their installation processes, maintenance, and repair as well as how the related projects are managed. Then there is also the business aspect with related skills such sales and consultancy. For example, the following skills will need to be taught to personnel, mainly to different kind of engineers, working with battery applications in offshore oil and gas:

- Energy Storage
- Battery System
- Project Management
- Business
- Customers

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- Analyse Test Data
- Ensure Conformity to Specifications
- Electrical Engineering
- Battery/Energy Storage Installing
- Preventive/Predictive Maintenance
- Maintenance Processes
- Battery Repair
- Safety Procedures

4.2.3 Target Groups

The need for recommendations is occurring now, as the use of batteries in offshore applications is increasing. The target groups include the companies involved in offshore oil and gas operations and their contractors and suppliers.

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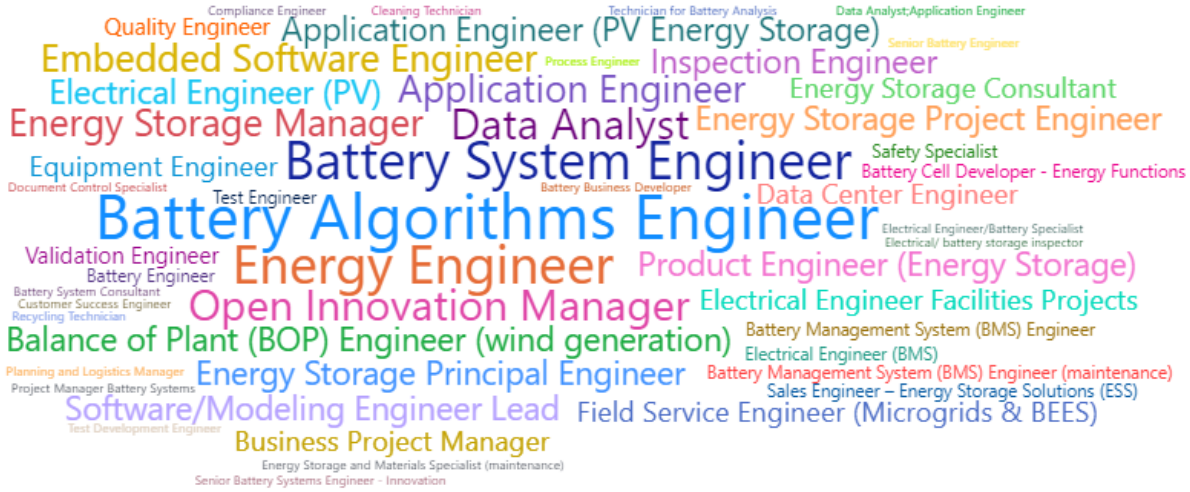
4.3 BASE STATIONS NEED BATTERIES TO SUPPORT THEIR POWER REQUIREMENTS

With new technologies hitting the market and their need for updated equipment, the power consumption has increased abruptly. Usually, base stations are equipped with a battery storage system whose function is to provide backup power in case of failure of the power supply. Lithium batteries have been gradually replacing lead-acid due to the increasing power requirements for the backup of base stations. The complexity of the battery storage systems, due to the cumulative augmentation on the requirements for battery systems, involve a set of needed skills in order to operate repair and maintain works on the devices.[28]

4.3.1 Skills Agenda



[28] ALBATTS - D4.1 Desk Research Data Analysis ISIBA1), ALBATTS project, 2020

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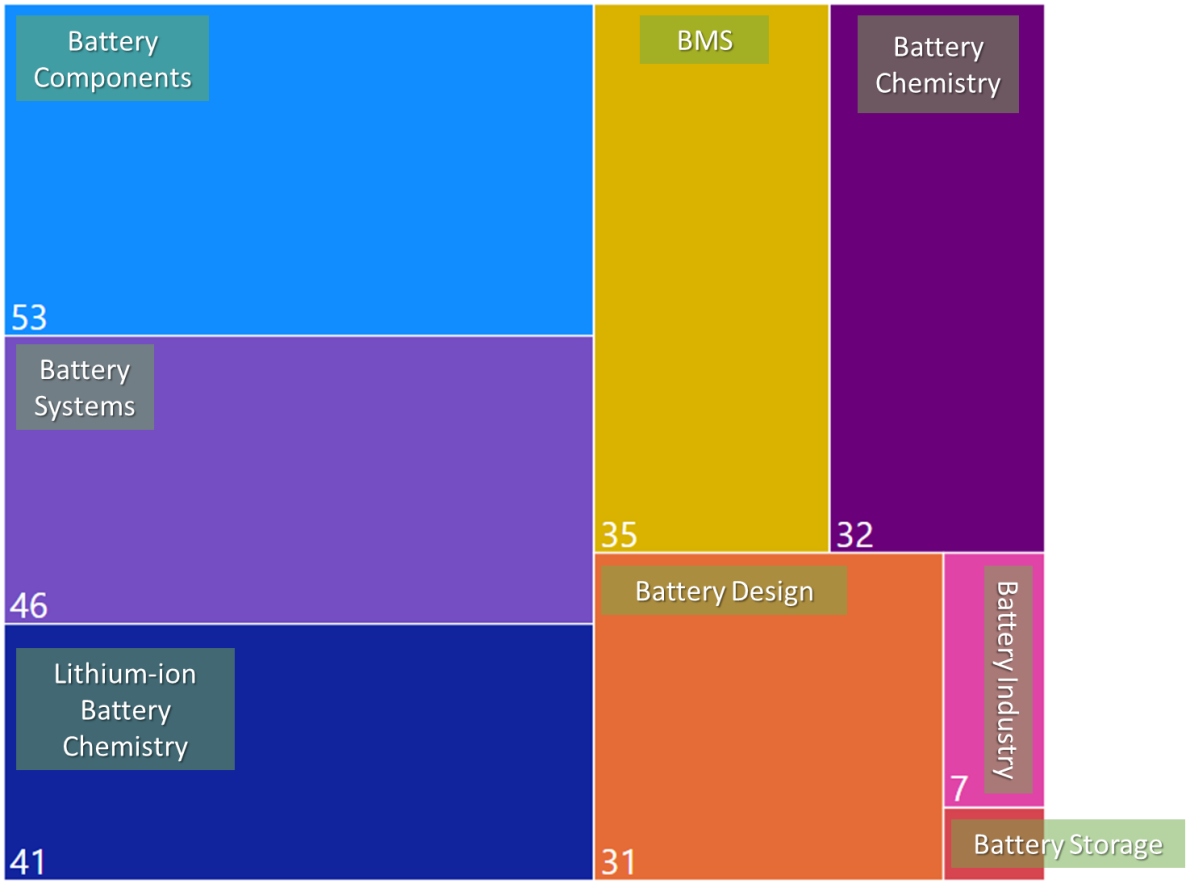

Figure 27. Sector Specific Competence

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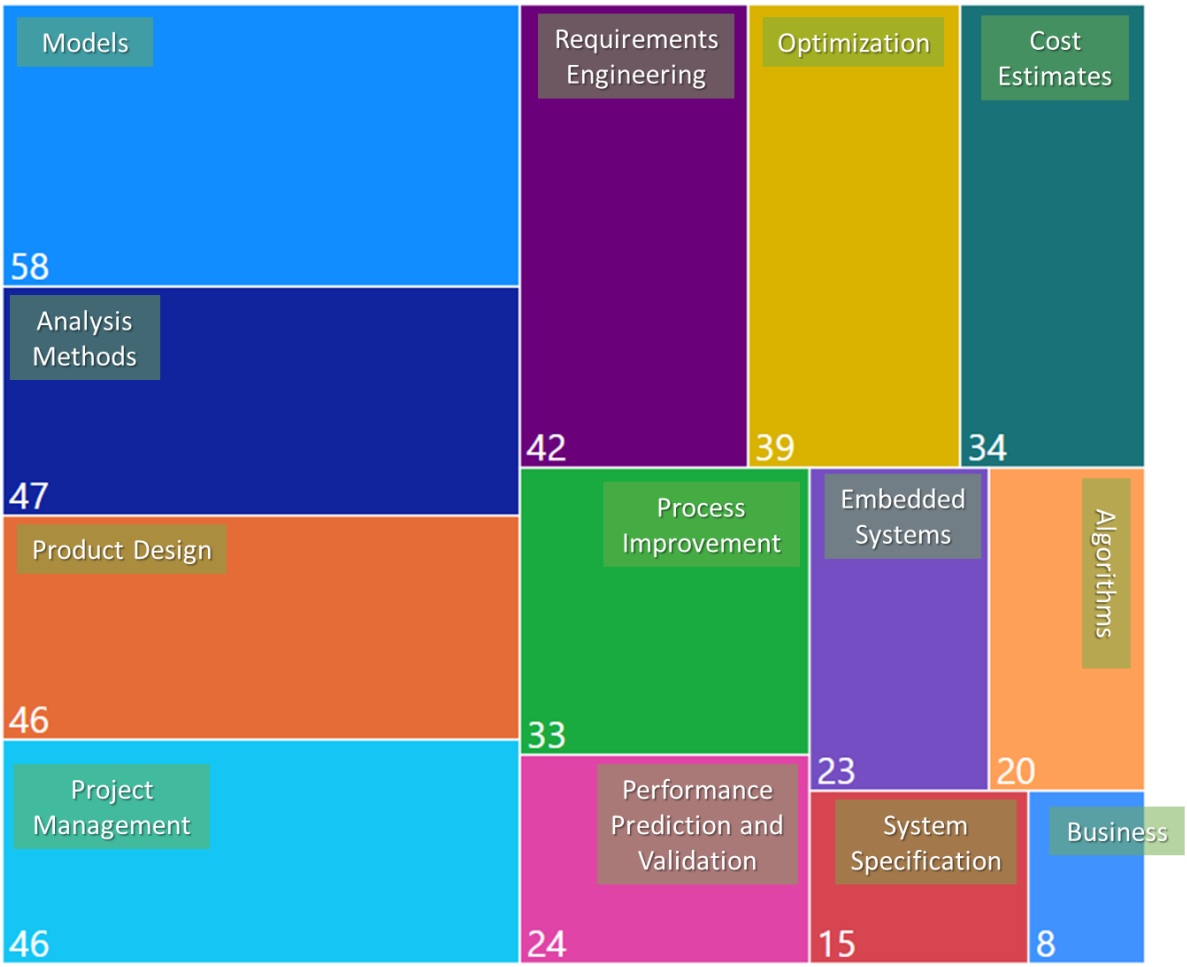

Figure 28. Cross-sectoral Competence

4.3.2 Recommendations and Actions

- Project planning and management:
  - Project managers need to have extensive knowledge on battery systems and their connections to the grid and base stations in order to make the setup more profitable
- With the number of base stations increasing and battery energy storage being recognized as a crucial help on deploying the needed power and energy to feed the antennas, owners of the base stations should have a team with competences to operate, repair and perform maintenance protocols on the battery system.

4.3.3 Target Groups

The need for batteries with base stations is occurring right now with the deployment of 5G base stations being in progress in the EU and beyond. This means that the recommended actions are needed currently.

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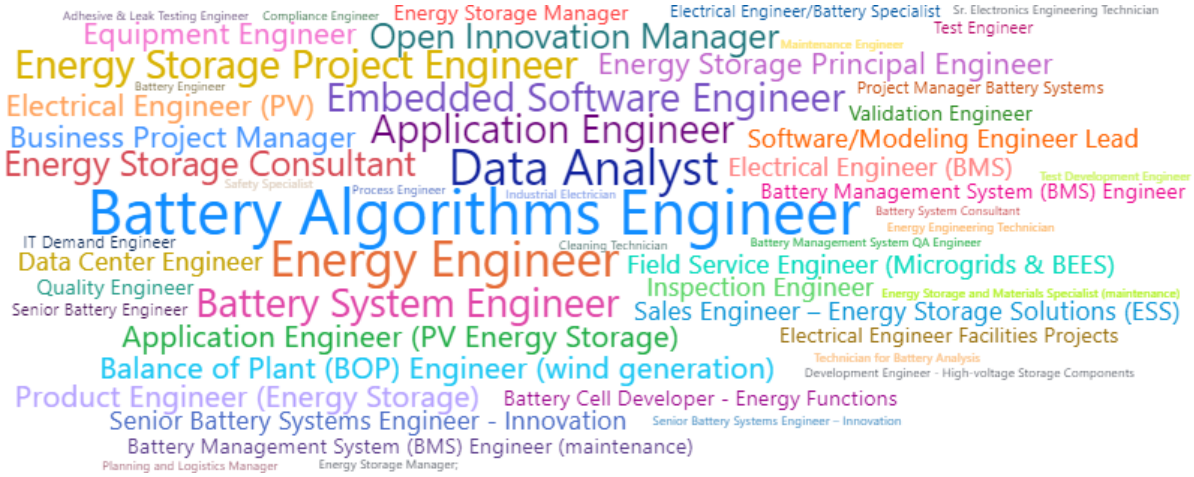
4.4 PROVIDE ELECTRICITY IN REMOTE PLACES WHERE A CENTRALIZED ELECTRICITY IS NOT SUSTAINABLE

Energy storages, when paired with, for example, renewable energy systems, enable generating power in off-grid circumstances. This helps the deployment of, for example, telecom base stations to provide the critical means of communications to remote areas as well as providing power to microgrids for remote community power applications. [29]

4.4.1 Skills Agenda



[29] ALBATTS - D4.1 Desk Research Data Analysis ISIBA1), ALBATTS project, 2020

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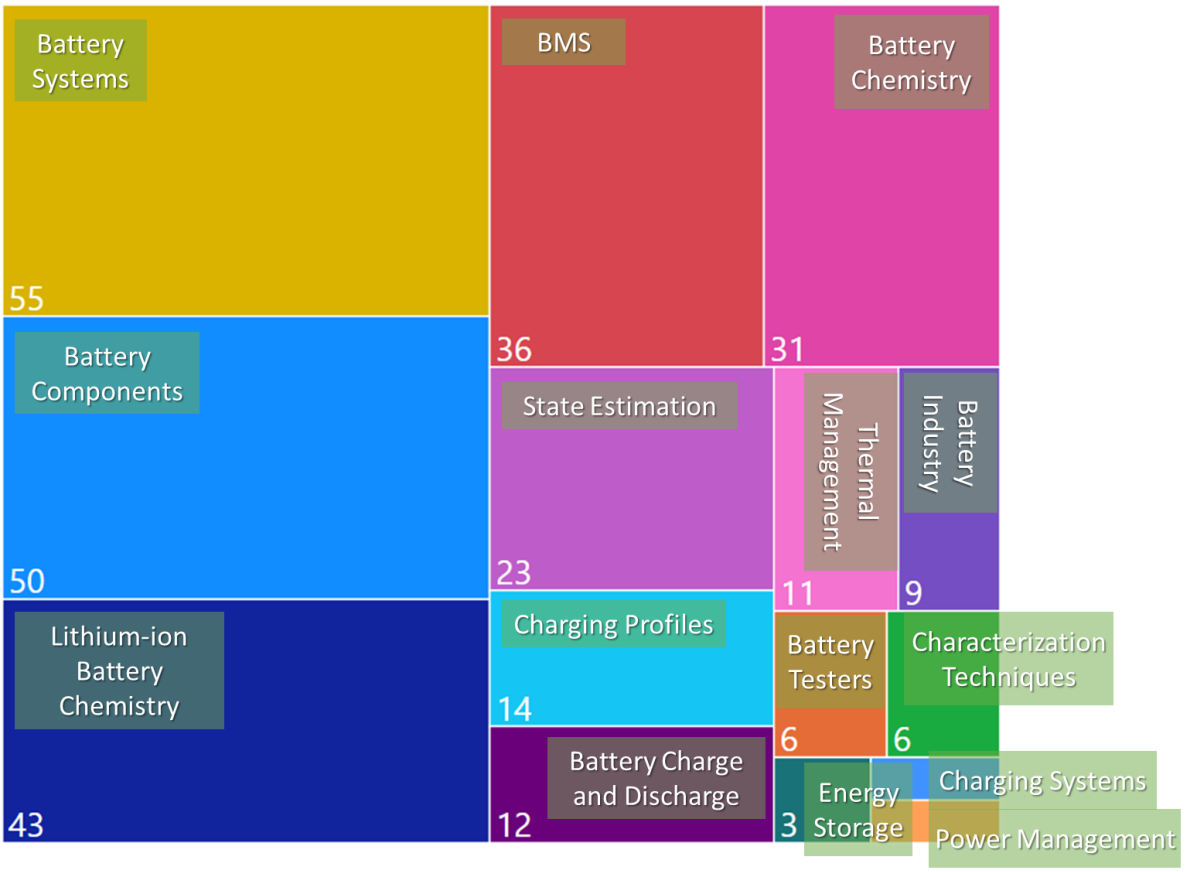

Figure 29. Sector Specific Competence

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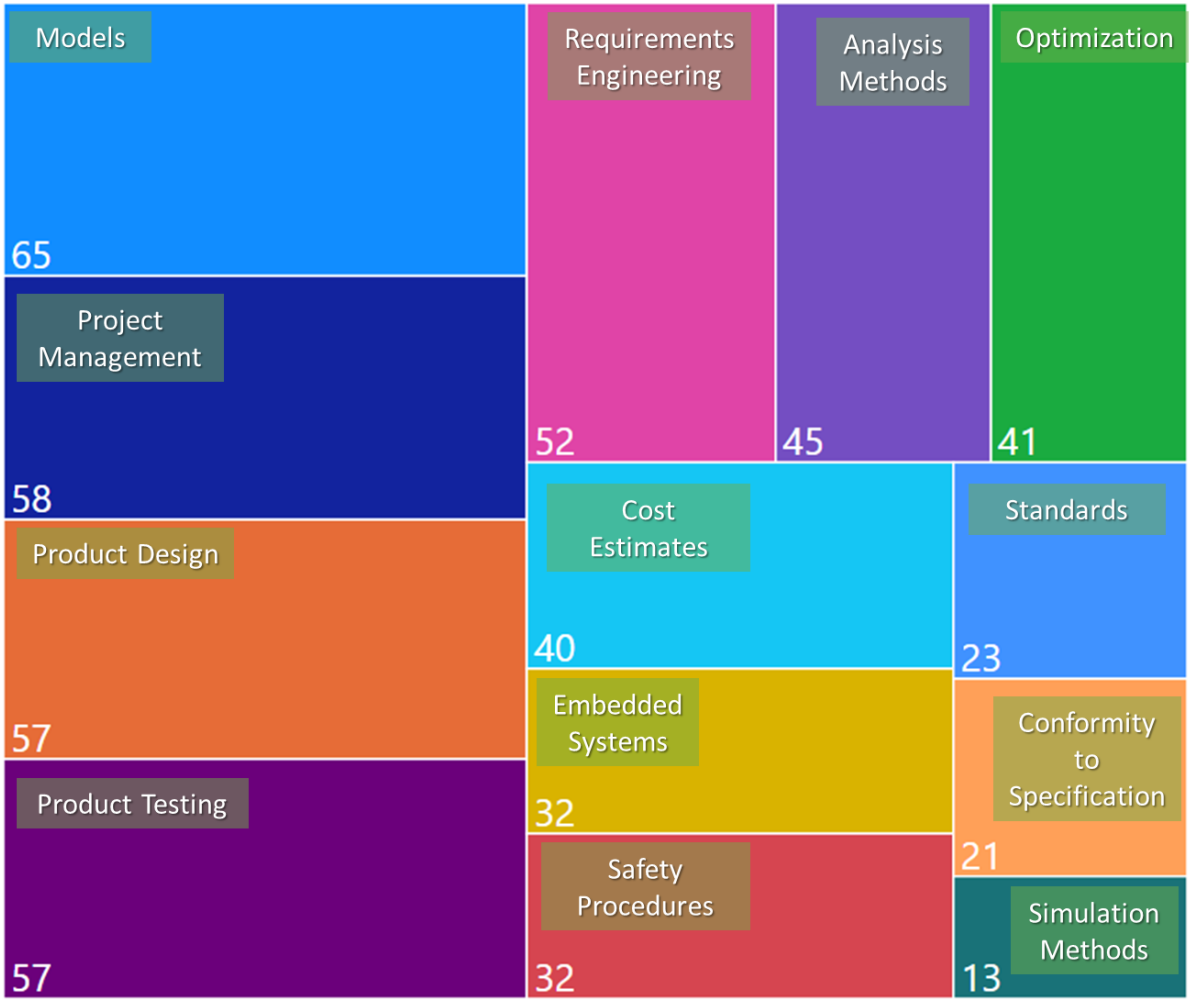

Figure 30. Cross-sectoral Competence

4.4.2 Recommendations and Actions

Understanding the projects related battery applications in the context of using variable renewable energy sources in remote areas is needed. The involved job roles are mainly engineers that need to be taught the following skills:

- Algorithms
- Project Planning
- Models
- Business
- Energy and Costing
- Energy and Costing
- Electrical Engineering
- Electrical Engineering

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- Environment
- Battery System
- R&D

4.4.3 Target Groups

The timeframe for the recommendations is ranging from 2021 to 2030. The target groups include for example stakeholders related to off-grid solutions as well as providers of telecom base stations in remote areas.

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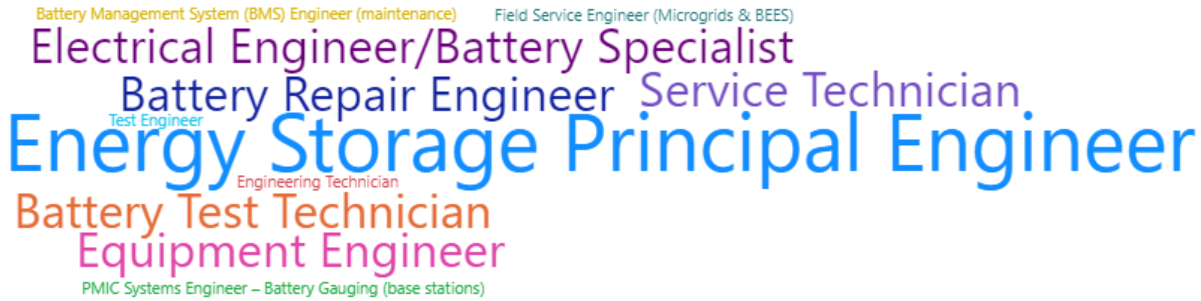
4.5 TRANSFER FROM LEAD-ACID BATTERIES TO LI-ION BATTERIES IN CELLULAR NETWORK BASE STATIONS

Lithium-ion batteries are increasingly replacing Lead-acid batteries in telecom networks with both off-grid or on-grid base stations. The decreasing costs of Lithium-ion batteries are making them competitive in terms of lifecycle compared to Lead-acid battery, which is still the most mature and cheapest type of battery. Additionally, Lithium-ion batteries provide a higher energy density which means less footprint, a key challenge for the compactness required for a base station. Lithium-ion batteries can perform more charge/discharge cycles and present a larger calendar life, which means that its needs for maintenance are lower and battery replacement can occur less frequently.[30]

4.5.1 Skills Agenda



[30] ALBATTS - D4.1 Desk Research Data Analysis ISIBA1), ALBATTS project, 2020

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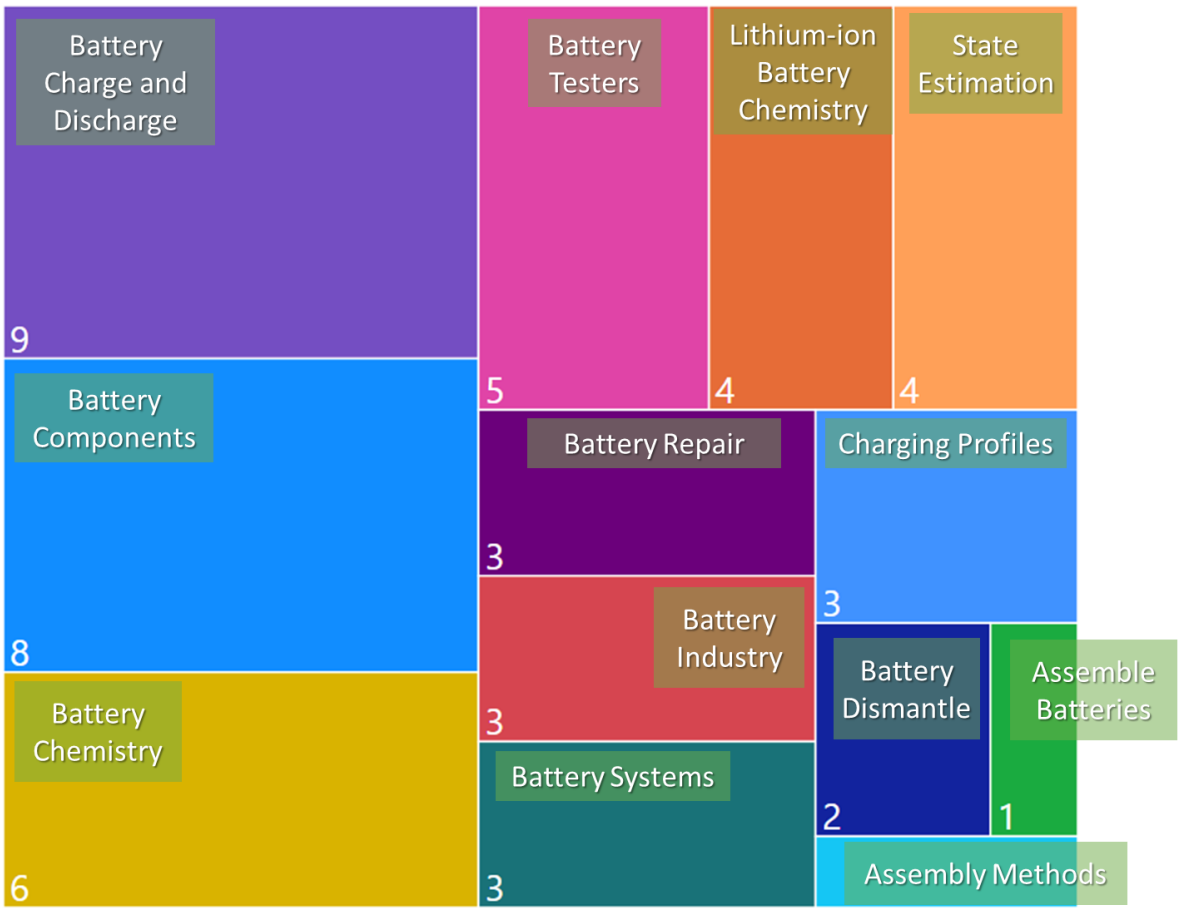

Figure 31. Sector Specific Competence

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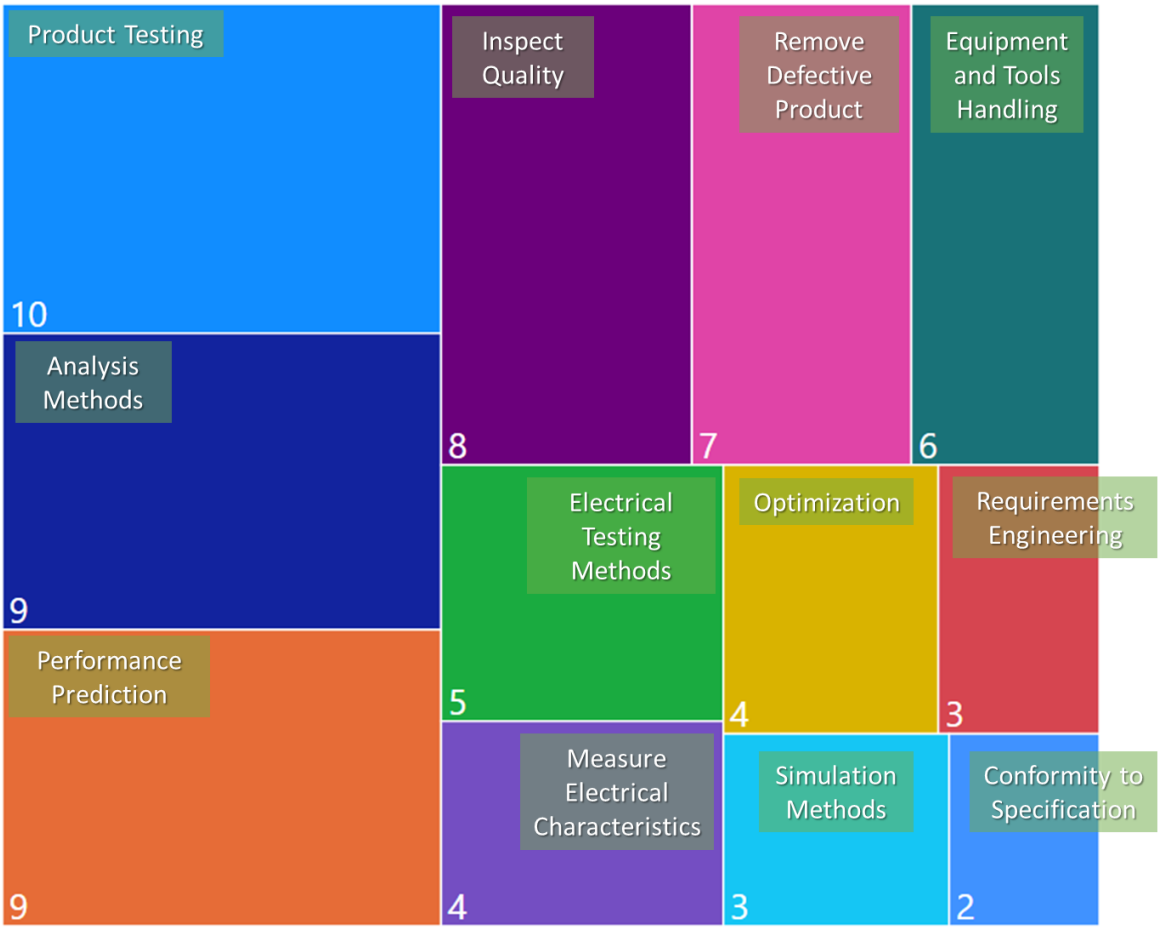

Figure 32. Cross-sectoral Competence

4.5.2 Recommendations and Actions

The transition from older lead-acid batteries and/or diesel generators to lithium-ion batteries implies special care and skilled workforce in regard to the 5G deployment and needed requirements for the base stations. Replacing lead-acid batteries with the Li-ion ones will require such skills as Battery/Energy Storage Installing, Battery Removal, Battery Repair, Battery Charge/Discharge and Battery Testers. The job roles which the personnel need to be taught with the above skills include for example battery engineers and specialists, service technicians, etc.

4.5.3 Target Groups

The need to follow the recommendations mentioned above is basically imminent due to the current global deployment of 5G networks.

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5 Sustainability[31]

Battery energy storage systems are a significant element in the pursuit of sustainability. Application of BESS supports the decarbonization goals by enabling the increasing use of intermittent VRE systems to provide power to a grid as well as enable powering for example off-grid telecom base stations without the need to use polluting and, at the same time, fuel consuming and potentially unreliable diesel generators for power generation. Another sustainability element is to ensure that the use of batteries themselves can be kept as sustainable as possible. The application of second life batteries, used EV batteries in energy storage solutions supports that cause. While technologically, we are able to allow second life application, further regulatory framework and standardization is needed to ease and support it.

With the above comes the need for skills that enable, once again, integration of BESS with other systems and numerous other skills. Second life application requires, for example, testing of used batteries to ensure their condition and state of health are adequate.

- Second Life Application
- Integration of battery systems with renewable energy sources, with the goal of decarbonization
- The need for sustainable and resilient base stations

[31] ALBATTS - D4.1 Desk Research Data Analysis ISIBA1), ALBATTS project, 2020

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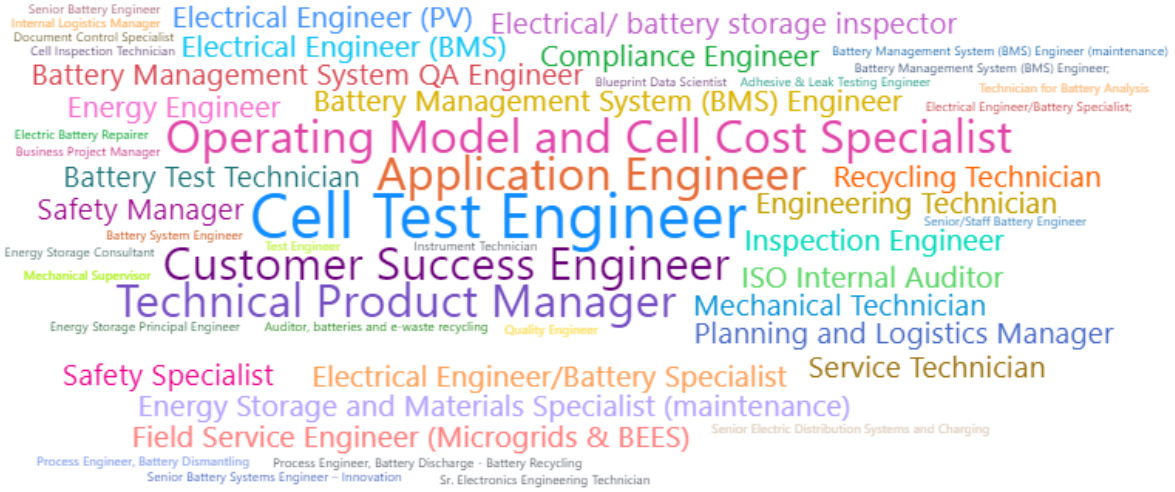
5.1 SECOND LIFE APPLICATION[32]

Battery energy storages consisting of second life EV batteries have been applied increasingly.

The solution can be, for example a combination of new and second-life batteries.

5.1.1 Skills Agenda



[32] ALBATTS - D4.1 Desk Research Data Analysis ISIBA1), ALBATTS project, 2020

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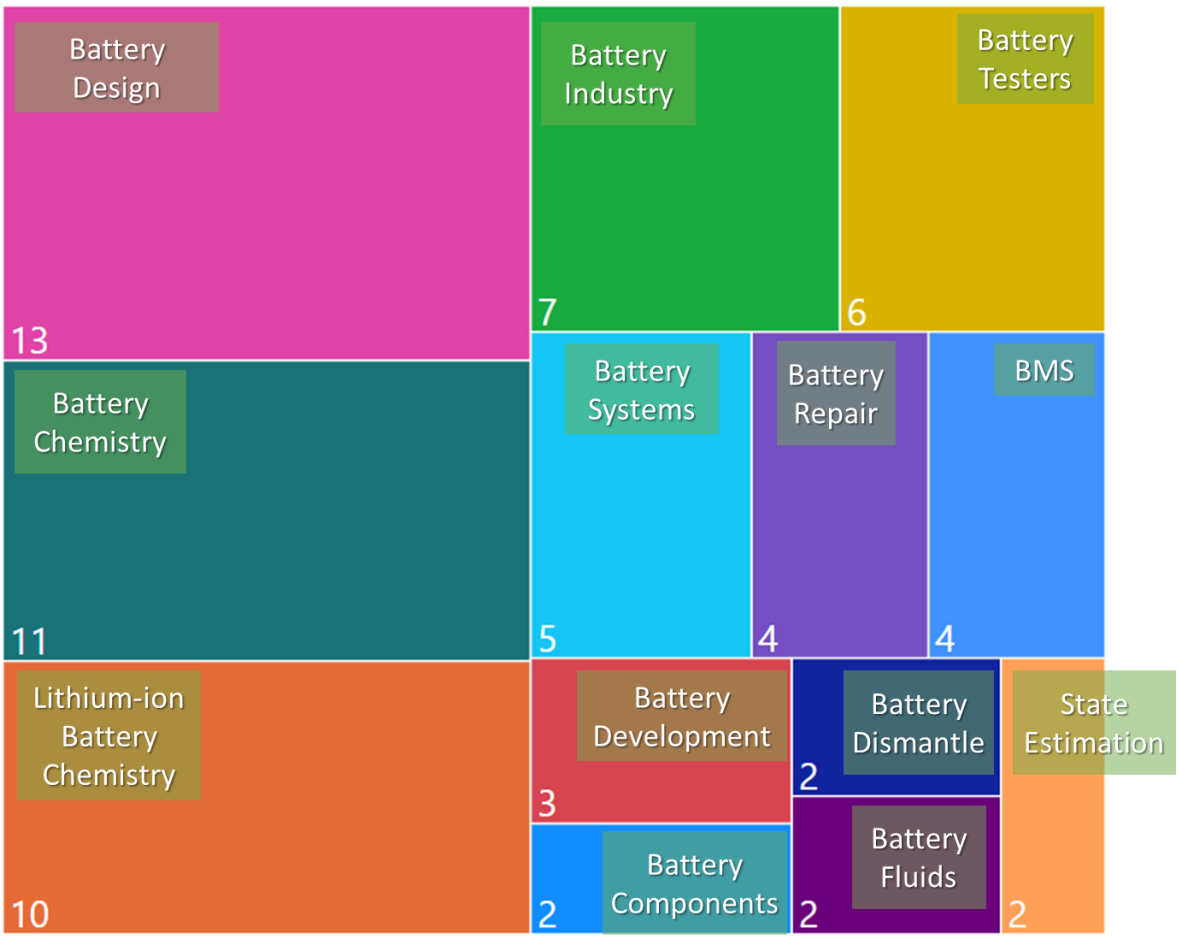

Figure 33. Sector Specific Competence

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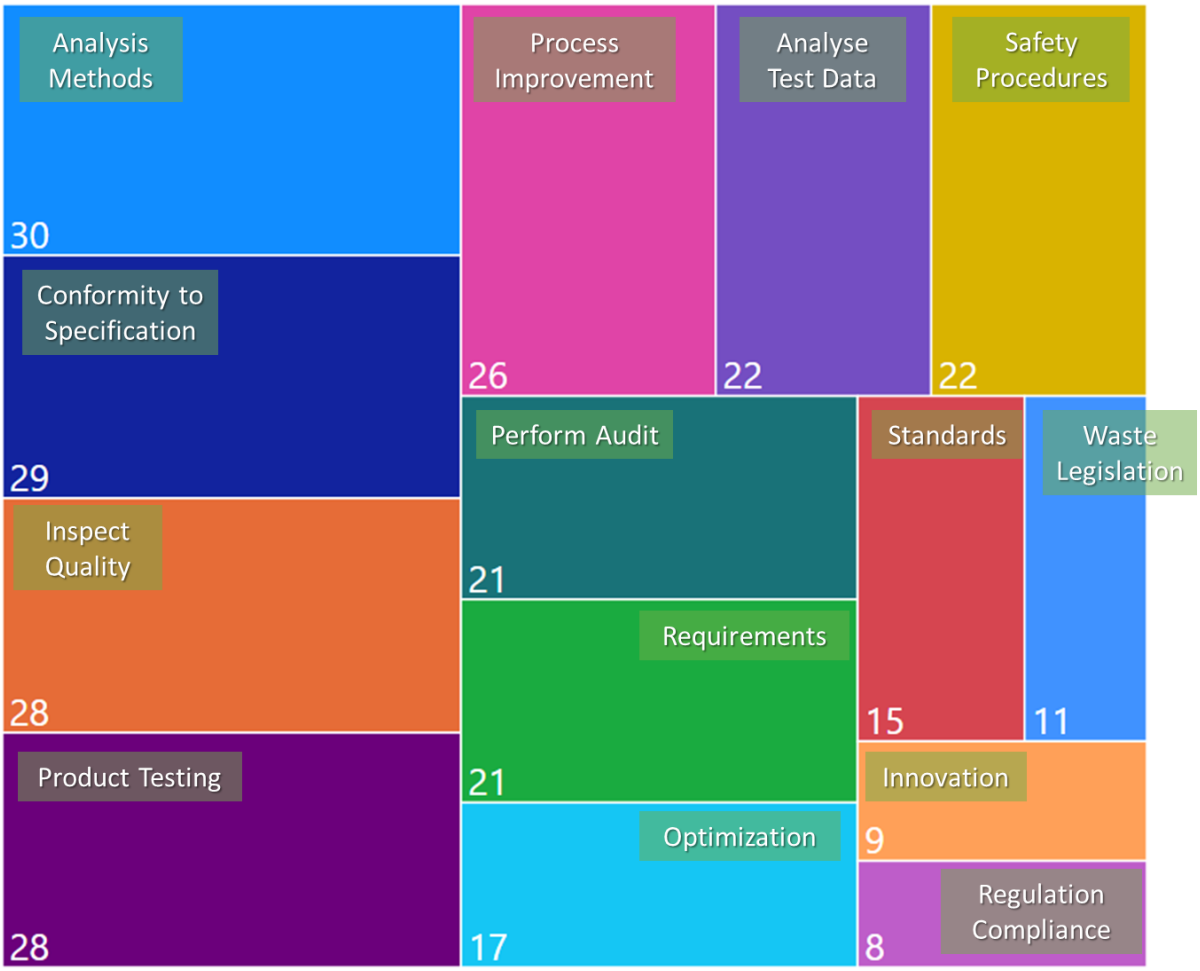

Figure 34. Cross-sectoral Competence

5.1.2 Recommendations and Actions

With second life application of batteries in energy storage solutions the associated personnel, who are mainly engineers, will need to be trained/educated with the following skills:

- Battery Testers
- Inspect Quality of Product
- Electrical Testing Methods
- Battery Repair

The development is occurring in Europe and also elsewhere around the world.

5.1.3 Target Groups

The timeframe for executing the recommendations is 2021. The target groups include for example various heavy-duty users of battery energy storage solutions.

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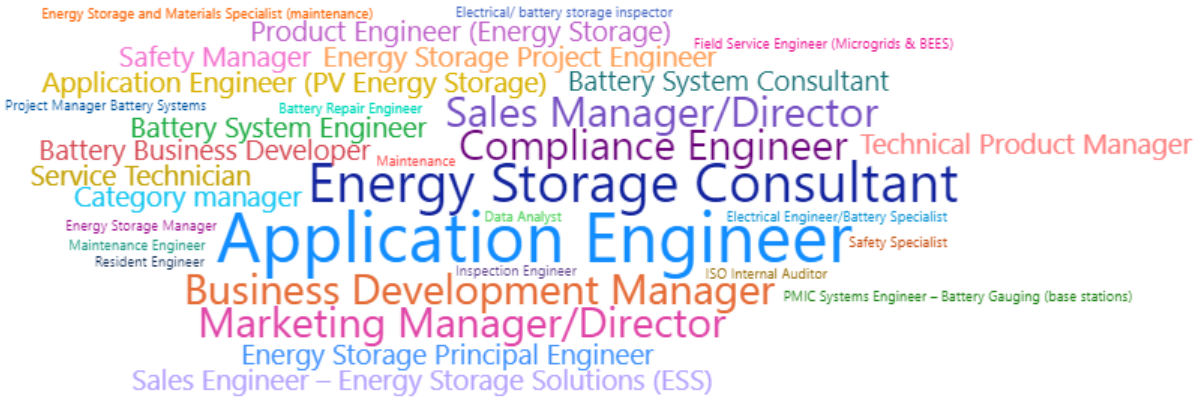
5.2 INTEGRATION OF BATTERY SYSTEMS WITH RENEWABLE ENERGY SOURCES, WITH THE GOAL OF DECARBONIZATION

The electric sector presents a consistent need for energy storage, significantly related to the integration of substantial shares of renewable sources. Over the last two decades, a massive integration of Renewable Energy Sources (RES) in the power/energy distribution systems has been prompted by the global increasing climate awareness and various economic incentives. The variable and intermittent nature of RES such as wind and sunlight amount (in the case of photovoltaic -PV) presents new difficulties in planning and operating power systems as they bring variability to the supply side which traditionally occurs on the demand side only. Therefore, battery storage and the flexibility that it may offer is regarded as rather complementary to the future integration of variable RES. The development is occurring in Europe and also other parts of the world. [33]

5.2.1 Skills Agenda



[33] ALBATTS - D4.1 Desk Research Data Analysis ISIBA1), ALBATTS project, 2020

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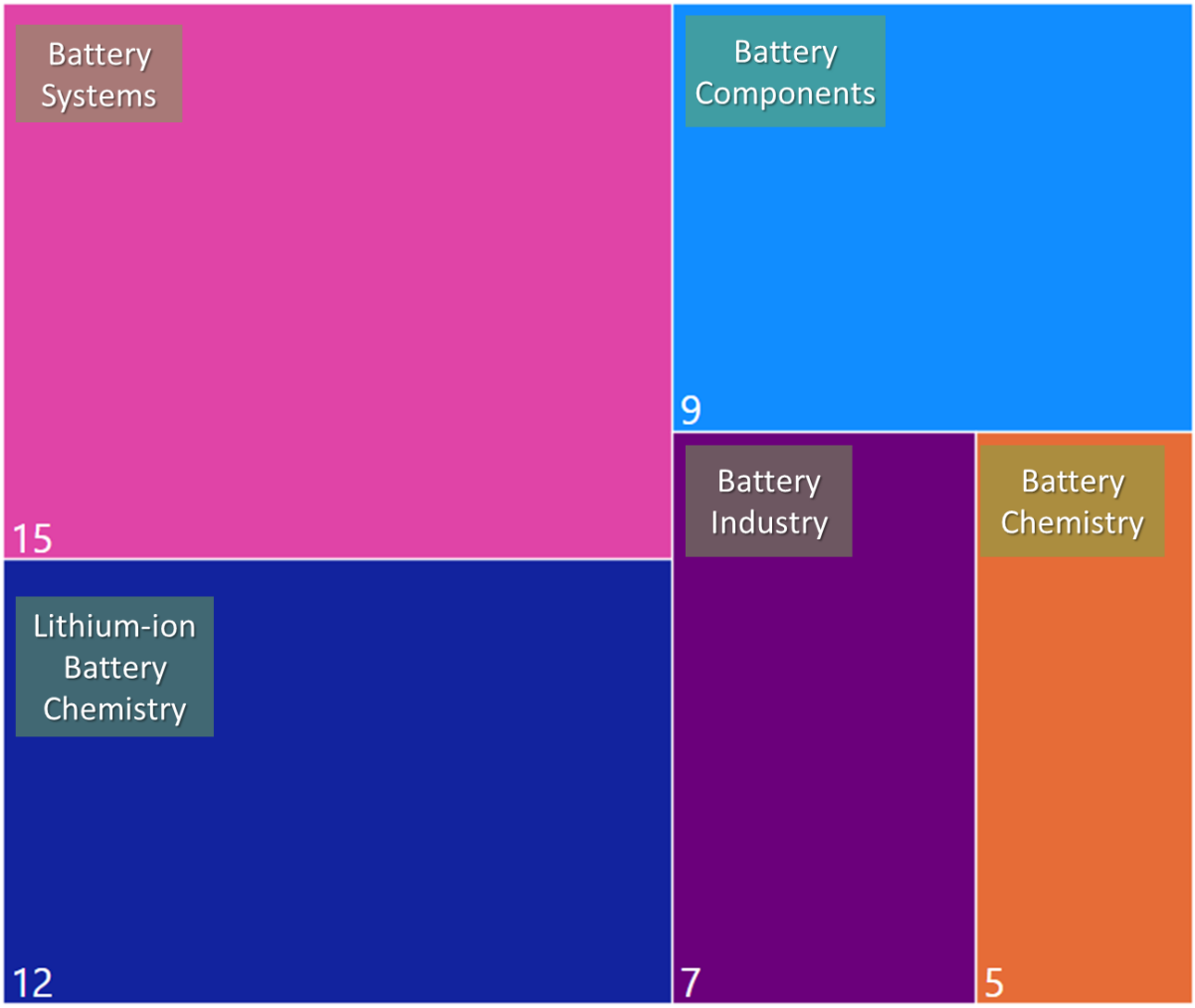

Figure 35. Sector Specific Competence

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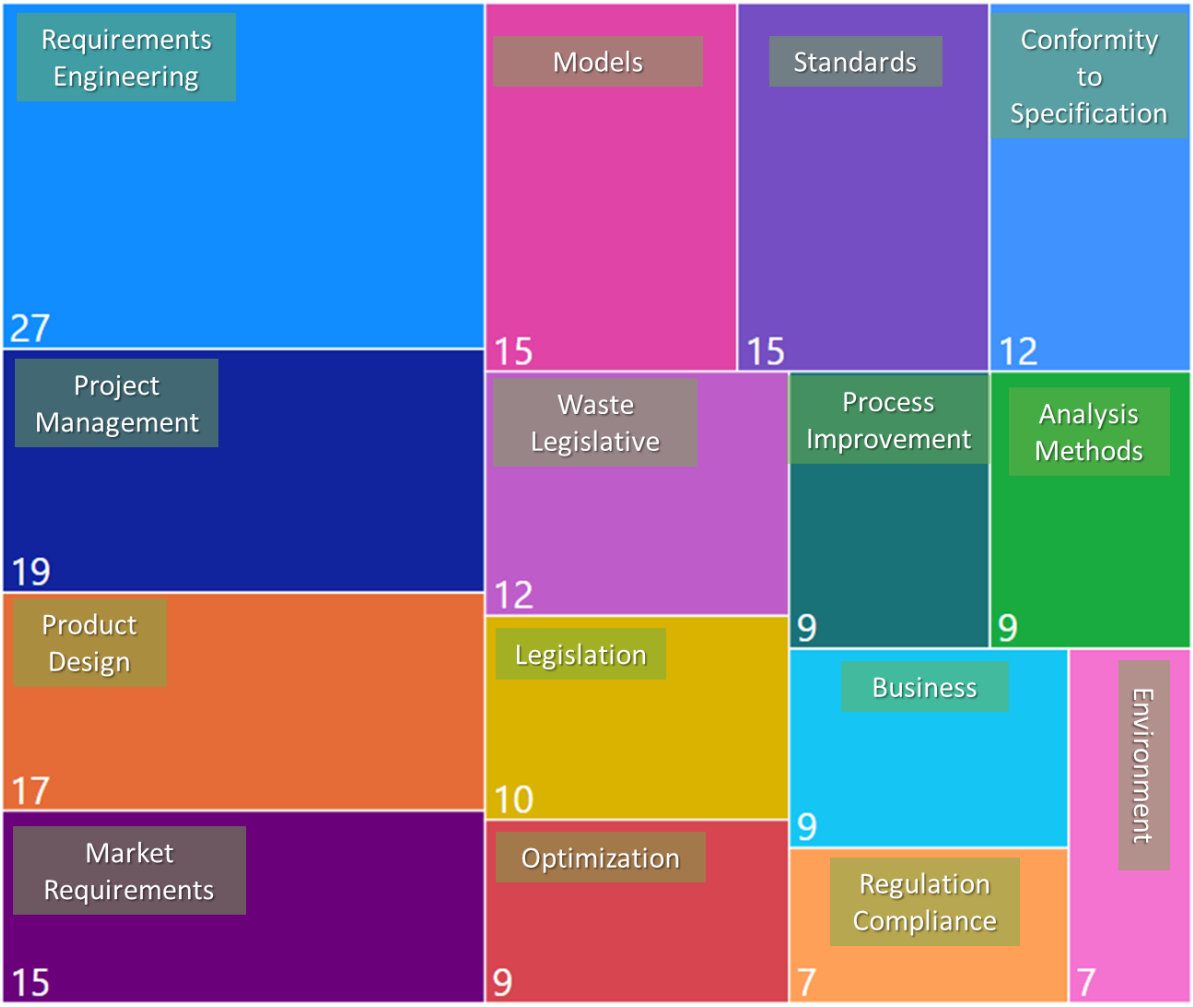

Figure 36. Cross-sectoral Competence

5.2.2 Recommendations and Actions

- At the consumer level, from residential to commercial and industrial, several stakeholders are now looking for ways to increase the return on investments made in renewable energy, namely photovoltaic (PV). Therefore, skills in the cost calculation processes are needed together with being able to plan the projects related to such endeavours.
- The goals to meet sustainability targets that boost the application of renewable energy sources in Europe and the rest of the world are creating a tremendous business opportunity for battery energy storage solution providers. Taking advantage of this development requires also business-related skills from consulting to sales, including combined technical know-how of the battery systems.
- Most job roles are various engineers, and they will need to be taught for example the following skills:

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- Algorithms
- Project Planning
- Models
- Business
- General Programming Languages
- Energy and Costing
- Simulation Methods
- Electrical Engineering
- Legislation
- Environment
- Battery System
- R&D

5.2.3 Target Groups

The timeframe for the recommendations ranges from the present situation until the mid-next decade.

The target groups include those that were also listed in the context of chapter 1.6 - Grid and Off-grid Systems and Applications.

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5.3 THE NEED FOR SUSTAINABLE AND RESILIENT BASE STATIONS[34]

In isolated off-grid areas, base stations are typically powered by small-scale Diesel generators. Even in areas where the main electrical grid may be accessible, Diesel generators may be installed for backup power purposes in case of grid failure. There is a trend to offset this pollution associated with the energy consumption by integrating local renewable generation, which can only be achieved through a flexible, high performing battery system such as Li-ion based battery storage.

The driver for battery storage is even more accelerated by the inherent characteristics of Diesel generators. Diesel generators showcase reliability issues, presenting a lower availability level than the one required for base station application, namely with the increasing dependence of people in telecommunications. This can be tackled by the combination of local renewable generation and battery storage, which can bring a significant reduction of the operational costs, reduce maintenance needs, and mitigate greenhouse gas emissions.

5.3.1 Skills Agenda

[34] ALBATTS - D4.1 Desk Research Data Analysis ISIBA1), ALBATTS project, 2020

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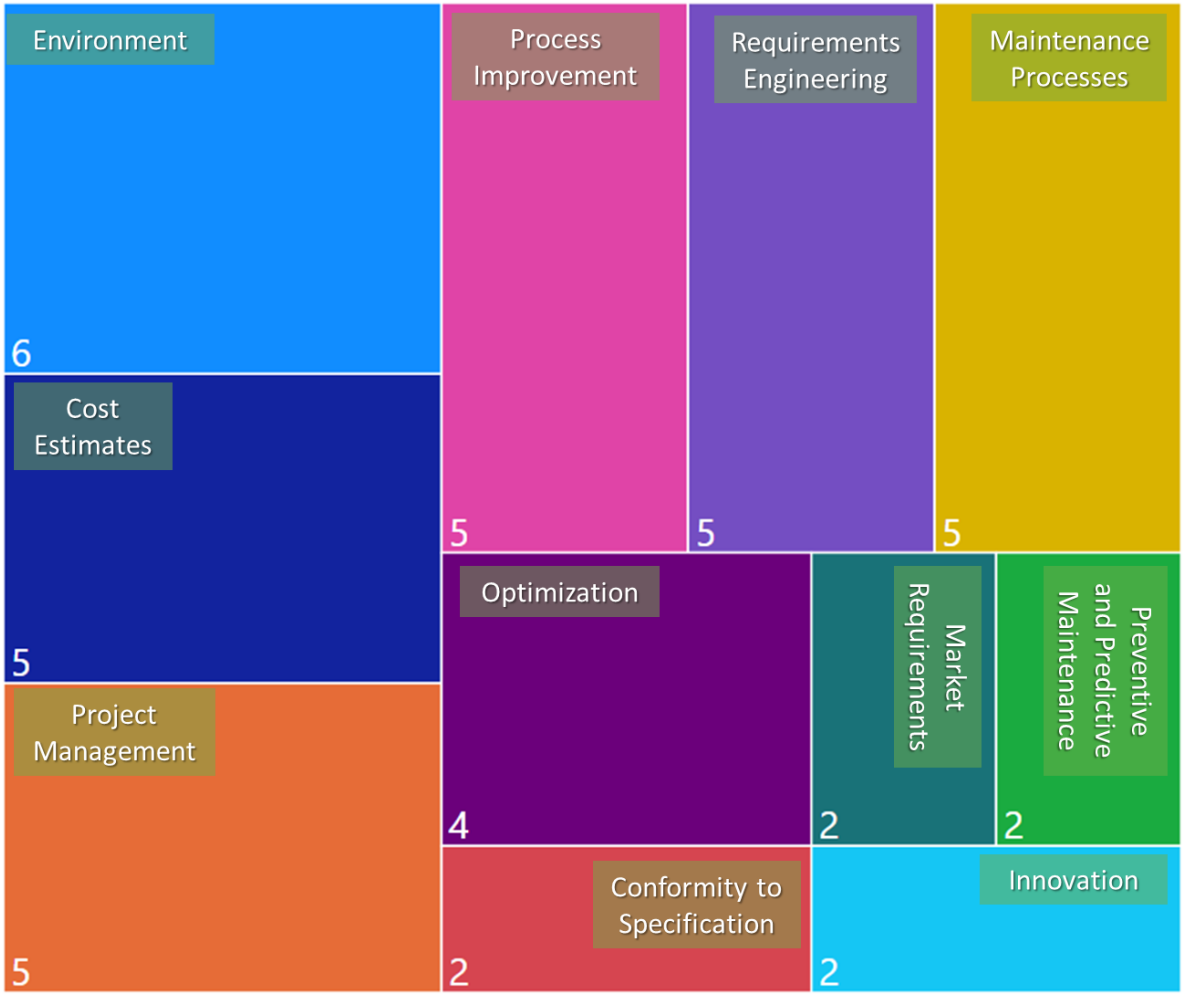

Figure 37. Cross-sectoral Competence

5.3.2 Recommendations and Actions

- Improvement in sustainability and further development of telecommunication and its implementation methodology and requirements are needed.
- Reaching the goal of having sustainable and resilient base stations will require skills in pulling through such projects as replacing Diesel generators with energy storages. That means that the engineers working with such projects possess project planning skills.
- The associated job roles include, for example, Planner, Planning and Logistics Manager, Process Engineer, Battery Systems Project Manager and Sales Engineer (Energy Storage Solutions (ESS)).

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5.3.3 Target Groups

While this development is already occurring now and is requiring the need for the execution of the recommendation as soon as possible, the timeframe the recommendations would become most essential is around the mid-2020s.

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