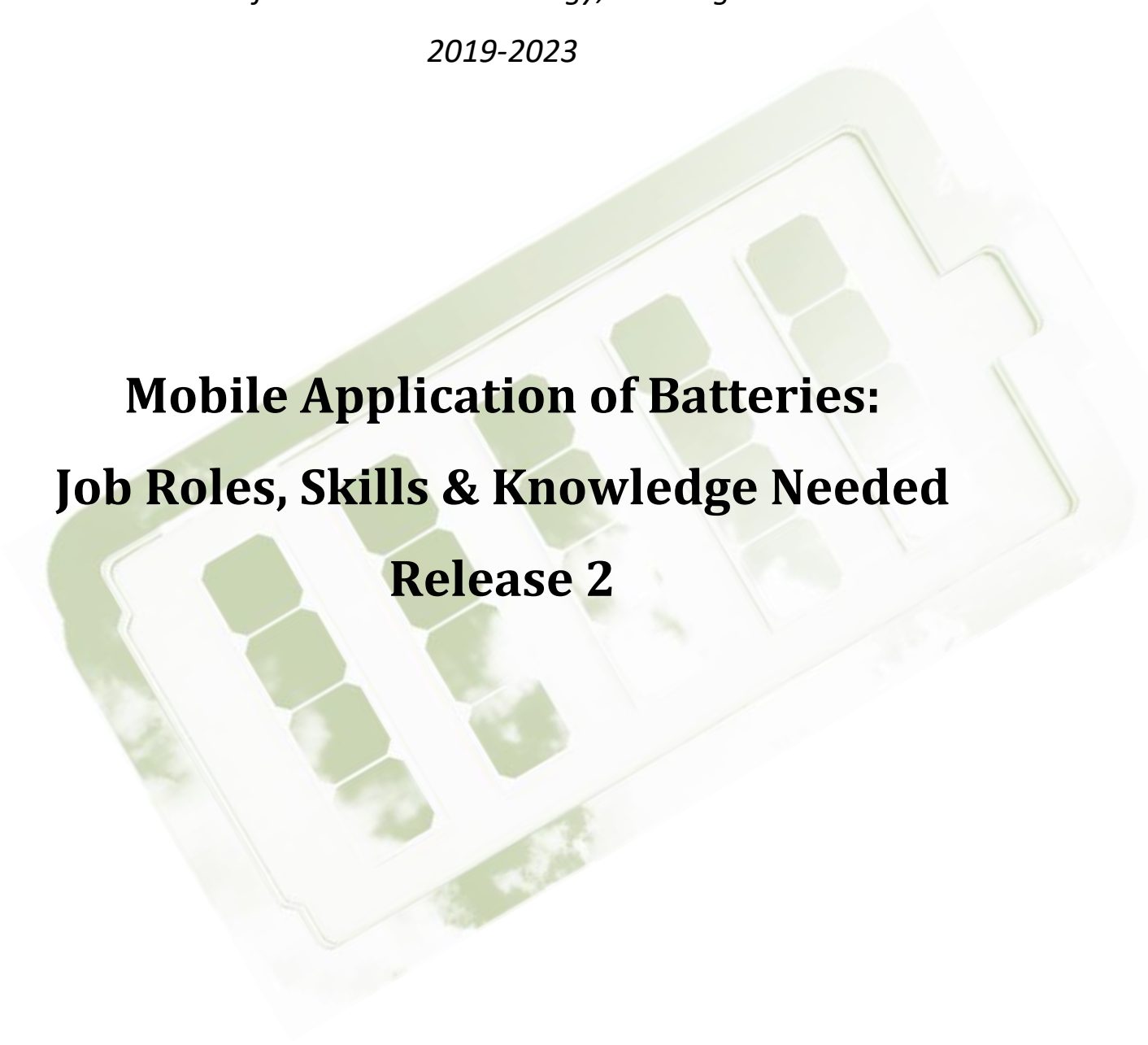
albatts

Alliance for Batteries Technology, Training and Skills

2019-2023



Mobile Application of Batteries:

Job Roles, Skills & Knowledge Needed

Release 2

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List of Abbreviations

AC	Alternating Current
ADAS	Advanced Driver-Assistance System
AFIR	Alternative Fuels Infrastructure Regulation
AR	Augmented Reality
BESS	Battery Energy Storage Systems
BETs	Battery Electric Trucks
BEV	Battery Electric Vehicle
BMS	Battery Management System
CET	Central European Time
CMM	Coordinate Measuring Machines
CO	Carbon Oxide
CO_2	Carbon Dioxide
DC	Direct Current
EER	Electrical Equipment Regulation
EP	Electronics Packaging
EVs	Electric Vehicles
HV	High Voltage
ICE	Internal Combustion Engine
ICT	Information and Communication Technology
ISS	International Space Station
IT	Information Technology
Li-Pol	Lithium-polymer
LNG	Liquified Natural Gas
MMLV	Multi-Material Lightweight Vehicle
MS	Mechanical Structures
NO_X	Nitrogen Oxides
PCB	Printed Circuit Board
PM	Particulate Matter
PPE	Personal Protective Equipment
PT	Production Technology
R&D	Research and Development
SCS	Safety Critical Systems
SoC	State of Charge
SoH	State of Health
UK	United Kingdom
US	United States
VR	Virtual Reality
VS	Vision Systems

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1 Introduction and Methodology

This report is part of a series of reports within the ALBATTS (Alliance for Batteries Technology, Training and Skills) project. It summarises the ALBATTS project's latest Work Package 5 – Intelligence in Mobile Battery Applications reports and **main findings** related to battery-relevant drivers of change, state-of-the-art technologies, stakeholders and job roles & skills needed by the emerging EU battery sector in the area of **mobile applications** of batteries.

Sections 2.2, 3.2, 4.2 and 5.2 contain **conclusions and recommendations** concerning, training, re-/up-skilling and specific skills needs within the analysed domains.

The following information is summarised in this report:

- **State-of-the-art of mobile battery applications** researched during 2022:
    1) Heavy-duty vehicles
    2) Vans
    3) E-Motorbikes
    4) Micromobility
    5) E-Bikes
    6) Aerospace
    7) Trains
    8) Inland waterway vessels
- Analysis of the currently **needed job profiles** by industry (selected stakeholders and companies relevant for the mobile applications as stated above and their job advertisements). The analysis considers the following job categories:
    1) Design and development
    2) Manufacturing
    3) Maintenance
    4) Sales, services, support, and technical management
- Information on future needs and other relevant data gathered via the **webinars and interviews** during this year up to the date of publication of this report, namely:
    1) EV servicing webinar

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2) EU regulation webinar

3) maritime webinar

The report's findings will be **further processed** within the upcoming WP3 – Sectoral Intelligence report due in November 2022, where the data will be merged with the main findings of a parallel report prepared by ALBATTS project "sister" work package WP4 - Intelligence in Stationary and Industrial Battery Applications

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2 Mobile Battery Applications

2.1 DESK RESEARCH REPORT

This chapter summarises key findings of the ALBATTS report *D5.7 Desk research and data analysis for sub-sector IMBA - Release 3*.[1] The report analyses drivers of change, technologies, stakeholders, and job roles & skills relevant to the usage of batteries in electrified heavy-duty vehicles, vans, motorcycles, bicycles, micromobility devices, aerospace, trains and inland waterway vessels.

Heavy-duty vehicles

Heavy-duty vehicles are a source of ca 25 % of EU CO_2 emissions from road transport and ca 6 % of total EU emissions.[2] Like in the case of passenger cars, increasing strictness of EU emission regulations and technology developments of lithium-ion batteries are among the key factors driving the segment towards its electrification

E-Trucks

Although there are some competing alternative technologies to diesel, such as Liquified Natural Gas (LNG) or fuel cells, the production of Battery Electric Trucks (BETs) is expected to rise exponentially, requiring many job roles relevant to **product development, battery integration** into the vehicle but also in the research area. Among the biggest producers of BETs are Europe, China and the US.

Passenger cars usually have one battery pack connected to the vehicle platform with battery capacity ranging from approx. 30 – 80 kWh, while trucks carry multiple battery packs with battery capacity ranging between approx. 200 and 500 kWh. Besides BETs, fuel cell trucks also need a battery, but 10 % the size of BETs battery.

[1] *Desk Research Report III. Other Mobile Battery Applications*. (2022, September). Albatts. https://www.project-albatts.eu/Media/Publications/67/Publications_67_20220831_161257.pdf (last accessed on 27. 9. 2022)

[2] *Reducing CO_2 emissions from heavy-duty vehicles*. (2019). Climate Action. https://ec.europa.eu/clima/eu-action/transport-emissions/road-transport-reducing-co2-emissions-vehicles/reducing-co2-emissions-heavy-duty-vehicles_en (accessed on 09. 09. 2022)

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According to EU legislation, truck drivers need regular resting periods, so one of the significant challenges ahead is to equip the resting areas along the highways with high-performance charging capacities so that the vehicles can be charged not only at the start and final destination but also during these resting periods. Furthermore, the currently discussed EU Alternative Fuels Infrastructure Regulation (AFIR) is expected to require a considerable number of additional charging stations installed along highways and roads, requiring qualified personnel to plan and execute the charging infrastructure roll-out effectively and deal with **high voltage** and grid connection. Furthermore, to reduce the load on the power grid, many high-performance charging stations for trucks and other heavy-duty vehicles will need to be equipped with **photovoltaics and battery storage**, requiring trained personnel. In addition, at least basic training will need to be provided to the drivers operating the trucks to deal with the **charging operations** and **react in case of an accident**.

In addition, the servicing of the vehicles will require qualified personnel with battery diagnosis, high voltage, and fleet management. Innovative solutions, possibly providing jobs in the **research and development** areas, are being piloted in wireless static charging when the vehicles are parked or dynamic charging while the truck is on the road. The charging can be done via pantographs or induction strips installed on the road.

The end-of-life of the trucks will require skilled personnel in the areas of **battery diagnostics** and **dismantling.**

E-Buses

The electrification of buses is driven by European but also local CO_2 and pollutant emission regulations, together with EU legislation concerning public fleets. Electric buses are particularly suitable for operations in cities since their engines, compared to the mainstream diesel technology, do not emit pollutants harmful to human health, such PNs or NO_X. That is why, according to some predictions, an eight-fold increase in registrations of electric buses can be expected.[3] Fuel cell buses are also an interesting but still costlier alternative.

[3] Luman, R. (2021, October 4). *All aboard Europe's electric bus revolution*. ING Think. https://think.ing.com/articles/all-aboard-europes-electric-bus-revolution-290921 (accessed on 09. 09. 2022)

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China is the biggest producer of electric buses, but other regions, including the EU, are catching up. Similar to the truck segment, new battery-relevant job roles in the areas of bus manufacturing are expected to include **product development** and **integration of the battery** into the vehicles. Operation of large fleets will require the development of fleet management solutions where **IT skills** are required. As in the cases of BETs, the operation of e-buses will require a robust system of **charging stations** that need to be built, operated and serviced by qualified personnel. There are alternative technical solutions, such as charging via rails, wireless induction charging or using a pantograph at a bus stop or depot. The servicing and end-of-life of electric buses will require **mechatronic** technicians, personnel with **high-voltage qualifications, battery diagnostics** and **battery dismantling** skills.

E-Utility Vehicles

Utility vehicles typically include garbage collection and road and terrain maintenance vehicles. Even if the majority of utility vehicles are currently not subject to EU CO_2 emission targets, their frequent use in **urban conditions** or industrial parks suggests their enormous potential for improving **air quality** and noise **reduction** in cities, nature reserves and other similar areas, making it a **strong** driver to electrify these vehicles.[4]

Electrification of this segment is not very advanced, but some European cities have been piloting these vehicles. Chinese manufacturers are at the forefront. In general, technological aspects, job roles, and skills needed do not differ from those relevant to buses and trucks.

Vans

Vans are commercial vehicles used for the transport of people and goods. Therefore, the total costs of ownership of these vehicles play an essential role. Like passenger cars, the electrification of vans is driven by EU CO_2 reduction targets and procurement legislation favouring zero-emission vehicles such as battery vans.

[4] *Looking to the future with electric garbage trucks - Eurocities*. (2020, December 16). Eurocities - Home. https://eurocities.eu/stories/looking-to-the-future-with-electric-garbage-trucks/ (accessed on 12. 09.2022)

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From the technological perspective, they are similar to passenger cars but are **larger and heavier** and thus require a **bigger battery capacity**. In addition, the construction of vans needs to be **robust** since these are often used by multiple users, e. g. in companies or rental services.

E-motorbikes

While the production of electric vehicles (EVs) is mainly driven by CO_2 emission regulation, one of the key drivers of electrification in the motorbikes sector is motivated by the expansion of the product portfolio. Electrified motorbikes are an exciting option for many users, including **city-sharing** companies, since there are much more silent and have good acceleration and relatively low operating costs. But also EURO norms[5] reducing pollutants such as limits of CO or PM make the use of combustion engines in motorcycles more complicated and costly**,** thus favouring electrification of the motorcycles, with zero local emissions.

E-motorcycles are manufactured by well-known, **established brands** such as BMW or Harley Davidson, but also by relatively **new players** focusing solely on e-motorcycles, such as the California-based company Zero Motorcycles. Many of these brands and manufacturing facilities are based in China, Europe and the US. A battery pack of an e-motorcycle can contain around **20 kWh** of energy capacity, but there are motorcycles and mopeds with much smaller battery capacity. Some e-motorbikes and e-mopeds, particularly those used by rental and shared mobility services, use a **swappable** battery.

Micromobility

Electric micromobility uses small & lightweight **personal mobility devices** such as e-bicycles (for details, see the following chapter eBikes), e-scooters, e-mopeds, e-skateboards, e-hoverboards or other kinds of one or two-wheelers by individuals to commute from one place to another, primarily within cities.

The success of micromobility devices was enabled by the introduction of lithium-ion batteries able to contain enough energy while keeping the weight and costs reasonable. In addition,

[5] *Infineum Insight - Euro 5 motorcycles.* (2018, August 14). Infineum Insight. https://www.infineuminsight.com/en-gb/articles/small-engines/euro-5-motorcycles/ (accessed on 14.09.2022)

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micromobility can **reduce traffic**, noise and pollution in cities. Nevertheless, it often raises **safety** concerns related to drivers and other road users, particularly pedestrians, which is why the cities often regulate it. In some countries, vandalism and theft are among the key challenges.

Micromobility devices carry relatively small batteries with capacities ranging from approx. **0.1 to 5 kWh.** The popularity of the devices and their spectrum increases quickly. Therefore, the battery demand in micromobility could require the production of about 2.5 Gigafactories.[6] In recent years, the micromobility market has been dominated by **Chinese companies** such as Xiaomi. However, European manufacturers like German companies are starting to catch up. In addition, the services of e-bike and e-scooter sharing companies create additional value.

E-bikes

Similar to the other micromobility devices, the popularity of e-bikes boomed with the introduction of lithium-ion batteries. E-bikes are used for **commuting, recreational activities, delivery,** and **postal services.**

E-bikes usually carry a battery pack with a capacity ranging from approx. **0.3 to 1.0 kWh.** China dominates the manufacturing of battery packs for e-bikes. In Europe, the most interesting manufacturing locations and markets for e-bikes are Germany, France, The Netherlands and Italy.

Aerospace

Batteries are also used in devices such as **aeroplanes** or **drones** that move in the atmosphere and also **satellites** and **spaceships** that travel in orbit or outer space. Following a number of explosions in orbit, nickel-hydrogen batteries in satellites have been replaced by lithium-ion technology. Also, the International Space Station (ISS) has undertaken the replacement of batteries from nickel-hydrogen to lithium-ion.

[6] Camara, C. (2021, December 12). *Micromobility "Made in Europe" to Achieve our Climate Targets and Make our Cities More Sustainable*. The European Files. https://www.europeanfiles.eu/climate/micromobility-made-in-europe-to-achieve-our-climate-targets-and-make-our-cities-more-sustainable (accessed on 16.09.2022)

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Aeroplanes

It seems that there needs to be some technological breakthrough to allow for the aeroplanes segment to go electric on a large scale. Even though the parameters of lithium-ion batteries improve every year, their **weight** significantly limits the aeroplane's range and, thus their overall usability. Nevertheless, there are some pilot projects such as the Lillium Jet project in Germany or the Israeli project Eviation with a plane Alice, able to carry **820 – 980 kWh** batteries. Battery aeroplanes can be used as an "air taxi" for **short distances**, one of the big advantages being reduced noise when taking off.

Drones

In recent years, the number of drones has increased rapidly due to technological advancements in lithium-ion batteries, their decreasing costs, good energy density, and reasonable weight, but also the long-term availability of cheap microprocessors and the possibility for drones to carry cameras. As a result, drones, initially mainly used for **military** or **surveillance** purposes, has expanded to the **hobby, commercial** and other **professional areas**. Interesting use cases include **delivery** services, tested by Amazon, for example.

Drones carry a battery typically with a voltage ranging from 3.7 V or 7.4 V and a capacity of around **1,000–2,500 mAh**. Li-Pol (Lithium-polymer) batteries are increasingly popular. Major dron manufacturing companies are based in China and the US but some successful companies are also in Germany, the UK and other European countries.

Trains

Similar to the aerospace segment, the use of batteries in trains has been minimal so far, mostly due to the battery **weight**. Hydrogen technology (also requiring a battery, but much smaller) seems to be more promising in the railway segment, but a technological breakthrough can happen. The possibility of **regenerative braking** to increase trains' energy efficiency is particularly interesting.

Modern trains are either primarily electric, using a pantograph taking electricity from the grid or primarily diesel with a small electric engine or diesel-electric combining both technologies.

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Nevertheless, there are some pilot projects, such as the Union Pacific Railroad testing 20 battery trains in the US, Arriva piloting battery trains in Netherlands and Alstom company having pilot projects in Germany.

Inland Waterway Vessels

Electrification of inland waterway vessels is driven by the customer demand by green solutions, the desire to reduce CO_2 emissions and emission of other pollutants, developments in battery technology and the declining price of batteries. **Passenger** and **tourist** vessels are more prone to electrification than cargo vessels.

Incentives from some countries, regions and cities are also helping the vessels to electrify. In this regard, the **Netherlands** is among the leaders. On the other hand, the sparse or non-existent charging **infrastructure** and a lack of **standardisation** of the charging plugs and are among the key obstacles.

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2.2 SKILLS AGENDA AND RECOMMENDATIONS

This section summarises **skills** and **job roles** needed by the sectoral stakeholders and companies active in the aforementioned mobile applications. It also provides concrete **reskilling, up-skilling**, and other recommendations related to the skills agenda.

2.2.1 Skills Agenda

Overall, 160 advertisements from various companies specialising themselves in heavy-duty EVs, vans, motorcycles, e-bikes, micromobility, drones, aerospace, trains and vessels were analysed during the desk research.

Needs are categorised with the following structure:

- Design and Development
- Manufacturing
- Maintenance
- Sales, Services, and Support; Technical Management

Importance is given to the **sector-specific** and **transversal** technical skills/knowledge per individual category.

Design and Development

The most relevant job roles needed in the design and development engineering disciplines are:

- **Electrical** and **electronics engineers**;
- **Industrial** engineers;
- **Material** engineers;
- **Mechanical** engineers;
- **Software developers** or **systems** engineers.

Results of the job advertisements analysis and the desk research **(see Figure 1, Figure 2 and Figure 3)**

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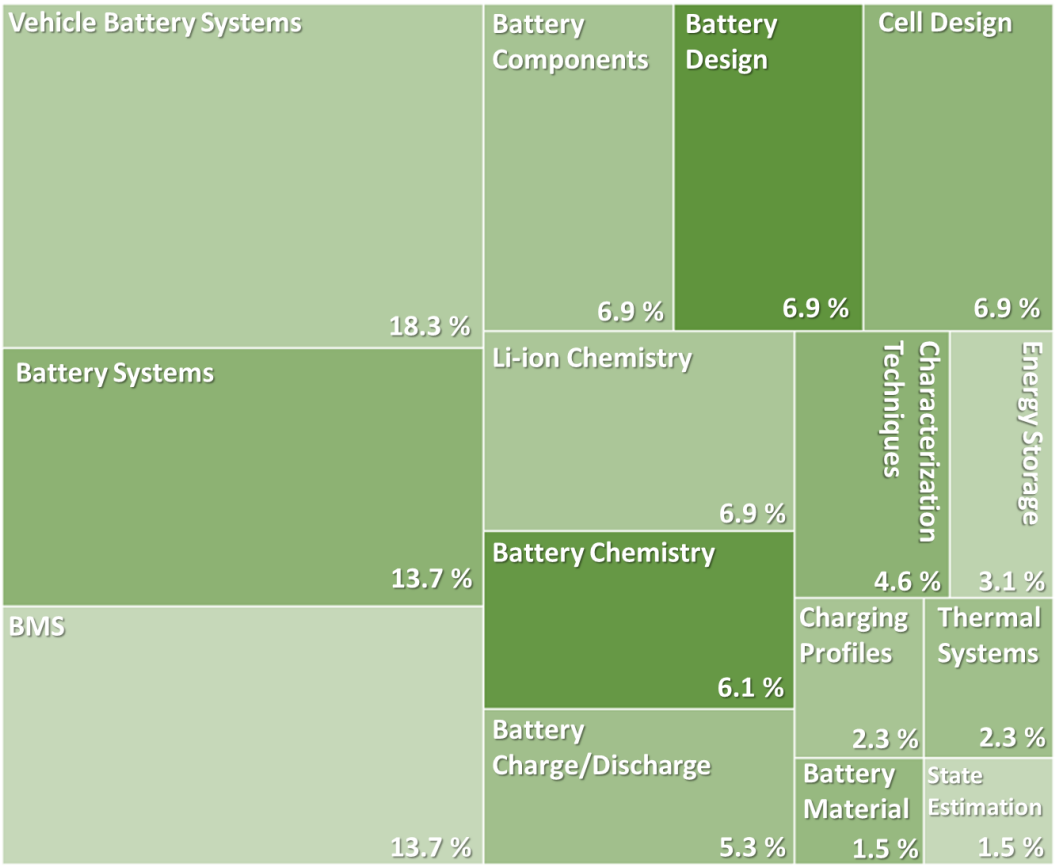

Figure 1: Design and Development – Sector-Specific Competence Needs

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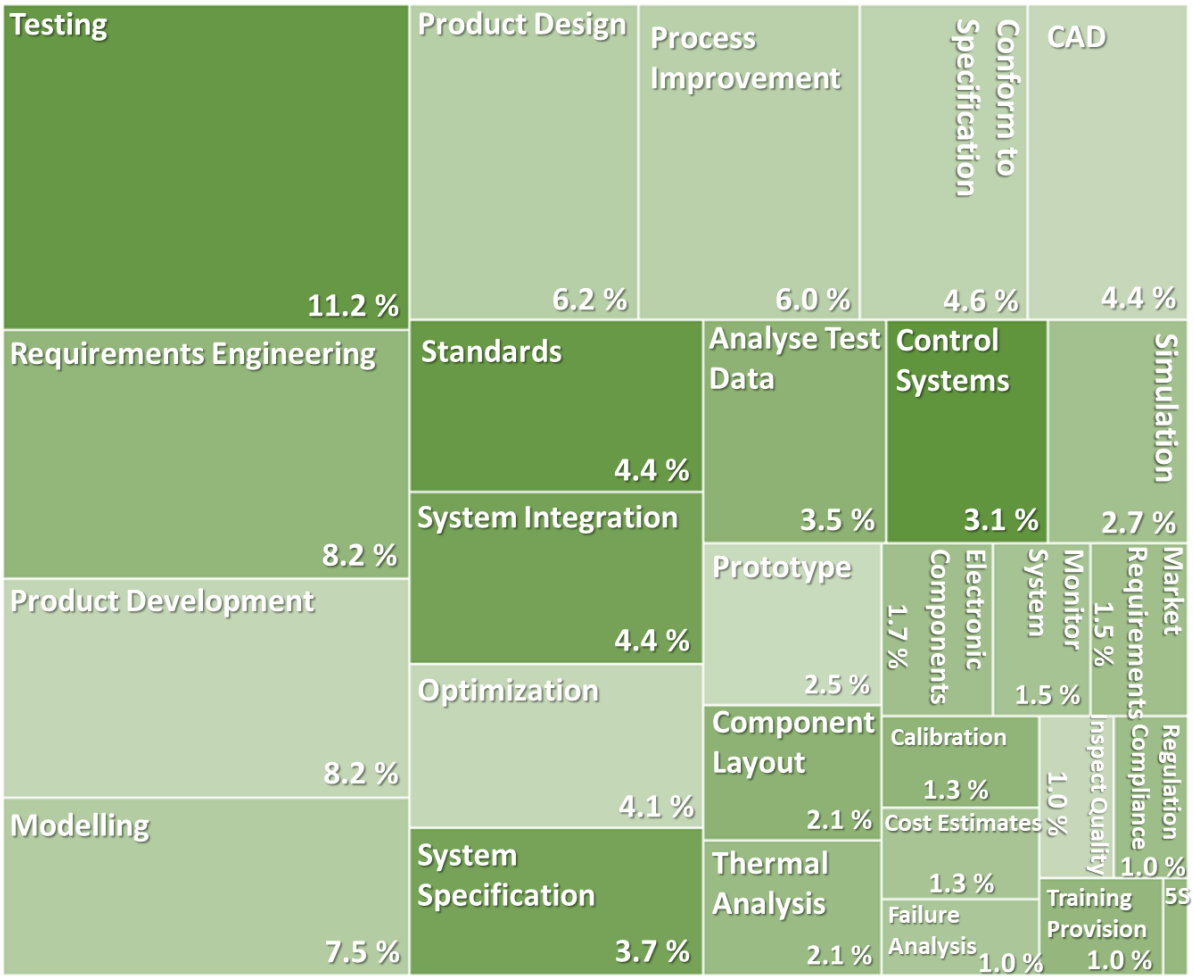

Figure 2: Design and Development - Cross Sectoral Specific Skills Needs

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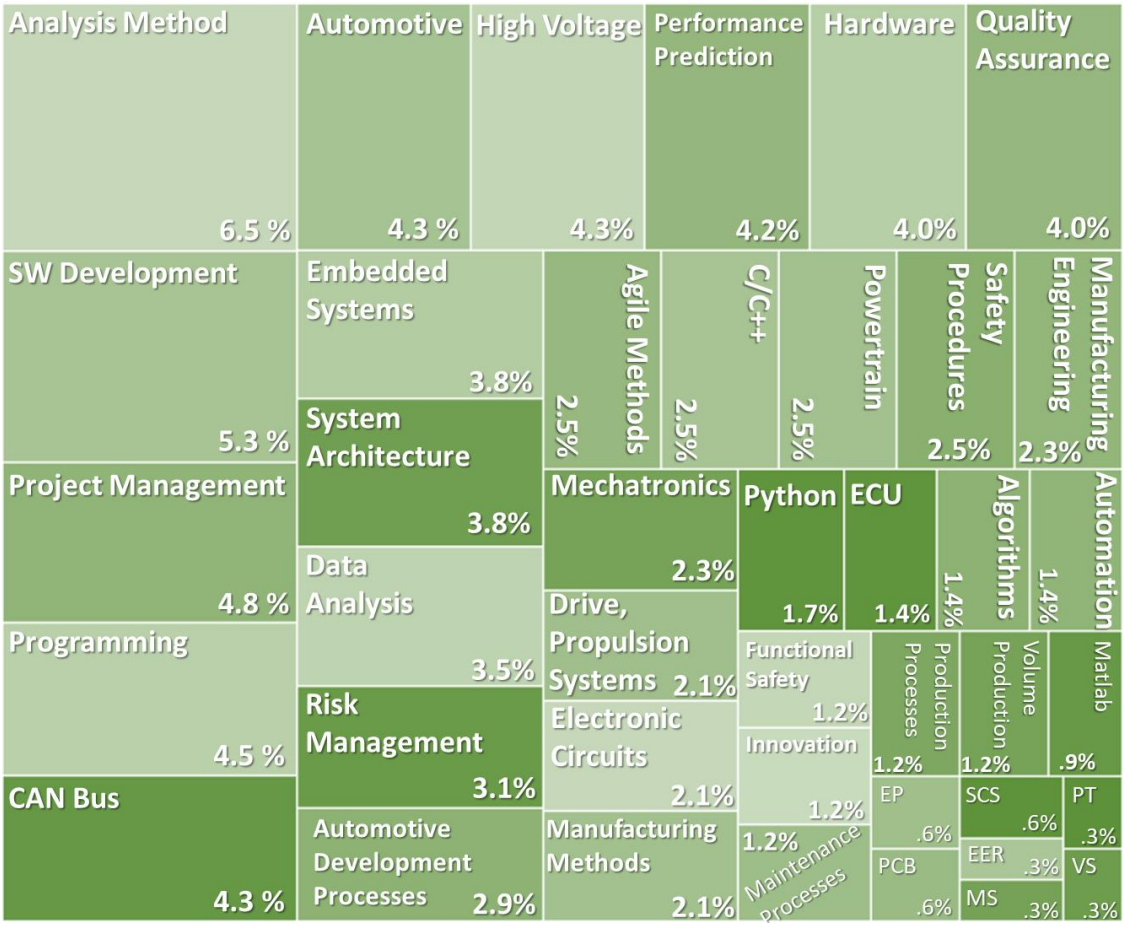

Figure 3: Design and Development – Cross-Sectoral Specific Knowledge Needs

* EP … Electronics packaging; SCS … Safety Critical Systems; PT … Production Technology; EER … Electrical Equipment Regulation; MS … Mechanical Structures; VS … Vision Systems; PCB … Printed Circuit Boards

Manufacturing

The most relevant job roles needed in the manufacturing disciplines are:

- **Electrical and electronic** equipment assemblers;
- **Electromechanical** equipment assemblers;
- **Engine** and other machines assemblers;
- **Team** assemblers – operators;
- Computer-controlled **machine tool** operators;
- **Machinists**;

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Manufacturing of electric vehicles and other mobile battery applications requires a skilled and numerous workforce **(see Figure 4, Figure 5 and Figure 6)**.

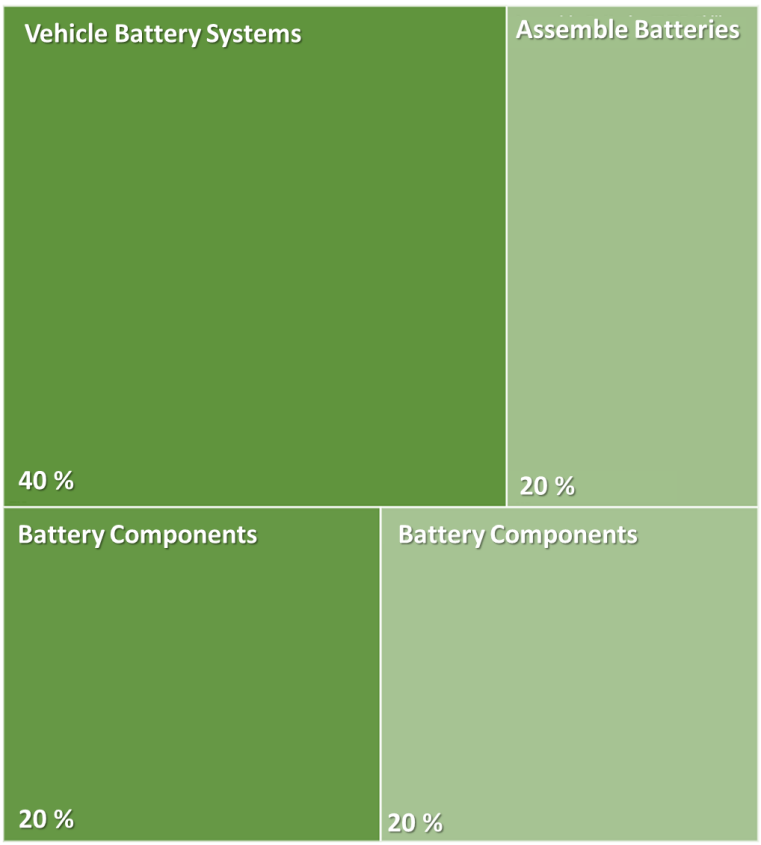

Figure 4: Manufacturing – Sector-Specific Competence Needs

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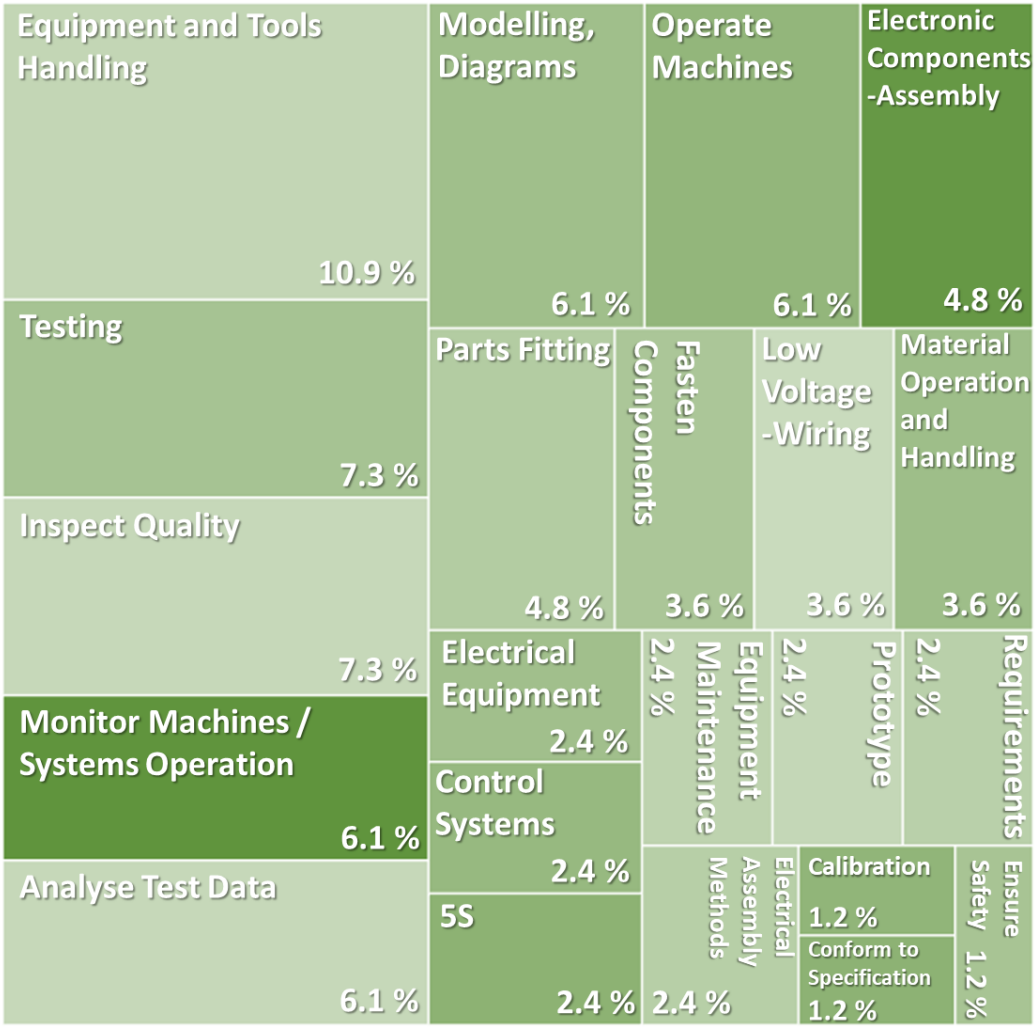

Figure 5: Manufacturing – Cross Sectoral Specific Skills Needs

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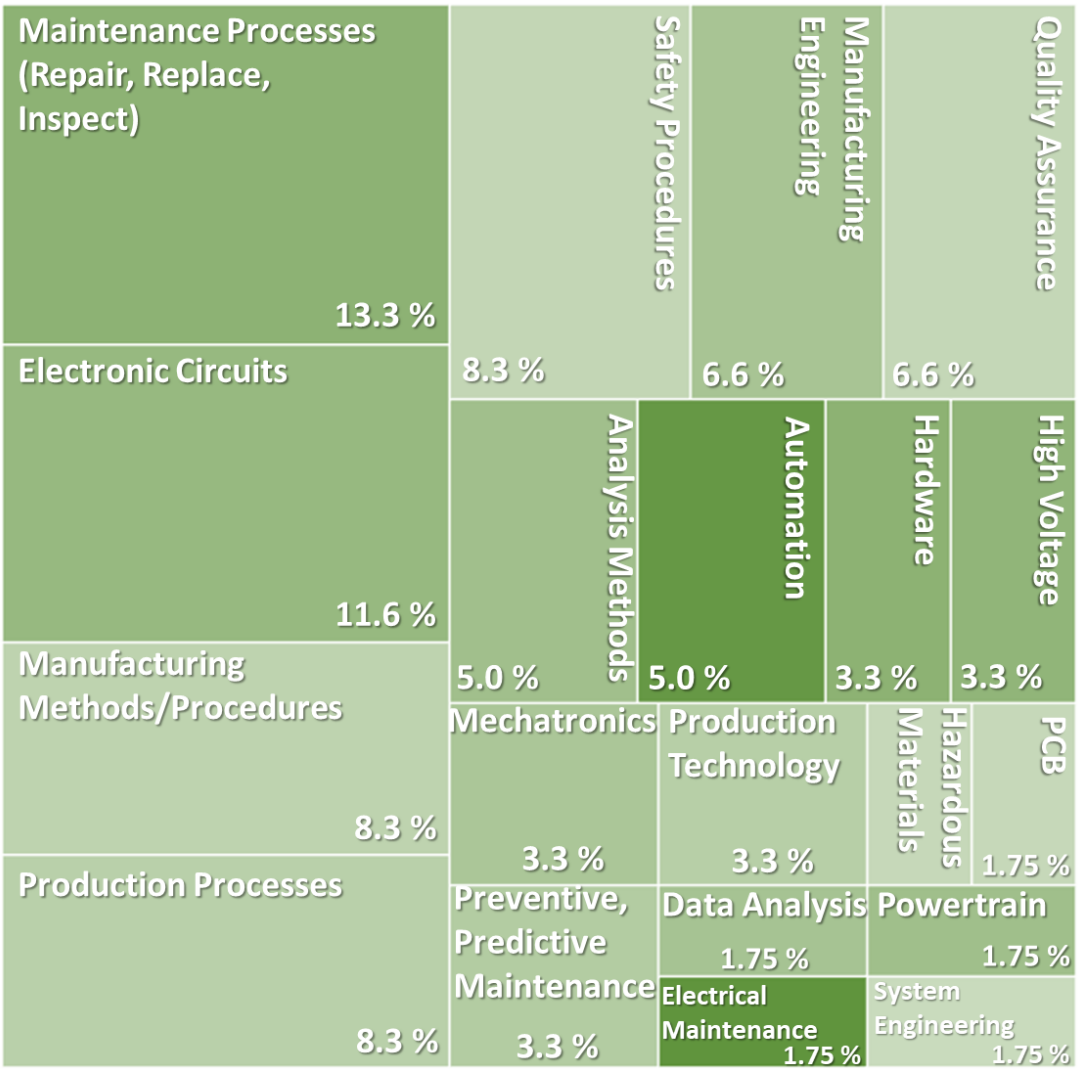

Figure 6: Manufacturing – Cross Sectoral Specific Knowledge Needs

Maintenance

The most relevant job roles needed in the maintenance disciplines are:

- **Service** technicians;
- **Mechanics**;
- **Electricians**;

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Ordinary repair workers can do routine maintenance and repair, but the batteries, electrical systems and drivetrain often need a **specially trained** workforce **(see Figure 7, Figure 8 and Figure 9)**.

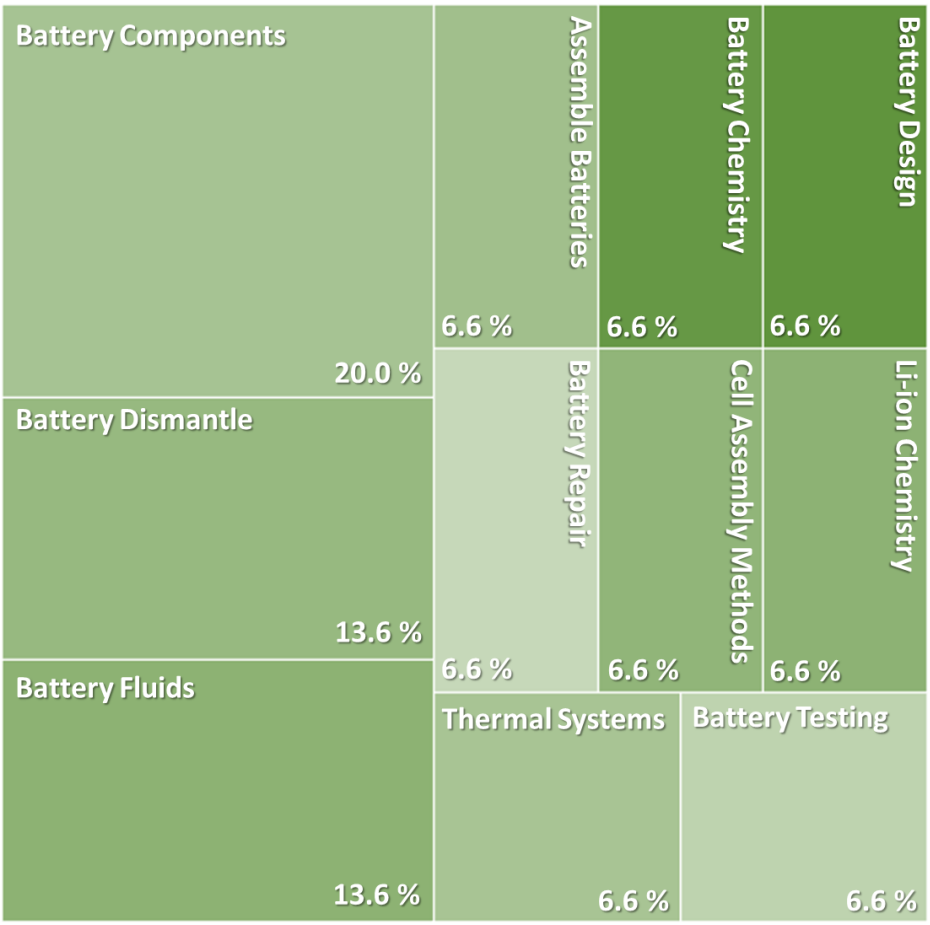

Figure 7: Maintenance – Sector-Specific Competence Needs

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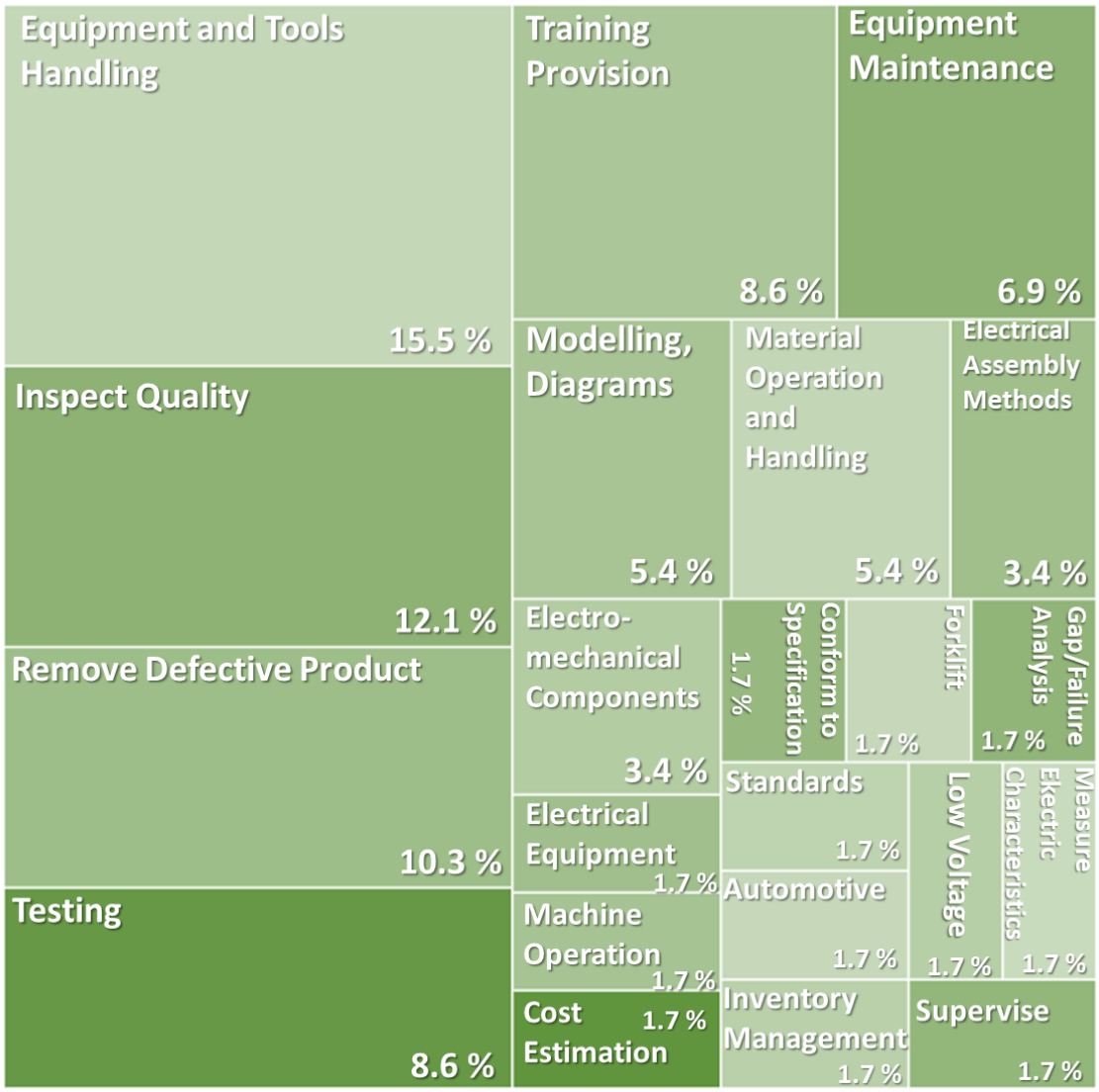

Figure 8: Maintenance – Cross Sectoral Specific Skills Needs

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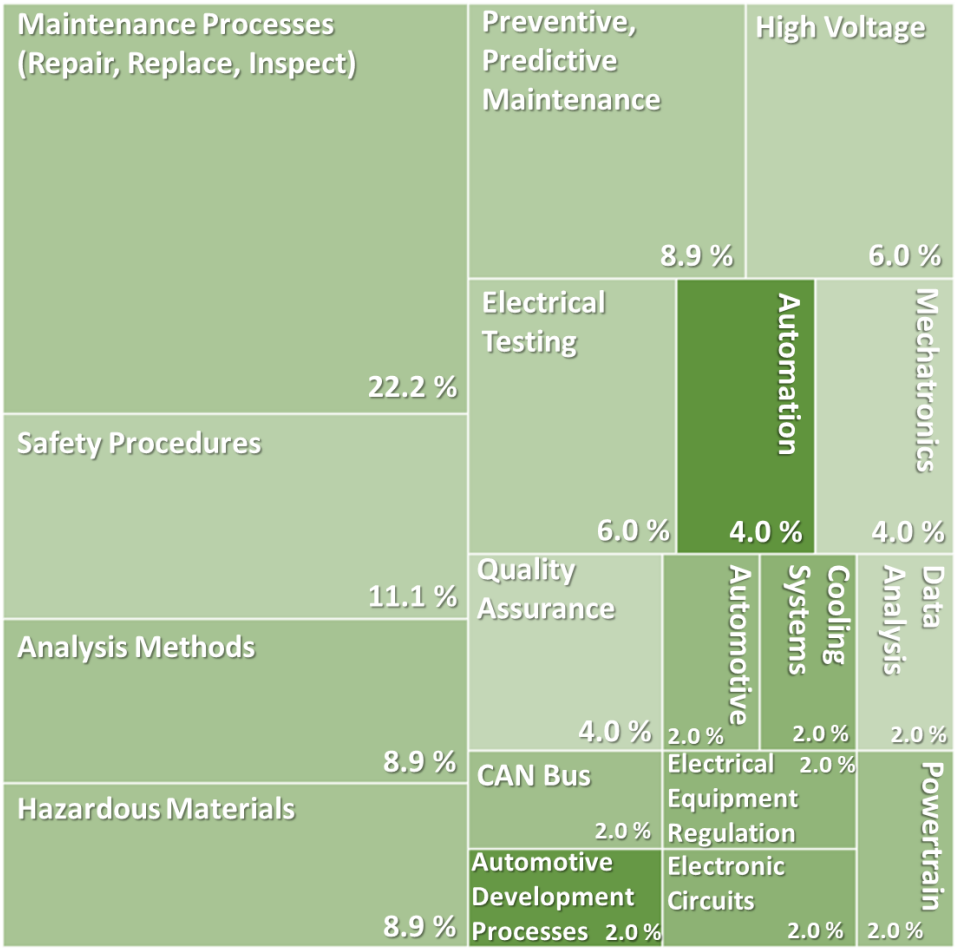

Figure 9: Maintenance – Cross Sectoral Specific Knowledge Needs

Sales, Services, Support, and Technical Management

The most relevant job roles needed in sales, services, support, and technical management are:

- **Retail** salesperson;
- **Customer services** representatives;
- **Product** managers;
- **Training** provision roles;
- **Strategic** development roles;
- **Supply chain** management roles;

For specific skills needs, see **Figure 10 and Figure 11.**

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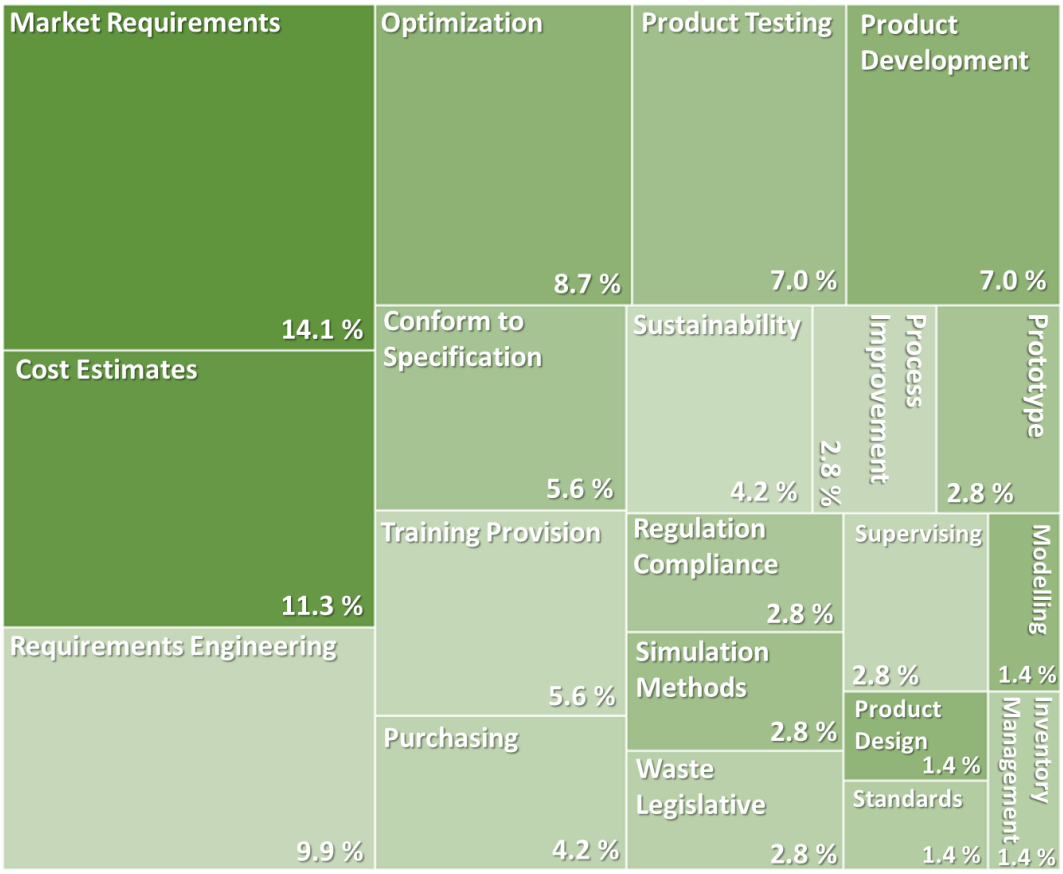

Figure 10: Sales, Services, and Support – Cross-Sectoral Specific Skills Needs

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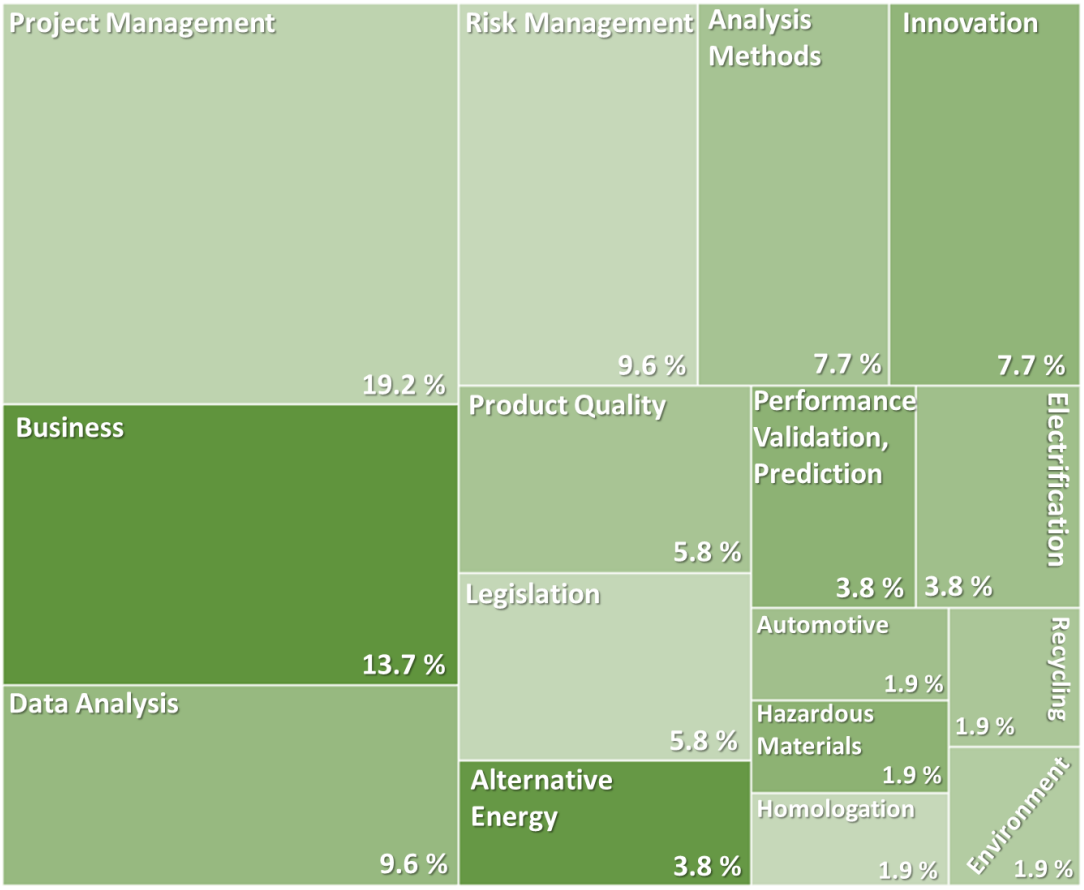

Figure 11: Sales, Services, and Support – Cross-Sectoral Specific Knowledge Needs

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2.2.2 CONCLUSIONS & RECOMMENDATIONS

This section provides conclusions and recommendations for education, training and re-/up-skilling specifically for the researched mobile applications of batteries.

Heavy-Duty Vehicles and Vans

- Increasing strictness of EU emission regulations and technological developments of lithium-ion batteries are among the key factors driving the segment towards its electrification;
- The rise of BETs trucks will require many job roles relevant to **product development, battery integration** into the vehicle but also in the **R&D area**;
- It is necessary to facilitate sufficient **charging infrastructure roll-out** in resting areas along the highways as well as along the highways in general according to the Alternative Fuels Infrastructure Regulation (AFIR) – this will require a competent workforce t deal with the infrastructure roll-out considering the **high-voltage** and **grid connection** aspects;
- It will be necessary to prioritise additional **photovoltaics and battery storage** to reduce load on the grid, this comes with the competence and workforce demand;
- It is necessary to educate and provide training to the drivers in topics of vehicle **charging operations** and accident **risk awareness** and how to react or mitigate.
- Servicing will require qualified personned with knowledge and skills on **battery diagnosis**, **high voltage**, or **fleet management** where **IT skills** are relevant;
- It is necessary to further develop and research innovative approaches/solutions and facilitate needed jobs in topics, such as wireless static charging or dynamic charging;
- End-of-life vehicles will require qualified personnel and technicians for battery **dismantle**, **diagnostics** and other relevant processes and operations;
- E-buses are suitable for operations in cities since their engines, compared to the mainstream diesel technology, do not emit pollutants harmful to the human health;
- Fuel cells buses are costlier compared to the e-buses;

E-motorbikes

Similarly to other mobile battery applications, the following skills and competencies need to be available throughout the lifecycle of the product:

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- **R&D** – **developing** and **designing batteries** and other **electric systems** for e-motorbikes
- **Manufacturing** – **integration of the battery** into e-motorbikes
- **Servicing** – servicing or replacement of malfunctioning or end-of-life battery cells or whole packs, refurbishing of the battery packs
- **Operation** – **roll-out** and **servicing of charging infrastructure**, assistance at **battery swapping** points. In the case of e-scooter sharing projects - the staff responsible for the monitoring of State of Charge (SoC), **collecting and charging** of e-motorbikes
- **Disassembly** – **diagnostics** and **disassembly** of e-motorbikes and their battery packs at the end-of-life

Micromobility

- Micromobility reduces traffic, noise, and pollution in cities; on the other hand, it often raises safety concerns for car drivers and other road users, such as pedestrians, which raises the need for regulation.
- **Systems Engineer for Battery Management Systems** (BMS) – one of the most desired job roles in the sector, requires studies in the field of **electrical engineering** and good knowledge of **battery systems** and **lithium-ion cells**, with solid **programming skills**[7]**;**
- **Product Design Manager** – another job very desired in the shared micromobility - with a focus on an experience in **building and shipping applications** or **software** and various **design tools such as Sketch, Flinto, InVision, Framer;**
- In general, many job roles rely on strong **IT skills** and/or **electronics/electrical engineering** and experience in **software engineering**. Additional competencies include strong **communication skills**, **business intelligence**, **measurement,** and **test technology handling**.

E-bikes

Similarly to other mobile battery applications, the following skills and competencies need to be available throughout the whole product lifecycle:

- R&D – **developing** and **designing batteries** and other **electric systems** for e-bikes

[7] Anforderungs- und Systemingenieur (m/w/d) für Batterie-Management-Systeme (BMS) wird eingestellt! (n.d.). bmz-group. https://bmz-group.csod.com/ats/careersite/JobDetails.aspx?site=4&id=255 (accessed on 18.04.2022)

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- Manufacturing – **battery pack/e-bike assembly**
- Servicing – **battery diagnostic, servicing** or **replacement** of malfunctioning battery packs and cells
- Operation - **roll-out** and **servicing** of charging infrastructure assistance at **battery swapping** points. In the case of e-bike sharing projects, the staff responsible for the **monitoring of State of Charge (SoC), collecting** and **charging** of e-bike batteries.
- End-of-life – **battery diagnostic, disassembly** of end-of-life e-bikes and battery packs

Aerospace

- There is still a need for further research and development in terms of **battery applications** in aerospace on a large scale;
- Competence and skills related to **battery systems development**, **aerodynamics** and **aeronautics**, and **propulsion systems** are needed, as well as handling **used materials** and ensuring **compliance** with legislation. **Testing** is also essential.

Trains

- Research and development in regenerative braking is an exciting option for increasing trains efficiency;
- Competent workforce and skills in domains such as **operations management**, **maintenance and servicing**, **charging infrastructure** and technologies, **propulsion** and **battery systems** are relevant with regards to piloting train battery applications;

Inland Waterway Vessels

Similarly to other mobile battery applications, the following skills and competencies need to be available throughout the whole product lifecycle:

- R&D - **developing** and **designing batteries** and other **electrical systems** for maritime operations, requiring high **safety** and **robustness** to fit Class society regulations to secure the highest standard of passenger and crew safety
- Manufacturing - **battery pack/modules assembly** into complete Marine Battery Energy Storage Systems (BESS).

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- Servicing - **commissioning** and **servicing vessels** in operation, at the dock, on board, or, if possible, remotely
- Operation - **education** and **training** of crew in maritime safety, operations, **charging**, and **manoeuvring** of vessels with Battery Energy Storage Systems (BESS)
- Disassembly - end-of-life BESS and battery packs ready for **reuse or recycling**.

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3 EV Servicing Webinar

3.1 THE WEBINAR

This chapter summarises key findings of the ALBATTS report *ALBATTS Workshops: Battery Relevant Job Roles & Skills: Impact of Technological and Legislative Trends.*[8] The webinar **"Servicing of Electric Vehicles: Future Qualifications Needed"** was held on September 29th, 2021, from 10.00 to 11.30 CET.

The webinar was motivated by the growing number of electric vehicles on European roads and the emerging lack of qualified personnel for servicing and maintenance. It aimed to provide a practical and valuable overview of the actual and future needs in servicing and maintenance operations for electric vehicles (EV) in terms of skills, competencies, and job roles, focusing on the needs and offers of training, the views of car manufacturers, repairers, and training providers. It was attended by 80 participants, streamed online, and published on the ALBATTS website.

Speakers and key messages:

James Copping (DG GROW, European Commission)

- EU Commission support to the EU battery sector – European Battery Alliance was established – 70 major projects, 60 bn. EUR of public and private investments are expected to reach 250 bn. EUR by 2025, InnoEnergy estimates this will lead to 3 – 4 million jobs, and at least 800 thousand current workers will need to be re-trained – this has motivated the Commission to support ALBATTS in partnership with DRIVES and the Automotive Skills Alliance

[8] *ALBATTS Workshops: Battery Relevant Job Roles & Skills - Impact of Technological and Legislative Trends.* (2022, February). Albatts. https://www.project-albatts.eu/Media/Publications/62/Publications_62_20220228_15859.pdf (last acessed on 27. 9. 2022)

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Jakub Stolfa (the Technical University of Ostrava, DRIVES coordinator, ALBATTS Work Package leader, Automotive Skills Alliance representative):

- Changes in the automotive sector include: decarbonisation, digitalisation, new mobility concepts, the impact of Covid-19
- Automotive Skills Alliance was established based (not exclusively) on DRIVES and ALBATTS project members. Within the Alliance, EV servicing topics are being dealt with in a working group led by CECRA
- Education providers are invited to register for online courses in DRIVES, while webinar participants are invited to register for the courses.

Bernard Lycke (European Council for Motor Trades and Repairers – CECRA)

- New skills envisaged – knowledge **of electric vehicle specifications, diagnosis of defects in the electric vehicles, maintenance and repair of electrical systems, knowledge of services and accessories to electric vehicles**
- Safety issues – some works on vehicles using new materials are potentially dangerous to people and infrastructure – also relevant to battery electric vehicles and hydrogen
- Lifelong learning is essential – an open mind is a key prerequisite

Sjoerd Zijlstra (EDUCAM Belgium)

- There has been a lack of **electrical competence** in garages for some time already, and this will very much increase in the future with electric vehicles
- Missing skills in the car repair segment identified – **electricity, diagnostics (ICT knowledge), MMLV repair, BEV, hydrogen, ADAS, connectivity**
- Different levels of EV servicing qualifications developed in Belgium started ten years ago using examples from other countries since the topic was not dealt with at the EU level. The key topic is safety, which is being dealt with on different levels:
    - Level 1 – Aware (employees especially need to know and be trained) – workers who do not touch the HV (high voltage) system but still need to be aware.
    - Level 2 – Qualified – disconnecting the HV system

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- Level 3 – Specialised – situations where it is impossible to take the electrical risk away by disconnecting the HV system – e. g. working inside the battery pack. Minimum requirements everybody shall have in Belgium: **safety, risk awareness/mitigation/analysis, technical competencies, knowledge of basic electricity, practice for opening the battery pack, including tools being used for working in the battery pack.**
- Level 4 – Expert – this level is being developed now in Belgium – sometimes, the car or the battery pack is in a situation where there is no procedure yet – experts develop the procedures for others. This is also being done for hydrogen.

- Practical examples are used within the training – e. g. in the case of opening of the battery pack, VR (virtual reality) training they developed is being used for some situations (e.g. working on the battery pack)

Hanna Persson (Volvo)

- Among the main challenges related to EVs are cell failure rate, compatibility of new chemistries and cells, spare parts supply, prediction of pack deviations and preventive repair, traceability of the battery pack during the lifetime, transportation of damaged packs, end-of-life vehicles, recycling
- **Battery remote monitoring** to predict a failure – a system is being developed to understand and follow battery State of Health on individual and fleet level
- Main challenges for service workshops and battery centres – safety, battery diagnostics, education of workshop technicians, investments for dealers in special tools and equipment, documentation, traceability of battery – after repair in the BC, the pack changes its battery pack ID, handling of all battery variants, information for first responders/emergency
- Competences needed in-service workshops and battery centres – **how to handle a battery with isolation faults, electric order of cells/modules, disassembly/assembly of high voltage systems, disconnection of the battery from the vehicle, interpretation of fault codes, and understanding what to repair, drainage of damaged battery pack/module.**

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Krzystof Burda (Polish Chamber of E-mobility Development Association)

- The chamber dealt with new competencies within the Sectoral Skills Council for Automotive and Electromobility (schools, universities, industry) in June 2021
- The most important recommendation was to include a new profession in the Polish national ministerial list, create a core curriculum for the profession **Electromobility Technician** on the technical secondary school level, a course for engineers at the university level, and to establish short forms of education to upskill/reskill the current workers in the automotive sector
- Education shall provide courses with new skills needed for **car servicing, charging infrastructure, IT sector – knowledge of programs such as Python, C++, Java skills, cybersecurity, and autonomous vehicles.**

Rafael Biszcz (Polish Chamber of E-mobility Development Association)

- **A combination of competencies** in the following fields is essential for e-mobility: **mechanics, electronics, energy, electrochemistry, programming**
- The industry is hustling, having no time to do the training. Knowledge transfer from the academy to the industry needs to be done comprehensibly.
- Different variants of batteries make the situation more complex
- PIRE knowledge hub provides training guidelines for all EV-relevant skills
- It is essential to start with the basic HV skills, and then more expert levels can follow.

Daniel Brown (Lucas-Nülle Academy, Germany)

- Challenges to EV servicing – Safety knowledge requirements, technical knowledge and competencies, how to standardise the training
- According to an IMI survey, only 6.5 % of UK service technicians have some basic qualifications to deal with high-voltage vehicles
- Safety – it is essential to understand the dangers of high voltage, use of Personal Protective Equipment (PPE – gloves, (helmets with) glasses, full-length clothes, measuring equipment), follow the insulation and voltage-free status check procedures

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- Creating a culture of safety, incl. warnings for third persons, awareness of unsafe procedures
- The work of various WorkSkills associations – HV skills were the topic of the event SkillsUSA First National HV Skills Station 2018 – findings: more than 50 % of the participants had no HV experience, poor knowledge of PPE or specialised tools
- There is a knowledge gap in the following areas: **high voltage batteries, inverters, 3phase motors, DC/DC converters, insulation testing, potential equalisation**
- Lithium-ion HV batteries – transport is difficult – dealerships shall be ready for repair to avoid unnecessary transport. In addition, the battery pack is often well-sealed – batteries can be destroyed when opening the cover
- Training:
    - Level 1 – Awareness training
    - Level 2 – Isolate HV vehicles
    - Levels 3/4 – Working on HV battery
    - First responders – receive a special training

Debate & Questions

- **On-board diagnostics** are expected to play an even more critical role in the future
- The maintenance of EVs is expected to be simpler than that of ICEs. However, **diagnostics in the battery pack** and of the **HV parts** will get much more complex
- **Electromagnetic training** should be provided understandably also outside the university level – e. g. at the lower technician level
- **EU-wide qualification standards** for EV servicing qualifications shall be developed
- Servicing of **hydrogen** vehicles shall be addressed as well.

3.2 SKILLS AGENDA AND RECOMMENDATIONS

The following section provides a summary of current and future missing competencies in terms of skills agenda, education, and re/up-skilling of the workforce:

- E-mobility technicians are needed – key competence include the following: **electricity and high voltage batteries; insulation; testing; potential equalisation; iCT; EV diagnostics;**

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MMLV repair; electric propulsion; inverters and converters; ADAS; connectivity and cybersecurity.

- Other relevant knowledge domains needed are **pack deviation prediction** with **SoC** and **SoH monitoring**;
- **Preventive** and **predictive repairs/maintenance** are essential together with **traceability** of the battery pack during the lifetime and its **handling** and **transportation**, ending with **recycling** or **second life use**;
- It is essential to link occupational safety with **high-voltage competence**;
- EV servicing qualification should be **harmonised at the EU level**;
- It is important to use **practical examples** and industry-used **tools** during the training and facilitate innovative approaches, such as **AR/VR training**; lifelong learning is vital as the paradigm shifts;
- **Education and education needs**: **(1) high voltage training for EV servicing; (2) short form of education to up-skill and reskill the current workers of the automotive sector; (3) life-long learning; (4) training guidelines for all EV-relevant skills; (5) hydrogen vehicle servicing education and training needed; (6) training on electromagnetism.**

Figure 12: Electric Vehicle Servicing - Needed Skills, Competences, and Knowledge

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4 EU Regulation Webinar

4.1 THE WEBINAR

This chapter summarises key findings of the ALBATTS report *ALBATTS Workshops: Battery Relevant Job Roles & Skills: Impact of Technological and Legislative Trends.*[9] The webinar **"New EU Regulatory Proposal: Implications for the Job roles & Skills**" was organised to learn about the implications of the currently negotiated legislative *Proposal for a Regulation of the European Parliament and of the Council concerning batteries and waste batteries…* (COM/2020/798) for the automotive value chain and energy sector and the job roles and skills needed for the future.

The webinar was held on October 22nd, 2021, from 11.00 to 12.30 CET and was attended by 52 participants. In addition, presentations and the video from the workshop have been available on the ALBATTS website, thus enabling an even wider reach to the stakeholders.

Speakers and key messages

Zdeněk Petzl (Czech Automotive Industry Association, ALBATTS WP5 leader)

- Brief description of the legislative proposal, its main features and challenging topics

Kari Valkama (Merinova, ALBATTS WP4 leader)

- Presentation of the ALBATTS project

Amélie Sophie Salau (ACEA)

- Changes in dealerships and repair shops are needed - authorised personnel working on EVs need to be able to work on high voltage; this is also relevant to rescue teams
- More **development and testing engineers** are needed, also **software developers** or **chemical engineers** – that means a holistic approach to cars

[9] *ALBATTS Workshops: Battery Relevant Job Roles & Skills - Impact of Technological and Legislative Trends*. (2022, February). Albatts. https://www.project-albatts.eu/Media/Publications/62/Publications_62_20220228_15859.pdf (last acessed on 27. 9. 2022)

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- Repurposing and remanufacturing of EV batteries – authorised operators must perform **repair, reuse, remanufacturing and repurposing** in authorised workshops as specific skills are crucial; **data collection and sharing** are carried out already under dismantling information
- Electronic exchange system and "battery passport" will require **monitoring and sharing of information** - assessment of existing tools (like Dismantling Information System) as well and real needs of stakeholders is essential
- Due diligence, including responsible **sourcing of raw materials** – impact on employment of procurement departments; need to avoid overlaps in legislation and administrative burden

Simon Godwin (BorgWarner, CLEPA)

- The industry will need more electrochemical engineers, electronics engineers, material scientists and chemical engineers, SW engineers; some skills can be converted from job roles related to conventional vehicles - like assembly; some jobs become obsolete, some will need intensive re-training; **STEM education** and attractiveness of the sector will be key to ensure a sufficient number of workers
- Recycled content requirement – company targets per year instead of requirement per battery would enable better planning and less burden for companies; this could be contradictory to high purity needs, lack of recycled materials on the market (which would limit the growth of European production) or hinder second life of batteries; skills implication: recycling technologies will become one of the primary activities of the sector – **materials and chemicals scientists and technicians** will be in great demand
- Restriction of hazardous substances – should not duplicate REACH and other legislation already in place; **chemical engineers** will be highly demanded
- Requirements like those on carbon footprint will require competencies like emissions modelling and simulation, climate scientists, as well as **lawyers and accountants**
- It is necessary to avoid duplication in durability and performance requirements, and align to UNECE standards; **engineers and physicists** will be needed.

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Michelangelo Aveta (EURELECTRIC)

- Electromobility means interaction and merging of mobility and energy industries – more discussion between the sectors are needed, e. g., launching of Platform for electromobility (https://www.platformelectromobility.eu/)
- The size of transition is immense – labour demand in the battery sector will increase, and requalification and relocations will be necessary.

Michiel Verbeeck (ELIA Group)

- The importance of batteries allows creating of new tools and business services, triggering communication platforms with security and personal data protection challenges – will **require IT, digital skills (installers and support), programmers, service security experts, cybersecurity experts, data scientists (forecasting tools)**
- According to consumer preferences, different settings are created (lower price, green electricity, increased use of self-consumption etc.) – this will require **mathematical formulas, battery, and system optimisation.**

4.2 SKILLS AGENDA AND RECOMMENDATIONS

The following section summarises current and future missing competence concerning skills agenda, education and re/up-skilling of the workforce needed with regards to the adoption of the EU Battery Regulation:

- More **development and testing engineers**, **electronics engineers, material scientists, electrochemical and chemical engineers,** or **software developers** will be needed;
- Competences related to **quality control** and **applying standards**, **certification activities, processes of compliance, testing,** and **inspection** will be highly relevant as well;
- **Repurposing and remanufacturing** EV batteries will require **specific skills** in authorised workshops;
- Rules on **carbon footprint** will require competencies and professions like **emissions modelling and simulation**, **climate scientists**, as well as **lawyers** and **accountants**;
- New requirements will also necessitate increased **monitoring** and **data sharing**;

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- Due diligence, including responsible sourcing of raw materials, will have an impact on employment in the **procurement departments**;
- **The use of batteries in the grid** allows creating of new tools and business services, triggering communication platforms with **security and personal data protection challenges**, which will require **IT, digital skills (installers and support), programmers, application developers, service security experts, cybersecurity experts, data scientists (forecasting tools)**, knowledge of **mathematical formulas, battery,** and **system optimisation**;
- **STEM education** and the sector's attractiveness will be vital to ensure a sufficient number of skilled workers.
- Internships, lifelong learning and cooperation on curricula change and development should be prioritised as well as training on automation, data sharing economy, and forecasting tools.

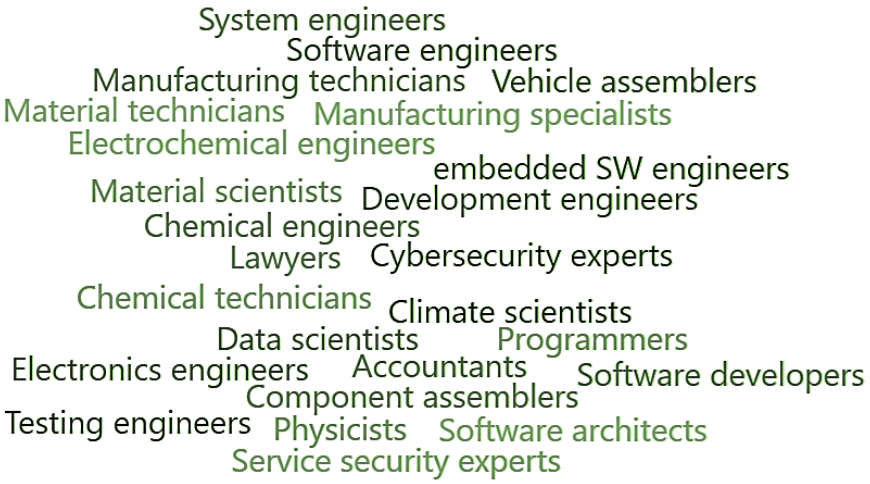

Figure 13: Battery Regulation - Needed Job Roles

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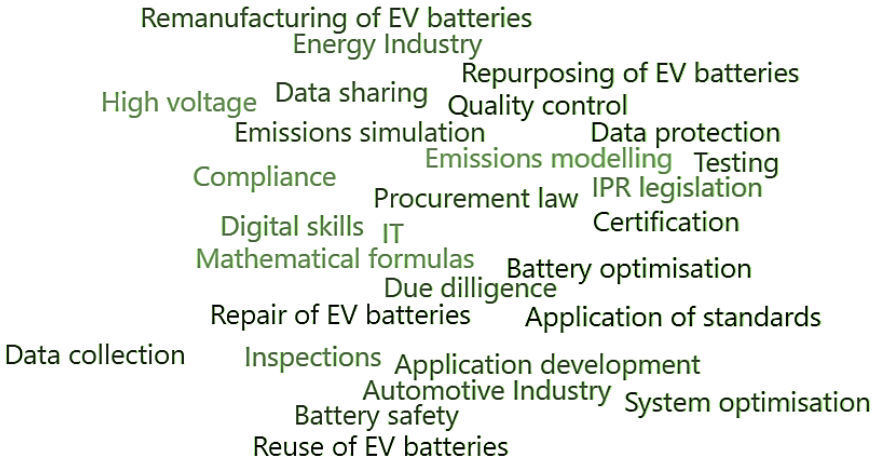

Figure 14: Battery Regulation - Needed Skills, Competences, and Knowledge

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5 Maritime Webinar

5.1 THE WEBINAR

This chapter summarises key findings of the ALBATTS report *ALBATTS Workshops: Battery Relevant Job Roles & Skills: Impact of Technological and Legislative Trends.*[10] The webinar **"Autonomous operations and Virtual Reality in Maritime. Job Roles & Skills"** was organised so that the participants can get inspired by technological innovation and trends in the maritime sector, which also has relevance for other innovative industries, including the emerging battery sector and the future job roles and skills needed there.

The webinar was held on November 7th, 2021, from 13.00 – 14.30 CET. It attracted 46 participants, and another 19 participants watched the event via Facebook live streaming. Presentations and video from the workshop have been available on the ALBATTS website, thus enabling an even wider reach to the stakeholders.

Speakers and key messages

Henning Dahl (Corvus Energy, ALBATTS project partner)

- Battery technology is a key driver for the maritime industry
- Autonomous operations drive the use of Virtual Reality and advanced simulation technology to train new skills and competencies for new job roles in the maritime industry

Vegard Evjen Hovstein (Maritime Robotics)

- Autonomous vessels enable acquiring massive amounts of data and development of new business models
- Autonomous and electric work well together

[10] *ALBATTS Workshops: Battery Relevant Job Roles & Skills - Impact of Technological and Legislative Trends.* (2022, February). Albatts. https://www.project-albatts.eu/Media/Publications/62/Publications_62_20220228_15859.pdf (last acessed on 27. 9. 2022)

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Jørgen Drønnen (Offshore Simulator Centre)

- Bridging humans and data, a gamechanger in digital twins and virtual prototyping
- Knowledge/Skills needed: **Automation, Computer Science, User interface**
- Gaming technology used in **virtual prototyping and simulation** creates many opportunities
- **Computer engineers** and **Unity developers** become increasingly important as we move into autonomous operations, and control scenarios and processes in a simulation environment, which requires fast development and technical know-how.

Pia Meling (Massterly)

- Future needs for skills & competence in Maritime - competent shore-based crew for the **energy transition (new fuels)**

Christian Hovden (University of South-Eastern Norway)

- **Remote Operations Center - Certified Operators** - the operator is monitoring the port operation of loading and discharging the ASKO sea drone and the connection and charging of batteries

Margareta Lützhöft (Western Norway University)

- Top future skills for the maritime industry (HUMANE, 2020):
  - IT and Cyber security
  - Tool handling
  - Seamanship
  - Safety awareness
  - Well-trained & multi-skilled
  - Communication
  - Emergency response

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5.2 SKILLS AGENDA AND RECOMMENDATIONS

Missing competence or future needs in terms of skills agenda, education, or workforce concerning electrified, (partly) autonomous vessels:

- **Software development** and **computer engineers** are key;
- Education related to **maritime safety, VR** and overall **lifelong learning programmes** should be prioritised.

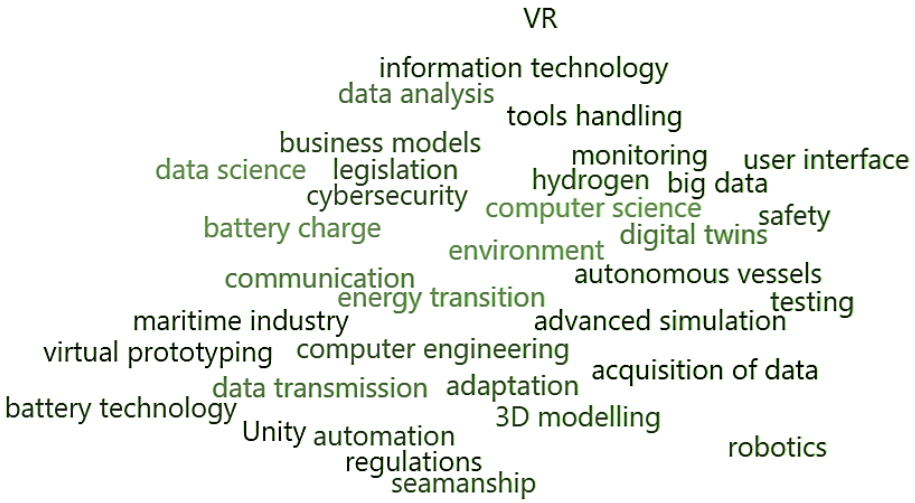

Figure 15: Autonomous Electric Vessels - Needed Skills, Competences, and Knowledge

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