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Alliance for Batteries Technology, Training and Skills

2019-2023

Survey Results for Battery Sector

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Deliverable D3.4 Survey Results for Battery Sector

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Executive Summary

Surveys, as one of the skills needs gathering techniques identified by ALBATTS, were used to analyse the EU battery sector according to the ALBATTS project's defined methodology, focusing on the whole battery value chain as well as the important topics of the sectoral intelligence: (1) job roles and skills; (2) trends and drivers of change; (3) sector attractiveness and views on the sector technological development and (4) needed re-skilling and up-skilling. Results of the survey were analysed from the point of view of battery applications and from the point of view of industrial stakeholders and education providers.

This document provides an analysis according to the defined KPIs, as well as a selection of charts, each describing specific implications and concrete statements that are relevant for the sector development.

Semi-structured interviews were also conducted to support and enlarge the gathered knowledge on sectoral needs. Respondents were asked about the trends and drivers of change of the EU battery sector development; workforce requirements and lacking skills that need to be improved; and overall evaluation of the battery sector strength and weaknesses.

Gathered knowledge is summarised in the last section and categorised by trends and factors; and by skills agenda, training and education. Each of these categories provides selected implications and concrete statements.

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Introduction

This report provides a deeper analysis of the results of the survey which was carried out by project ALBATTS consortium and builds on two reports done in WP4 – Intelligence in Stationary and other Industrial Battery Applications; and in WP5 – Intelligence in Mobile Battery Applications. These reports contained raw data and a preliminary analysis of the results with the future goal of broader analysis to be done in WP3 – Sectoral Intelligence.

The Report is structured into 5 main sections – section 1 provides the overall methodology that was used for the survey data collection, the structure of the survey and the detailed description of the key performance indicators (KPIs).

Section 2 provides a detailed analysis of the survey results based on the defined KPIs within the three application scopes: (1) overall battery sector; (2) stationary/industrial applications sub-sector and (3) mobile applications of batteries sub-sector.

Section 3 analyses results from the point of view of different stakeholder groups – industrial stakeholders and education providers.

Section 4 consolidates the results of an additional activity undertaken by ALBATTS project partners – semi-structured offline interviews with stakeholders. The main purpose of this activity was to supplement and further extend the results of the survey and provide additional view on the sectoral needs.

Section 5 contains the implications and concrete statements resulting from the analysis. This information will be further used for the sectoral intelligence roadmap that is being developed in the ALBATTS project.

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List of Abbreviations

5S	…	**Methodology for a workplace organisation**
ALBATTS	…	Alliance for Batteries Technology, Training and Skills
BMS	…	Battery Management System
CAD	…	Computer-Aided Design
CO_2	…	Carbon Dioxide
COVID-19	…	Coronavirus disease 2019
DoC	…	Driver of Change
ESCO	…	European Skills, Competences, Qualifications and Occupations
ESG	…	Environmental, Social, and corporate Governance
EU	…	European Union
EV	…	Electronic Vehicle
GDPR	…	General Data Protection Regulation
HR	…	Human Resources
HT8	…	Handheld Terminal
IMBA	…	Intelligence in Mobile Battery Applications
Industry 4.0	…	The Fourth Industrial Revolution
IoT	…	Internet of Things
ISIBA	…	Intelligence in Stationary and other Industrial Battery Applications
IT	…	Information Technology
KPI	…	Key Performance Indicator
NACE	…	Nomenclature statistique des activités économiques dans la Communauté européenne
OEM	…	Original Equipment Manufacturer
PhD	…	Doctor of Philosophy
PLC	…	Programmable Logic Controller
UOM	…	Unit of Measure
US	…	United States
USA	…	United States of America
VET	…	Vocational Education and Training
WP3	…	Work Package 3 – Sectoral Intelligence
WP4	…	Work Package 4 – Intelligence in Stationary and other Industrial Battery Applications
WP5	…	Work Package 5 – Intelligence in Mobile Battery Applications

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1 Survey Methodology and Approach

The main purpose of the survey was to gather information and valuable data on skills/competences and knowledge from sectoral stakeholders, as well as their view on the battery sector future and its attractiveness. Further expansion of the sectoral intelligence and verification of the desk research results are important when forming the roadmap for the EU battery sector. This section will describe the approach to the survey, target groups and key performance indicators (KPIs) further below.

Methodology, structure, and overall results are based on the D4.2 Survey Results for Sub-sector – Stationary and Industrial Battery Applications[1] and on D5.2 Survey Results for Sub-sector – Mobile Battery Applications[2].

1.1 EXECUTION OF THE SURVEY

The survey was open for responses from 7.12.2020 to 10.2.2020, targeting a wide spectrum of stakeholders that are active in the EU battery sector in **(1)** stationary applications of batteries sub-sector, **(2)** mobile applications of batteries sub-sector, or **(3)** stakeholders that cover both sub-sectors.

1.1.1 Battery Supply Chain

Stakeholders were categorised according to the battery value chain as defined in the ALBATTS project, ranging from raw materials and processing to battery recycling. The full battery value chain (Figure 1) and descriptions for each supply chain step can be found below.

[1] Project ALBATTS. (2021). (tech.). D4.2 Survey Results for Sub-sector, Stationary and Industrial Battery Applications.Retrieved from https://www.project-albatts.eu/Media/Publications/15/Publications_15_20210226_153256.pdf

[2] Project ALBATTS. (2021). (tech.). D5.2 Survey Results for Sub-sector, Mobile Battery Applications. Retrieved from https://www.project-albatts.eu/Media/Publications/11/Publications_11_20210226_1128.pdf

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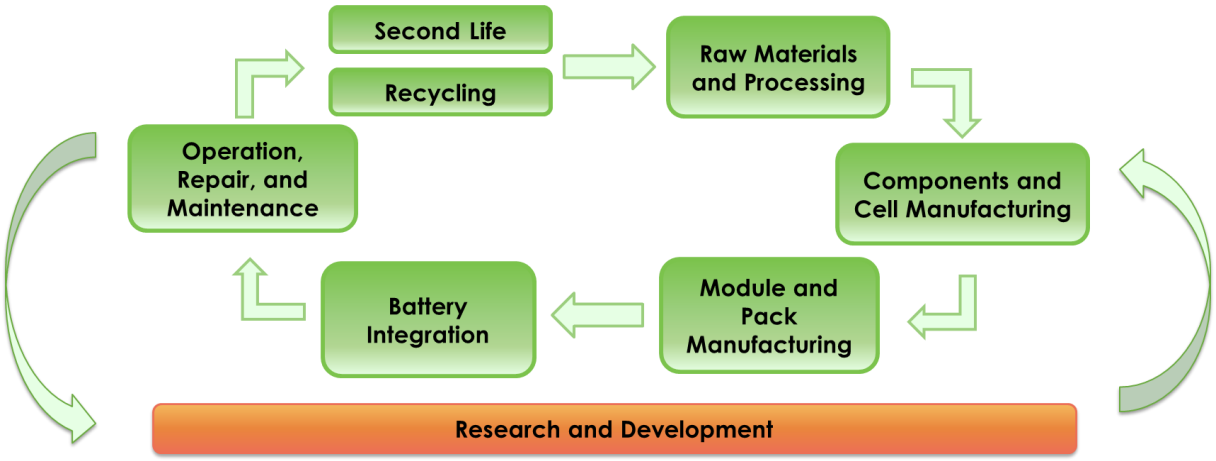

Figure 1 Battery Supply Chain

- **Raw materials and processing:** primary material sourcing with emphasis on rare and scarce metals. In the future, the integration of the recycled materials stemming from end-of-life batteries into the production stream will also be included.
- **Components and cell manufacturing:** battery components and cell manufacturing methods.
- **Module and pack manufacturing:** creation of larger systems from battery cells and modules.
- **Battery Integration:** integration of assembled battery modules together with battery management systems into the specific use cases, such as passenger cars or energy storage systems, and others.
- **Operation, Repair, and Maintenance:** topics related mainly to specific use cases of battery systems, their operation, repair, and maintenance.
- **Second life:** second use of batteries and the repurposing from one application to the other.
- **Recycling:** re-use of the materials reclaimed from decommissioned batteries, in line with the principles of circular economy.

1.1.2 Survey Structure

The survey was structured into five main sections. Each section is described in chapter 1.2, that talks about the key performance indicators and the survey structure in more detail.

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1. **General Information:** characterisation of the respondents including personal information and GDPR consent, characterisation of the respondent's organisation and its relation to application sub-sector, NACE code and battery supply chain steps.
2. **Drivers of change:** evaluation of drivers of change that were identified in the previous desk research activities. Each driver of change was rated by importance and urgency.
3. **Job Roles:** evaluation and prioritisation of selected job roles to better understand the current situation of the fast-emerging battery sector – validation of the selected desk research results.
4. **Skills:** following the job role section, if the respondent decided to provide more details on a specific job role, the selection of related skills/competences and knowledge was offered for further rating by the respondent. Based on this rating, the skills index was developed.
5. **Attractiveness of the sector:** questions on what is needed to increase the attractiveness of the sector to better understand the current situation of the sector, by focusing on target groups which include primarily potential newcomers to the sector and workers from other sectors who are considering entering the growing battery industry.

1.2 KEY PERFORMANCE INDICATORS – KPIS

Based on the survey structure, the following groups of KPIs were chosen. This section describes the survey structure in relation to the KPIs.

1.2.1 Sample Characterization

This group of KPIs contains information about the number of responses for certain respondent sample, types of organisations present in the sample and their NACE code categorisation, supply chain coverage of the sample and geographical coverage.

1.2.2 Drivers of Change

Drivers of Change are those factors which are going to bring change and have an impact on a sector across different levels. The 3 following macro categories of drivers of change have been analysed:

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- **New technologies:** the need for urgent and intense actions against climate change is widely recognized and batteries are an essential system for storing energy and making renewable energy a reliable alternative source.
- **Globalisation:** over the next years, production in global markets for batteries is expected to grow strongly and the EU production must completely change its position to create a competitive advantage.
- **Climate goals, regulation, and environmental challenges:** batteries are one of the most important tools for decarbonization and they support the transition to a renewable power system.

Each macro category has 3 drivers of change for all sub-categories that were analysed as well. The analysis consisted of importance rating (1 – least important; 5 – most important) and urgency rating (whether the driver of change should be addressed by 2021, 2025 or by 2030). Additionally, respondents had an opportunity to suggest other drivers of change that they thought were important.

1.2.2.1 Climate goals, regulation, and environmental challenges

- **Electrification and green energy**: Batteries can fundamentally reduce greenhouse gas emissions in the energy industry and therefore play an increasingly important role as a systemic enabler of a major shift to greenhouse gas neutrality**.**
- **Reducing CO_2 emissions from battery manufacturing**: since the production of batteries requires significant amounts of energy, an increase in the share of renewable energies and energy efficiency enhancement in the battery value chain would be major steps for decreasing CO_2 emissions from battery production.
- **Widespread charging/refuelling infrastructure**: demand for widespread charging infrastructure is a key driver to boost the commercialization of all propulsion technologies based on batteries. The easier the access to a reliable and suitable charging infrastructure is, the quicker the deployment of such technologies will occur.

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1.2.2.2 Globalization

- **Access to raw materials**: with a rapid increase in number of batteries rolling off the assembly lines, activities linked to raw materials are bound to become critical, especially if some resources limited in terms of quantity or geographical presence are necessary to produce key components.
- **Global regulatory dialogue**: The Commission and EU national governments will need to play a fundamental role in the elaboration of policies and strategies, from which the battery sector could benefit.
- **Restructuring**: industries related to the emerging battery sector are expected to undergo structural changes due to the development of zero-emission ecosystem.

1.2.2.3 New Technologies

- **Cybersecurity:** exponential growth of IoT devices connected to a network, cloud infrastructures as well as the navigation and location information can compromise customer privacy and security, requiring providers to keep communications secure. This threat landscape requires the industry to modify the security approach, aimed at guaranteeing the resilience of the infrastructures to cyber-attacks. That will affect various battery applications in the future.
- **Global Technical Harmonisation, Standardisation**: the supply chain structure within the sector will need to meet the challenges posed by the introduction of new technology but also meet changing market conditions.
- **Smart Grid**: the energy storage is one of the most important smart grid components due to its key role in complementing renewable energy generation.

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1.2.3 Job Roles and Skills

Respondents were asked to evaluate a selected set of job roles as well as a selected set of skills/competences and knowledge. Selection of both was based on the previous research in the ALBATTS project (particularly the desk research results). Each set is categorised based on the battery value chain – each battery value chain step contains a subset of job roles which are to be evaluated by stakeholders and in addition, based on the job roles, the subset of skills/competences and knowledge is provided for evaluation. Evaluation of the job roles is done by grading the importance (1 – least important; 5 – most important). Optionally, the "analyse" checkbox could have been ticked for further analysis of the job roles and thus the evaluation of skills/competences and knowledge that are mapped to the job role and battery value chain. Evaluation of is done in the same way.

Skills/competences and knowledge are categorised into 3 main categories: **(1)** soft; **(2)** transversal and **(3)** sector specific; of which the soft and transversal concepts are grouped together in the further analysis. The concepts are compliant with ESCO, wherever possible.

Soft Skills/competences and knowledge – combination of peoples skills, social skills, communication skills, character or personality traits, attitudes, career attributes, social intelligence, and emotional intelligence quotients, among others, that enable people to interact with their environment, work well with others, perform well, and achieve their goals with complementary hard or sector specific skills.

Transversal skills/competences and knowledge – ability or expertise which may be used in a variety of roles or occupations. Examples include communication, problem-solving and self-control.

Sector specific skills/competences and knowledge – particular or specialised skills necessary to perform work in specific sectors.

Skills/competences and knowledge are evaluated by the score of the **skills index** which is calculated based on the different variables – each skill score is based on the job roles with which it is associated (this gives the basis for the calculation); as a second step the number of stakeholders who analysed associated job roles is taken into consideration (the higher the

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number of analysed job roles, the higher the final score will be); as a final step the actual importance evaluation of this specific skill is added into the score aggregating the final score.

1.2.4 Attractiveness of the Sector

The success of a sector depends on the competitiveness of the companies that operate there, which in turn depend on the skills of the workers. A strong attractiveness of the sector brings together skilled and talented workers within it, creating a virtuous process of success. Therefore, to strengthen the success of the sector it is first necessary to understand how it is perceived by existing and potential workers, as well as what their preferences and priorities are. This section analyses factors the battery sector should concentrate on to increase its attractiveness. In the survey, a list of possible attractiveness factors was made available to the respondents for their evaluation.

1.3 ANALYSIS OF RESPONDENT SAMPLES

This report analyses the survey results from two different perspectives, one being the application sub-sector (section 2 - Results per Battery Sector and Battery Applications) – responses only for stationary/other industrial applications, responses only for mobile application of batteries, or responses by stakeholders that are active in both sub-sectors.

Due to the nature of the responses, the section on job roles and skills differs in sample selection and grouping: **(1)** Overall battery sector sample contains all responses of the survey; **(2)** stationary/other industrial applications sub-sector sample contains responses where stakeholders specified their activity in stationary and other industrial applications sub-sector and in both sub-sectors; **(3)** mobile applications sub-sector sample contains responses where stakeholders specified their activity in mobile applications sub-sector and in both sub-sectors. Second perspective of the analysis is the industrial stakeholders' point of view in comparison to education providers' point of view, where the industrial stakeholders cover the answers from companies, sectoral and industrial associations, and technology centres whereas answers from education providers cover educational institutions such as universities, VET providers/umbrella organisations, colleges, or private education providers.

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2 Results per Battery Sector and Battery Applications

In the following section, responses are analysed according to the battery application sub-sector. The following KPIs are used to map the outcomes of the survey as seen in Table 1.

Table 1 Analysis based on the Application Sub-sector KPIs

KPI	INDICATOR TITLE	UOM	OVERALL	ISIBA	IMBA	By Supply Chain
1.1	N° OF RESPONDENTS	N°	X	X	X	
1.2	TYPE OF ORGANISATION	%	X	X	X	
1.3	NACE CODE	%	X	X	X	
1.4	SUPPLY CHAIN COVERAGE	%	X	X	X	
1.5	GEO - Respondents per Country	%	X	X	X	
2.1	IMPORTANCE OF DRIVERS OF CHANGE GROUPS - MACROCATEGORY	%	X	X	X	
2.2	URGENCY OF DRIVERS OF CHANGE GROUPS - MACROCATEGORY	%	X	X	X	
2.3	DoC CLIMATE GOALS, REGULATION, AND GREEN ENERGY - IMPORTANCE	%	X	X	X	
2.4	DoC CLIMATE GOALS, REGULATION, AND GREEN ENERGY - URGENCY	%	X	X	X	
2.5	DoC GLOBALIZATION - IMPORTANCE	%	X	X	X	
2.6	DoC GLOBALIZATION - URGENCY	%	X	X	X	
2.7	DoC NEW TECHNOLOGIES - IMPORTANCE	%	X	X	X	
2.8	DoC NEW TECHNOLOGIES - URGENCY	%	X	X	X	
2.9	SUGGESTED DRIVERS OF CHANGE AND ADDITIONAL QUESTIONS	OTHER	X			
3.1	JOB ROLES INDEX	INDEX	X	X	X	X
3.2	SUGGESTED JOB ROLES AND ADDITIONAL QUESTIONS	OTHER	X			
3.3	SKILLS INDEX	INDEX	X	X	X	
4.1	ATTRACTIVENESS FACTORS	%	X	X	X	
4.2	ATTRACTIVENESS OTHER QUESTIONS	%	X			
5.1	COVID-19 EFFECT	%	X			

2.1 SAMPLE CHARACTERISATION

2.1.1 Number of Respondents

The overall number of respondents was 98, of which 43 respondents identified themselves as active in both application sub-sectors, 37 as active in mobile battery applications sub-sector, and 18 as active in stationary/other industrial applications of batteries.

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2.1.2 Type of Organisation

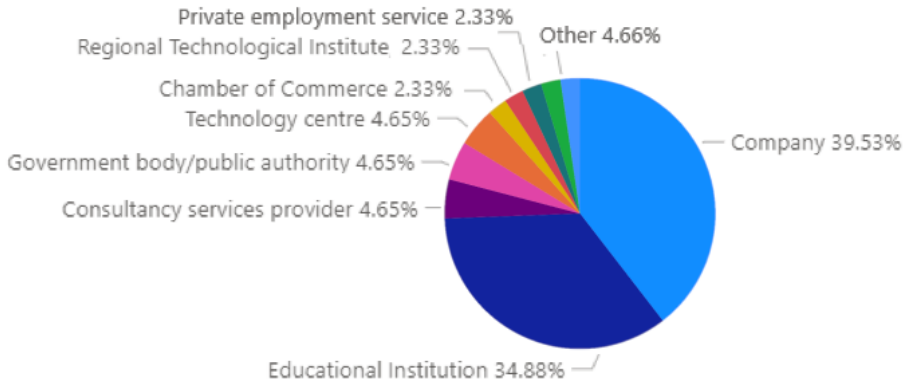

Figure 2 Overall Battery Sector

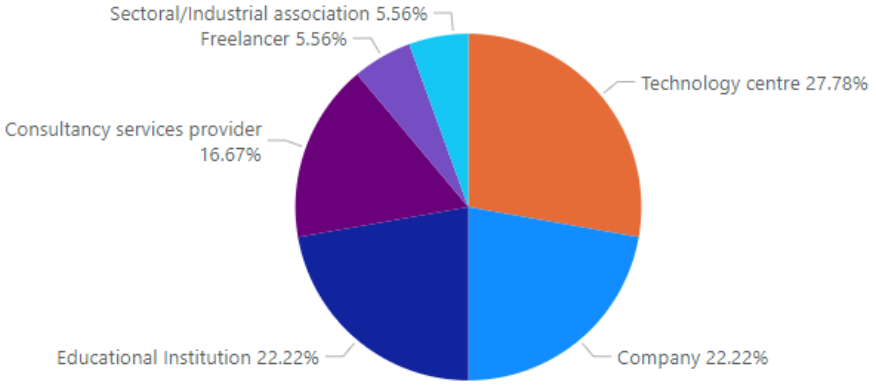

Figure 3 Stationary and Industrial Applications Sub-sector

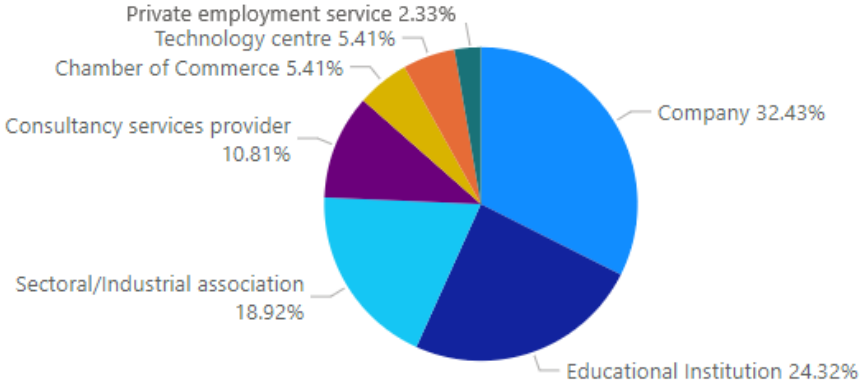

Figure 4 Mobile Application Sub-sector

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When it comes to the battery sector, we can see that most respondents belong to **companies** (39,53%), followed by **educational institutions** (34,88%), as presented in Figure 2. The distribution changes when analysing each sub-sector. Companies represent 22,22% within Stationary and Industrial Applications and 32,43% within Mobile Application. Similarly, educational institutions represent 22,22% in Stationary and 24,32% in Mobile (Figure 3, Figure 4).

The third type of organizations represented in the battery sector are **consultancy services providers** and **government bodies/public authorities** (4,65% each), followed by **technology centres** (4,65%).

When analysing the Stationary sub-sector, we can see that technology centre (27,78%) is the third most represented, followed by companies (22,22%) and **consultancy services providers** (16,67%).

For the Mobile sub-sector, sectoral/industrial associations are in third place (18,92%) followed by consultancy services provider (10,81%) and technology centre and chambers of commerce (5,41% each).

2.1.2.1 Implications and Concrete Statements

According to the survey results:

- Having considered the type of organizations represented, we can state that the prevailing perspective of the survey replies is that of companies and educational institutions. This shall be taken into consideration when analysing the replies, although there are other organizations represented to a minor extent.
- For the Stationary sub-sector, the first organization type to be considered when analysing the replies are technology centres which is a difference when it comes to the overall sector or mobile applications of batteries.
- For the Mobile sub-sector, the first organization type to be considered when analysing the replies are companies, which is in line with the overall sector.

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2.1.3 NACE Codes

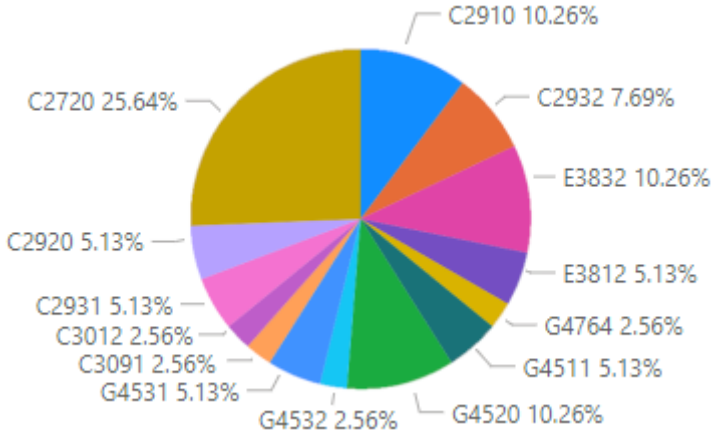

Figure 5 Overall Battery Sector

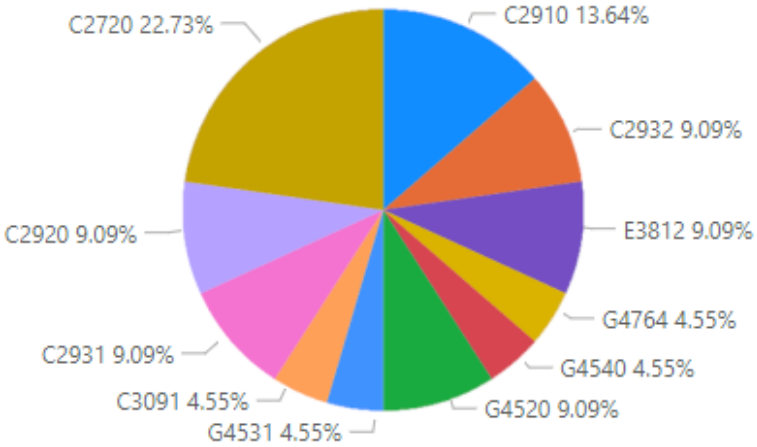

Figure 6 Stationary and Industrial Applications Sub-sector

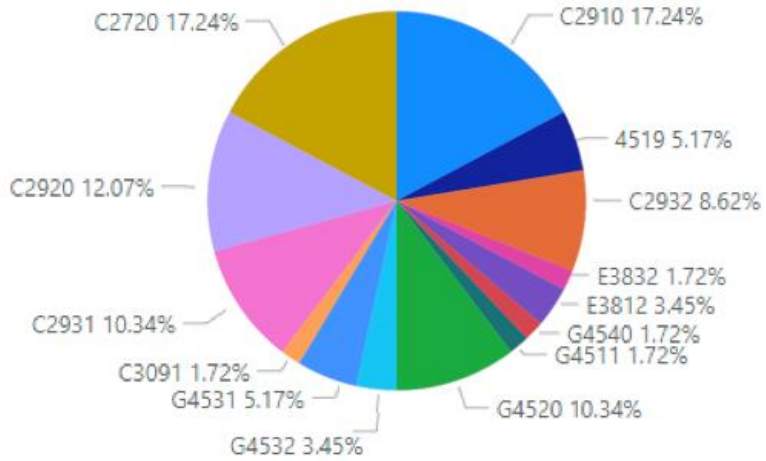

Figure 7 Mobile Application Sub-sector

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With reference to NACE codes, from an overall perspective, most of the respondents belong to **C2720 Manufacture of batteries and accumulators** (25,64% - Figure 5), followed by **C2910 Manufacture of motor vehicles** (10,26%) and **G4520 Maintenance and repair of motor vehicles (electrical repairs, repair of motor vehicle parts – battery)** at 10,26%.

The situation is similar for Stationary (C2720 - 22,73%, C2910 – 13,64% and G4520 – 9,09%) and Mobile (C2720 - 17,24%, C2910 – 17,24% and G4520 – 10,34%), as shown in Figure 6 and Figure 7 respectively.

2.1.3.1 Implications and Concrete Statements

According to the survey results:

- When analyzing the replies, C2720 - Manufacture of batteries and accumulators and C2910 - Manufacture of motor vehicles are the most represented NACE codes for both sub-sectors.

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2.1.4 Supply Chain Coverage

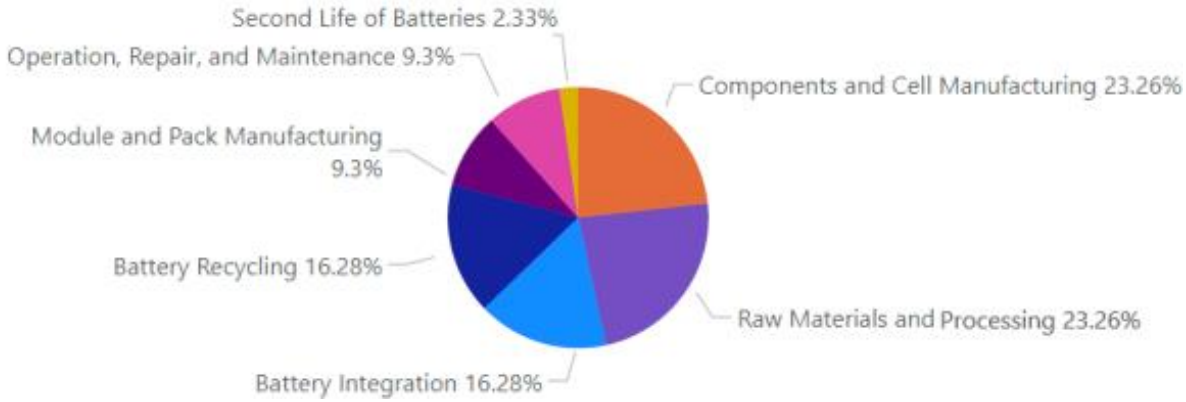

Figure 8 Overall Battery Sector

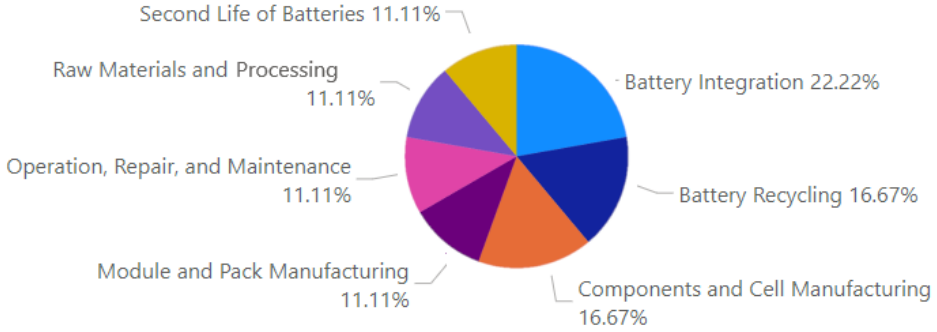

Figure 9 Stationary and Industrial Applications Sub-sector

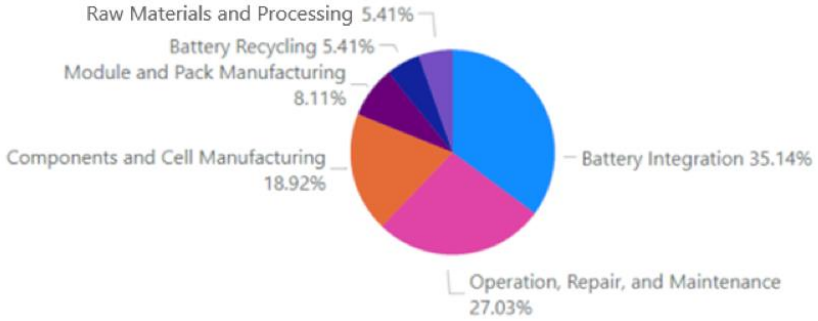

Figure 10 Mobile Application Sub-sector

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Regarding the supply chain coverage for the whole battery sector, **component and cell manufacturing** and **raw materials and processing** were the most frequent (23,26% each), followed by **battery integration and battery recycling** (16,28% each) as shown in Figure 8.

The distribution differs for Mobile (Figure 10), where battery integration is the most frequent (35,14%), followed by operation, repair, and maintenance (27,03%). The results change for Stationary (Figure 9), where we see that battery integration was the most frequent choice (22,22%), but closely followed by **battery recycling** (19,67%).

2.1.4.1 Implications and Concrete Statements

According to the survey results:

- The value chain coverage changes according to the battery application – the mobile application sub-sector is represented by battery integrators and entities that are active in operation, repair, and maintenance whereas the majority of stationary application entities represent integrators.

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2.1.5 GEO – Respondents per Country

Figure 11 Overall, Stationary and Mobile Battery Sector

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The majority of respondents from the Mobile applications sub-sector come from **Czech Republic** (21,62%) and **Portugal** (18,92%) whereas for the Stationary sub-sector, the majority of respondents come from **Portugal** (33,33%) and **Finland** (22,22%). There are also responses from Germany, Norway, Romania, Poland, and other countries, as shown in Figure 11.

2.1.5.1 Implications and Concrete Statements

According to the survey results:

- When examining the replies, geographical distribution must be considered as some countries have wider representation compared to the others.

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2.2 DRIVERS OF CHANGE

2.2.1 Importance of Drivers of Change Groups – Macro Category

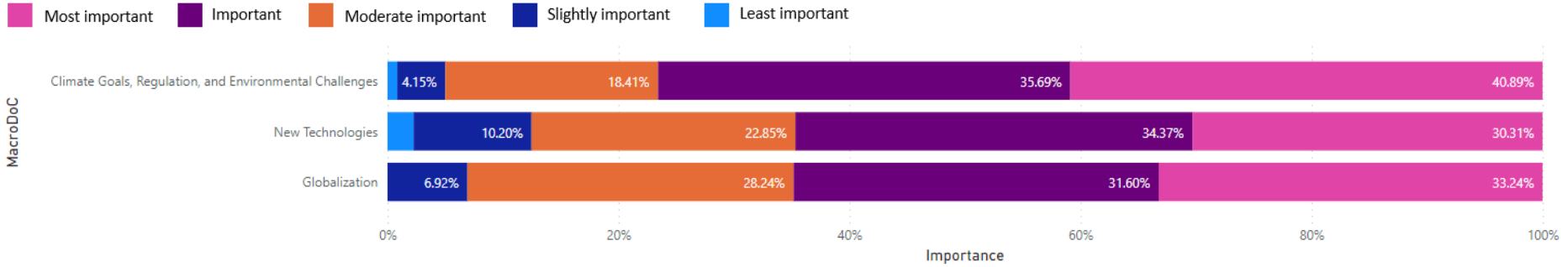

Figure 12 Overall Battery Sector

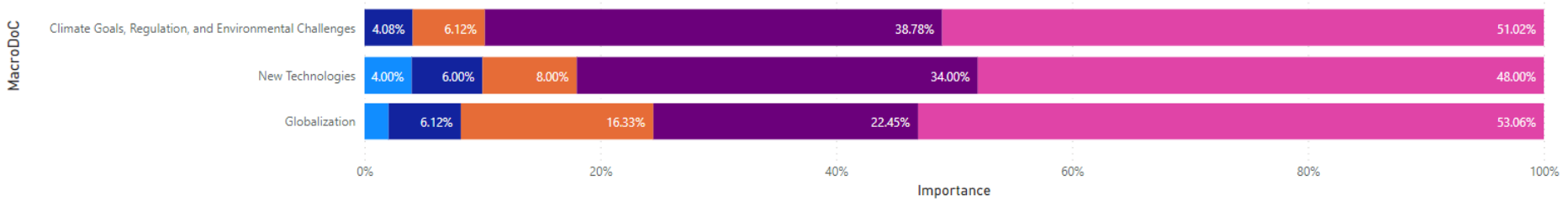

Figure 13 Stationary and Industrial Applications Sub-sector

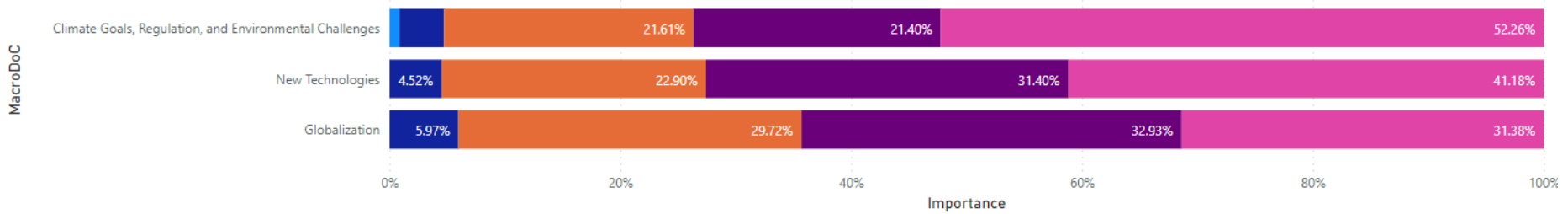

Figure 14 Mobile Applications Sub-sector

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A matrix with the three above mentioned macro categories was proposed, and respondents were asked to evaluate them based on their importance (**1 - least important**; **5 - most important**). The results for the overall sector (Figure 12) show that **climate goals, regulation and environmental challenges** is perceived as the most important category (40,89% rated it with "5"), followed by **globalization** at 33,24% and **new technologies** at 30,31%.

The distribution changes when considering Stationary: globalization is perceived as the most important category (53,06%) followed by climate goals, regulation, and environmental challenges (48,00%), as shown in Figure 13.

As for Mobile, it shows that **climate goals, regulation and environmental challenges** is the most important category (52,26% rated it with "most important") followed by new technologies and globalization respectively (41,18% and 31,38%).

2.2.1.1 Implications and Concrete Statements

According to the survey results:

- Around 40% of respondents for both sub-sectors agree that the battery sector is going to face major changes due to opportunities and challenges arising from climate goals, regulation, and environmental challenges.
- At the same time, the speed of globalization and the evolution of technologies that are certainly linked to climate change and the demand for new energy storage are going to have an impact on the sector across different levels.

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2.2.2 Urgency of Drivers of Change Groups – Macro Category

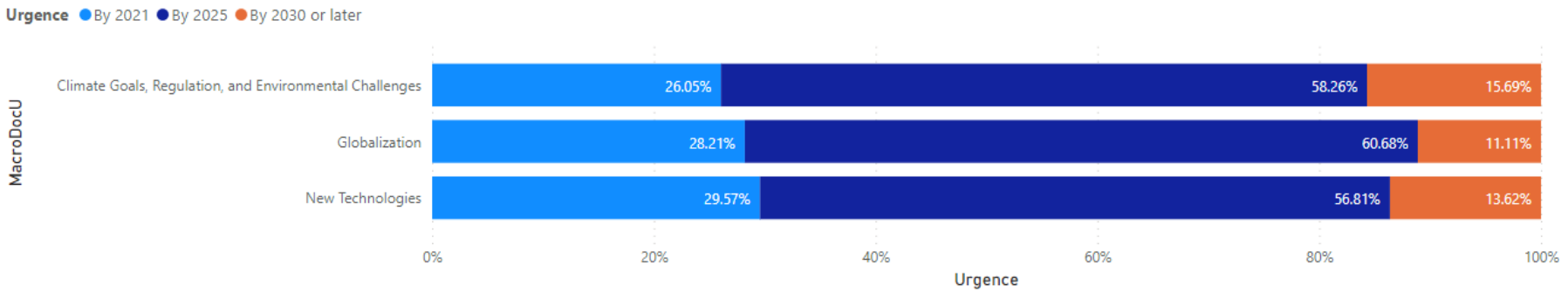

Figure 15 Overall Battery Sector

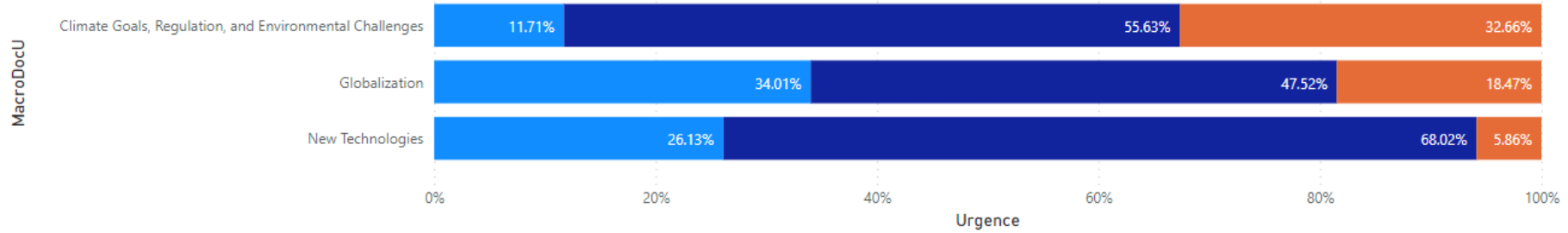

Figure 16 Stationary and Industrial Applications Sub-sector

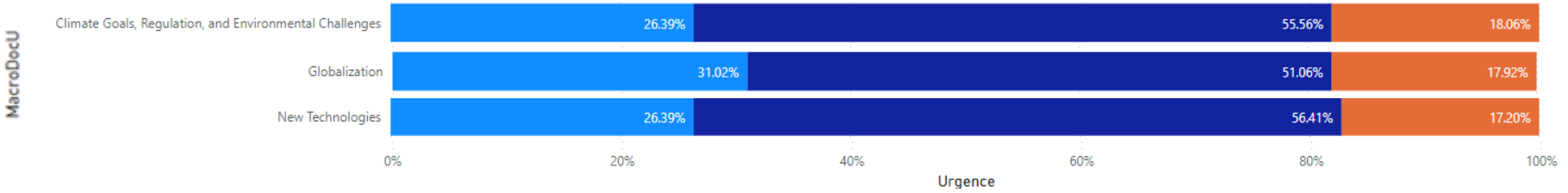

Figure 17 Mobile Applications Sub-sector

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A similar matrix has also been applied regarding the perceived urgency of the drivers of change (whether the macro category shall be addressed by 2021, 2025 or by 2030 or later). The results show that the urgency of all these macro categories is not equal, both from an overall perspective of the sector and when considering Stationary and Mobile. Regarding Stationary and Mobile, **globalization** is perceived as more urgent than the others (34,01%, 31,02%) as seen in Figure 17.

2.2.2.1 Implications and Concrete Statements

According to the survey results:

- Globalization and new technologies are going to have the greatest impacts by 2025.

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2.2.3 Climate Goals, Regulation, and Environmental Challenges – Importance

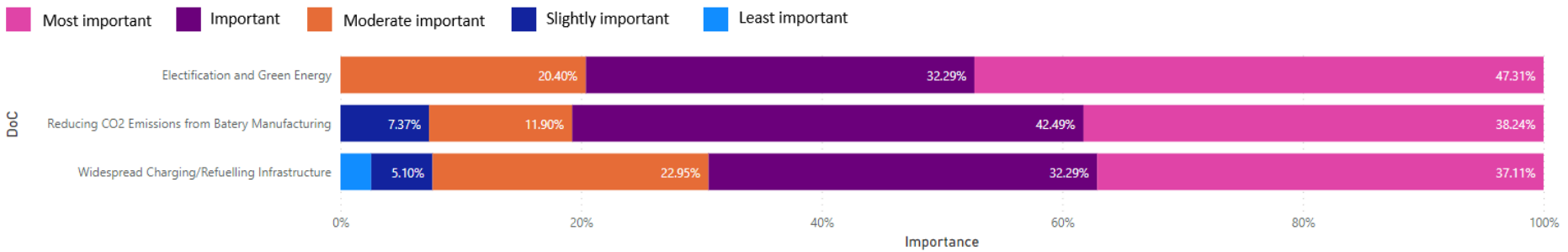

Figure 18 Overall Battery Sector

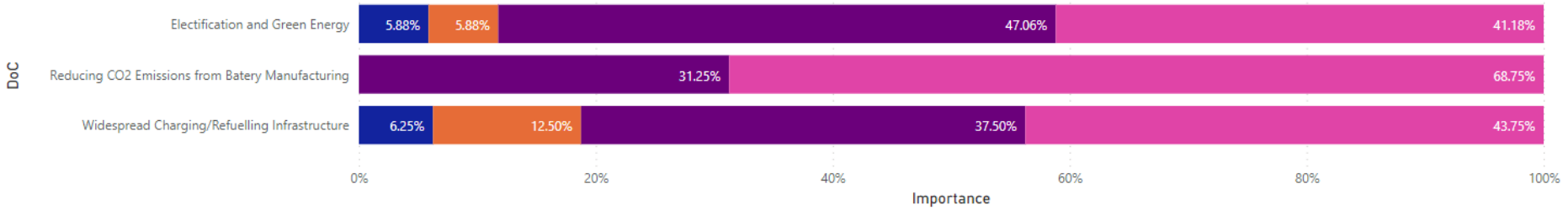

Figure 19 Stationary and Industrial Applications Sub-sector

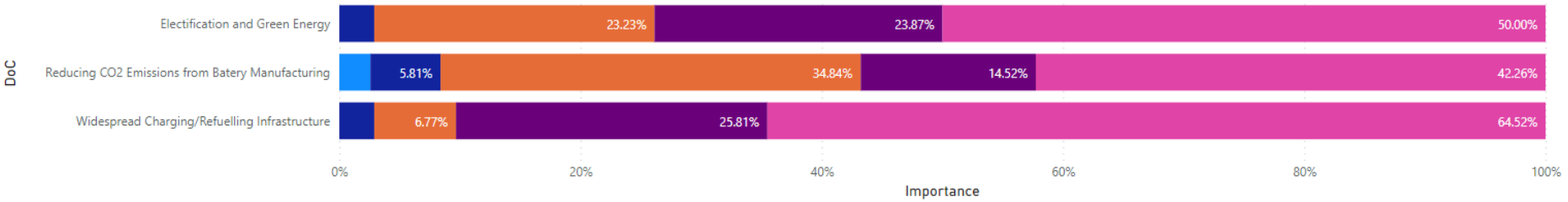

Figure 20 Mobile Applications Sub-sector

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According to results from an overall perspective, **electrification and green energy** is considered the most important (47,31% as Figure 18 shows).

The situation is different in Stationary (Figure 19), where we see that, for respondents, it is more important to focus on **reducing CO2 emissions** (68,75%). As for Mobile, it is instead perceived as most important to concentrate on **widespread charging/refuelling infrastructure (**64,52% as shown in Figure 20).

2.2.3.1 Implications and Concrete Statements

According to the survey results:

- Within the category of **climate goals, regulation, and environmental challenges**, we see that the results tend to change according to the perspective of each sub-sector. While for Mobile Applications, the demand for widespread charging infrastructure is a key driver, for Stationary, the mitigation of CO2 emissions from battery production seems to have greater importance.

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2.2.4 Climate Goals, Regulation, and Environmental Challenges – Urgency

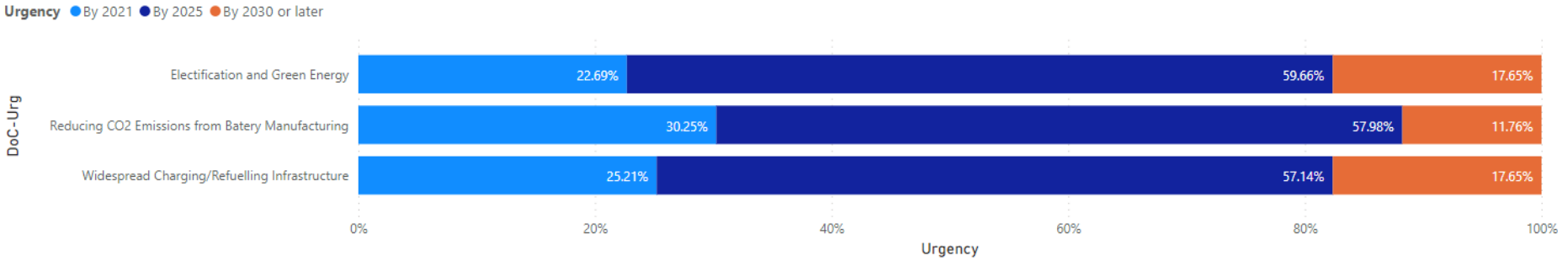

Figure 21 Overall Battery Sector

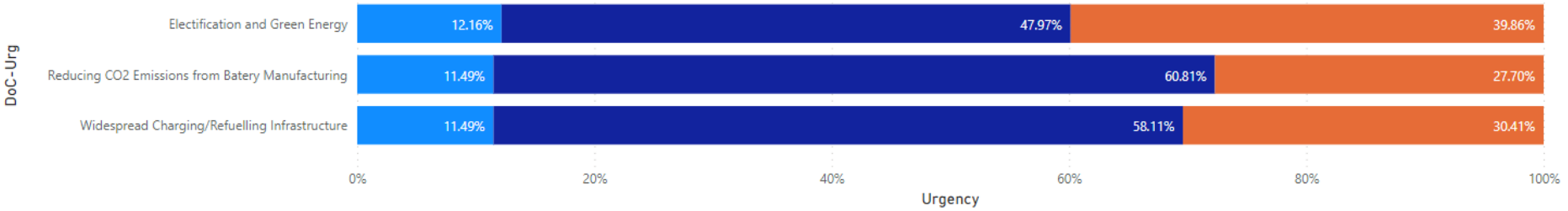

Figure 22 Stationary and Industrial Applications Sub-sector

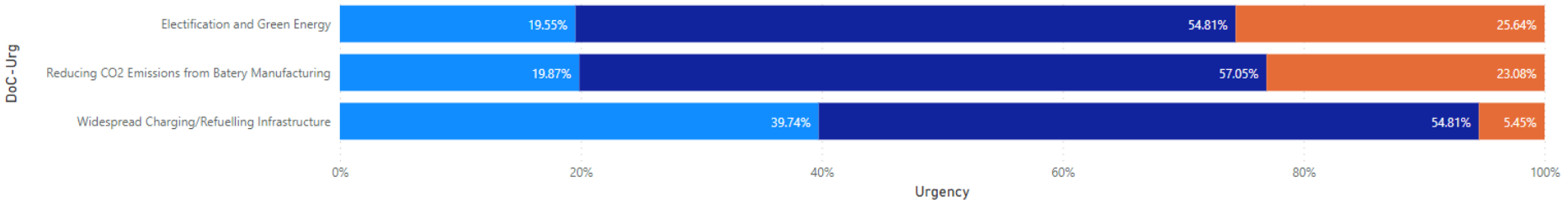

Figure 23 Mobile Applications Sub-sector

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Figure 21, Figure 22, Figure 23 analyse the urgency of the three sub-categories **electrification and green energy**, **reducing CO_2 emissions from battery manufacturing** and **widespread charging/refuelling infrastructure**. Overall, **reducing CO_2 emissions** is considered the most urgent (by 2021).

Regarding Stationary, we see that the three sub-categories have almost the same weight in terms of urgency by 2021, whereas **electrification and green energy** is the one to focus on in the longer term (39,86%) - by 2030 or later.

When considering Mobile, **widespread charging/refuelling infrastructure** (39,74%) is the most urgent sub-category.

2.2.4.1 Implications and Concrete Statements

According to the survey results:

- When focusing on urgency (although **reducing CO2 emissions from battery manufacturing** is key from an overall perspective), Mobile Applications tend to perceive as most urgent the **widespread charging/refuelling infrastructure**. This also confirms what has been stated in Figure 20, where this sub-category was also the most important to concentrate on.

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2.2.5 Globalization – Importance

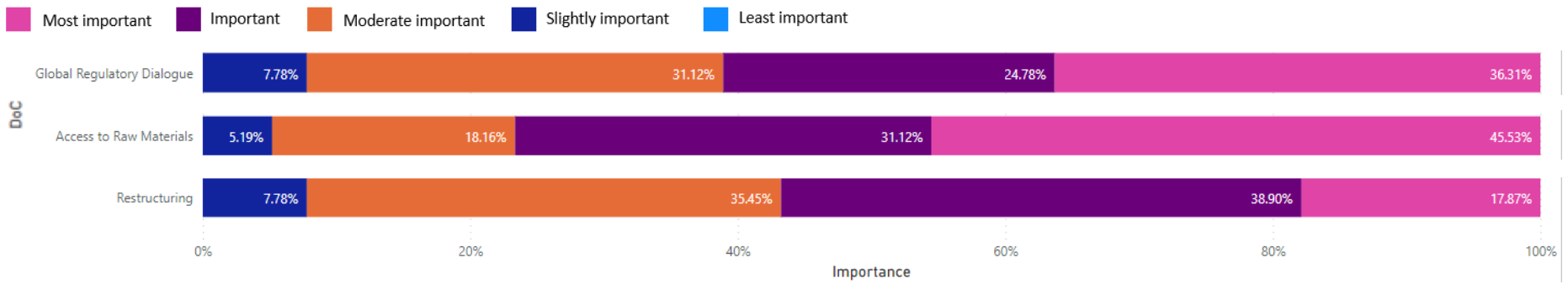

Figure 24 Overall Battery Sector

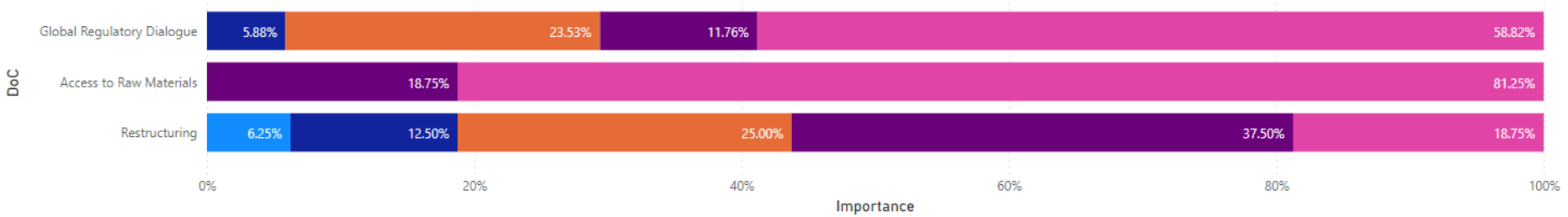

Figure 25 Stationary and Industrial Applications Sub-sector

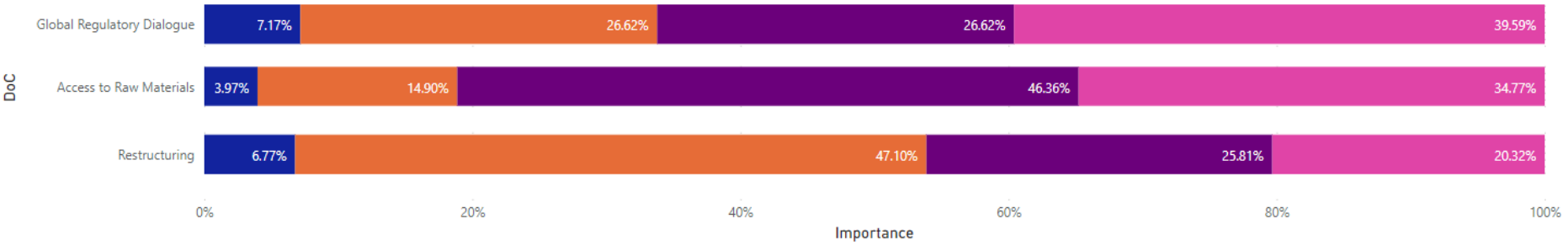

Figure 26 Mobile Applications Sub-sector

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The results from an overall perspective show that **access to raw materials** is the most important (45,53% - Figure 24).

This is widely confirmed when taking into consideration only the Stationary applications alone, where the same sub-category is considered as most important by 81,25% of respondents.

As for Mobile, the situation is slightly different: 39,59% of respondents perceive **global regulatory dialogue** as the most important sub-category.

2.2.5.1 Implications and Concrete Statements

According to the survey results:

- It is clear from an overall perspective that **activities linked to raw materials** are becoming crucial, and this is demonstrated by the very high percentage this sub-category has received especially for Stationary Applications.

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2.2.6 Globalization – Urgency

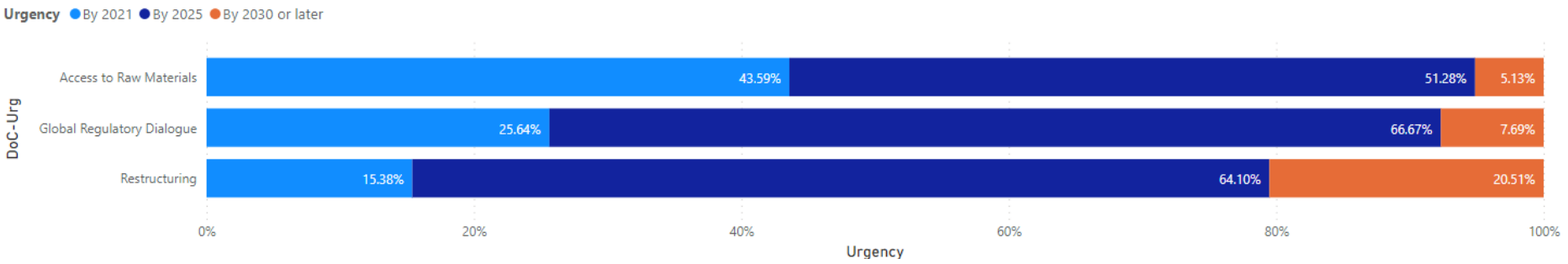

Figure 27 Overall Battery Sector

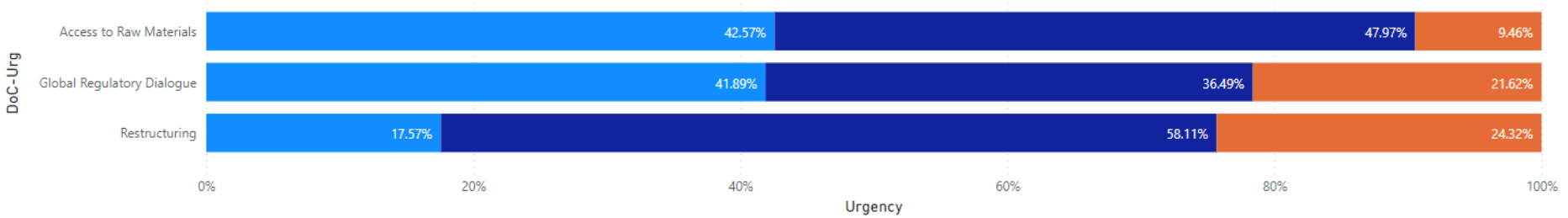

Figure 28 Stationary and Industrial Applications Sub-sector

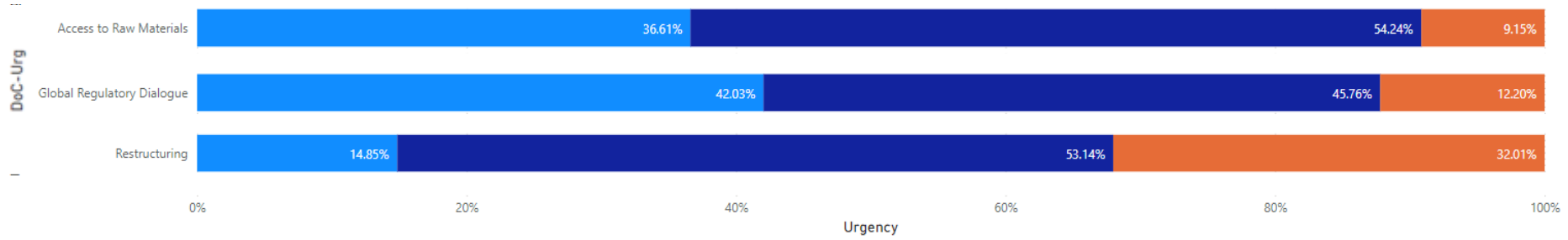

Figure 29 Mobile Applications Sub-sector

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Figure 27, Figure 28, and Figure 29 show the urgency of the three sub-categories within the macro category **Globalization**. Again, it is interesting to note that **access to raw materials** is also considered as the most urgent to tackle from an overall perspective (43,59% respondents said it should be addressed by 2021).

When analysing Stationary, **access to raw materials** and **global regulatory dialogue** have almost equal weight in terms of urgency by 2021 (42,75% and 41,89% respectively).

Global regulatory dialogue is instead perceived as the most urgent to focus on by Mobile applications (42,03%).

2.2.6.1 Implications and Concrete Statements

According to the survey results:

- While **access to raw materials** remains the most urgent and important from an overall perspective, attention should also be paid to **global regulatory dialogue**, especially from the perspective of Mobile Applications.

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2.2.7 New Technologies – Importance

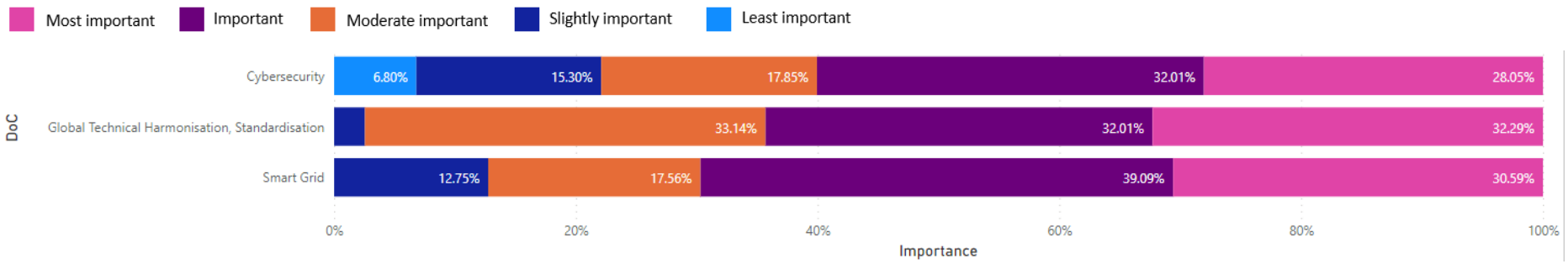

Figure 30 Overall Battery Sector

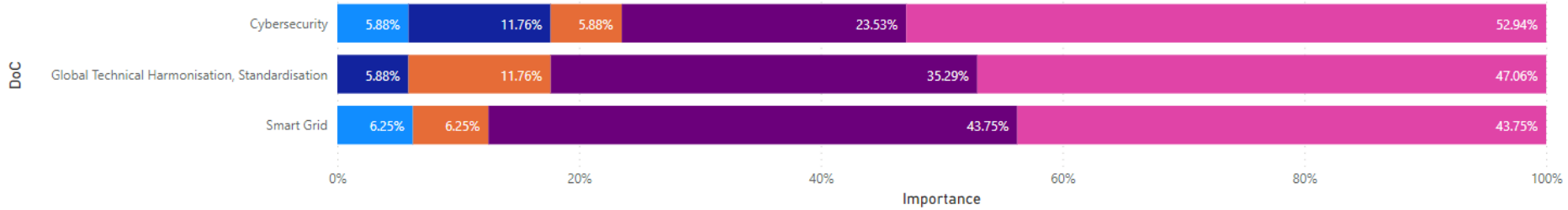

Figure 31 Stationary and Industrial Applications Sub-sector

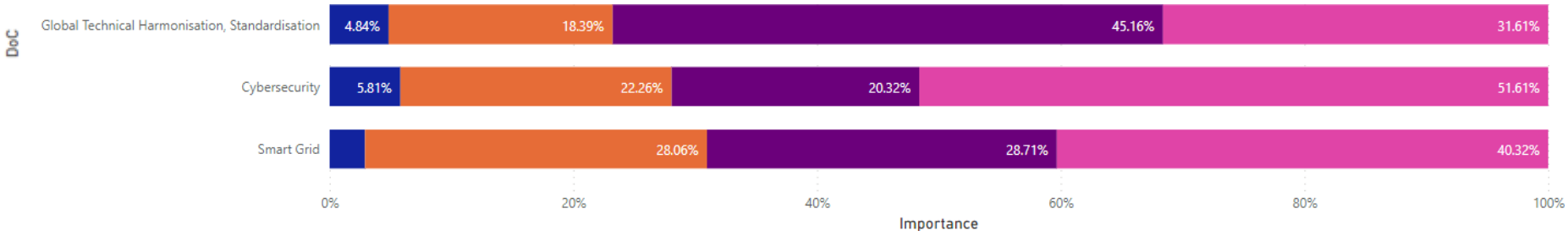

Figure 32 Mobile Applications Sub-sector

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When looking at the results from an overall perspective, the three sub-categories are almost equal in terms of importance, even though **global technical harmonisation and standardisation** received the highest number of votes (32,29 - Figure 30).

Regarding Stationary and Mobile, we see that, for respondents, it is most important to focus on **cybersecurity** (52,94% and 51,61%).

2.2.7.1 Implications and Concrete Statements

According to the survey results:

- Even if there are no huge differences among the three sub-categories, it is evident that cybersecurity is perceived as highly relevant when considering Mobile and/or Stationary Applications only, and therefore it is important that the industry think thoroughly about the security approach.

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2.2.8 New Technologies – Urgency

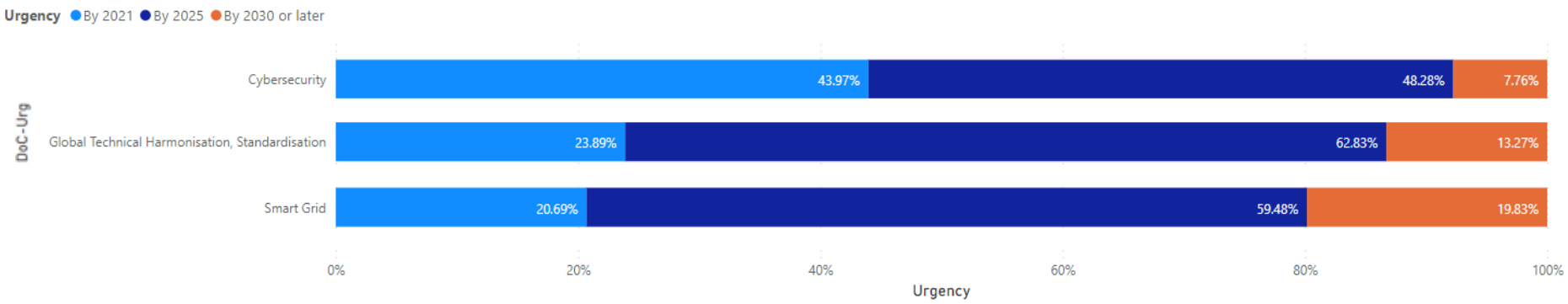

Figure 33 Overall Battery Sector

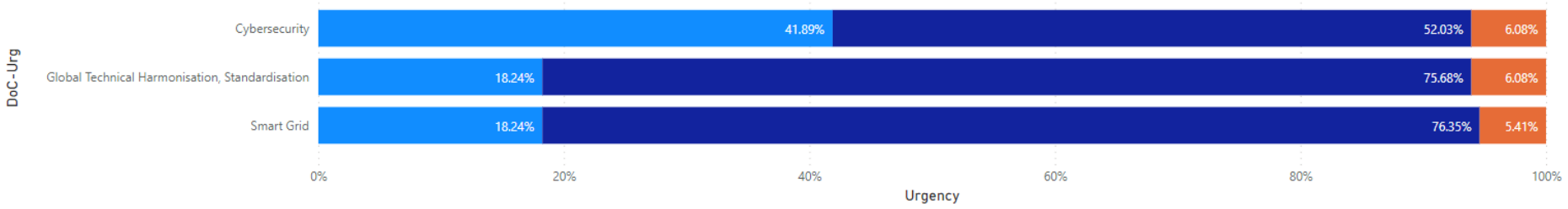

Figure 34 Stationary and Industrial Applications Sub-sector

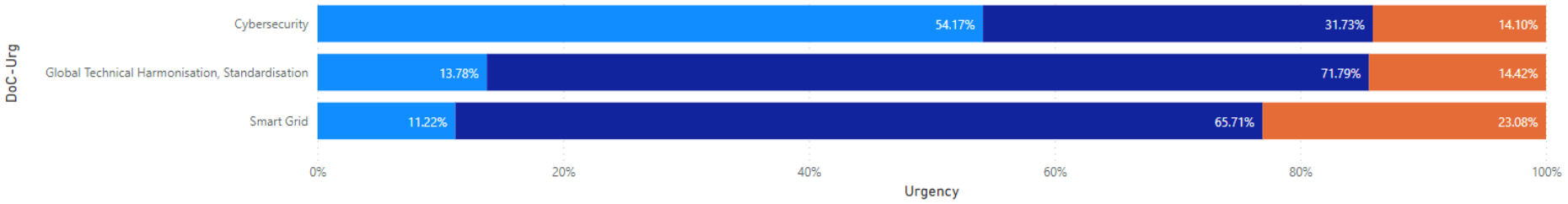

Figure 35 Mobile Applications Sub-sector

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Figure 33, Figure 34, and Figure 35 show the urgency of the three sub-categories within the macro category of **new technologies**.

The overall battery perspective tells us that **cybersecurity** is the most urgent sub-category to tackle by 2021 (43,97%), and this is strongly confirmed when analysing both Stationary and Mobile Applications, where 41,89% and 54,17% of respondents confirm the urgency to address **cybersecurity** issues.

2.2.8.1 Implications and Concrete Statements

According to the survey results:

- When considering new technologies, the battery sector and its sub-sectors perceive the need to address **cybersecurity** as most important and most urgent, in order to guarantee resilience to cyber-attacks as well as customer privacy and security.

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2.2.9 Suggested Drivers of Change and Additional Questions

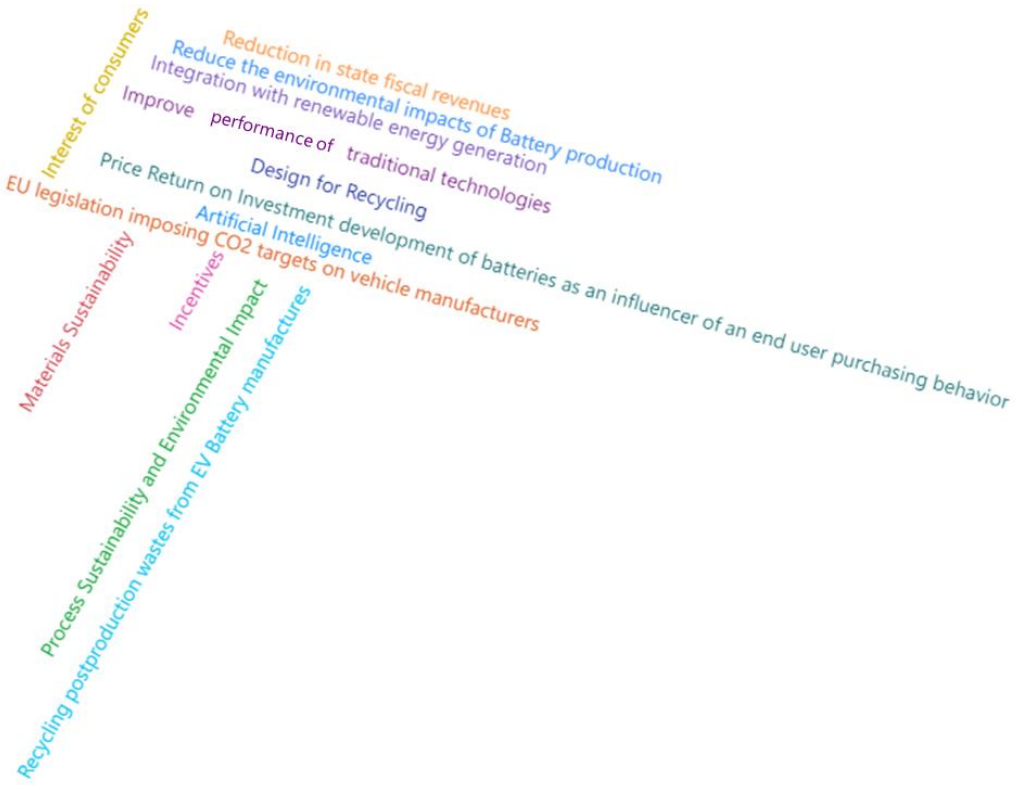

Figure 36 Suggested Drivers of Change

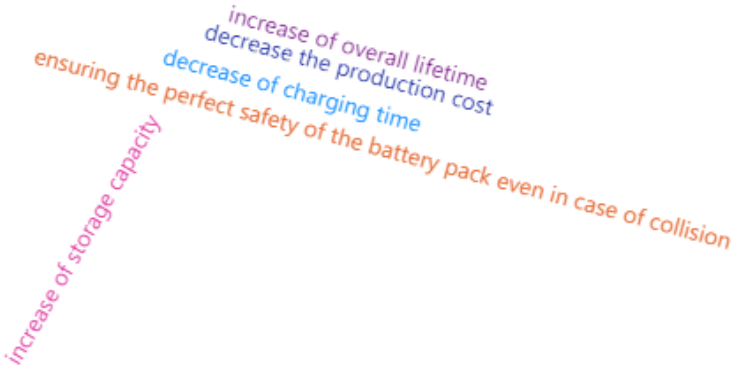

Figure 37 Needed Improvements on Batteries in the Future

Figure 38 Most Urgent Challenges of Battery Sector

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Respondents were also asked to list other drivers of change that they perceived as important and urgent to focus on, as well as the aspects that need to be improved on batteries in the future and the most urgent challenges of the sector. As we can see in Figure 36, Figure 37 and Figure 38, there are several suggestions:

- For drivers of change, some of them refer to the macro categories described above (e.g. materials sustainability), whereas others belong to other categories (e.g. interest of consumers).
- Regarding the improvement on batteries in the future, reference was made to decreasing production cost and charging time, but also increasing overall lifetime and storage capacity.
- Regarding the challenges, lack of proper instructions, separation of materials and storage in view of the recycling are considered crucial aspects to be addressed.

2.2.9.1 Implications and Concrete Statements

According to the survey results:

- It is important to take into account the suggestions of the respondents in order to enrich further research by adding and/or revising the drivers of change, the main challenges and the improvements to be made for the future of the battery sector.

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2.2.10 Covid-19 Effect

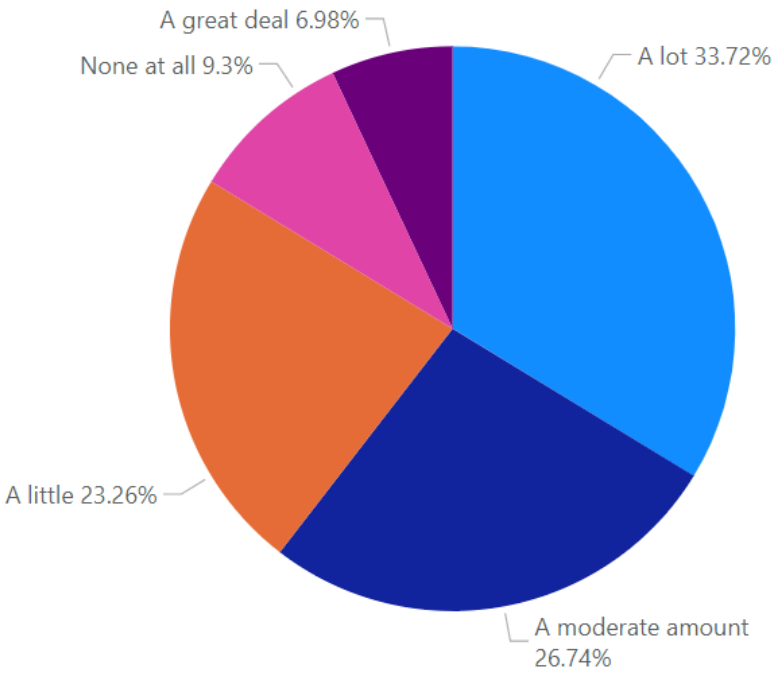

Figure 39 Covid-19 Impact on the Business

2.2.10.1 Implications and Concrete Statements

The survey has investigated also the COVID-19 effects and impacts on the business at sectoral level. Figure 39 shows very diversified perceptions: 33,72% of the respondents reported that there have been a lot of impacts on the general business, whereas 26,74% reported a moderate amount of negative effects, and 23,26% stated that it was little.

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2.3 JOB ROLE AND SKILLS

2.3.1 Overview of the Job Roles

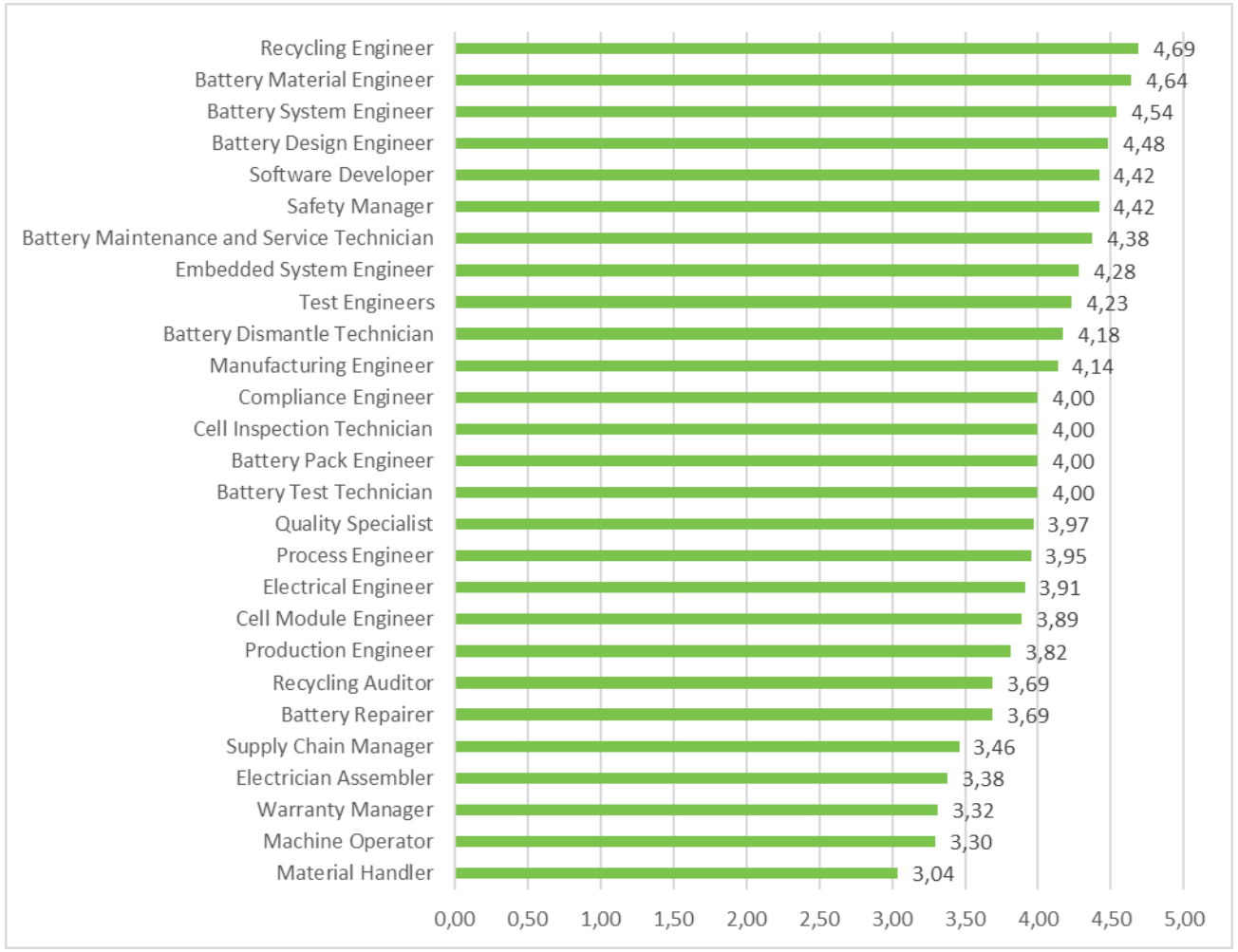

Figure 40 Overall Battery Sector

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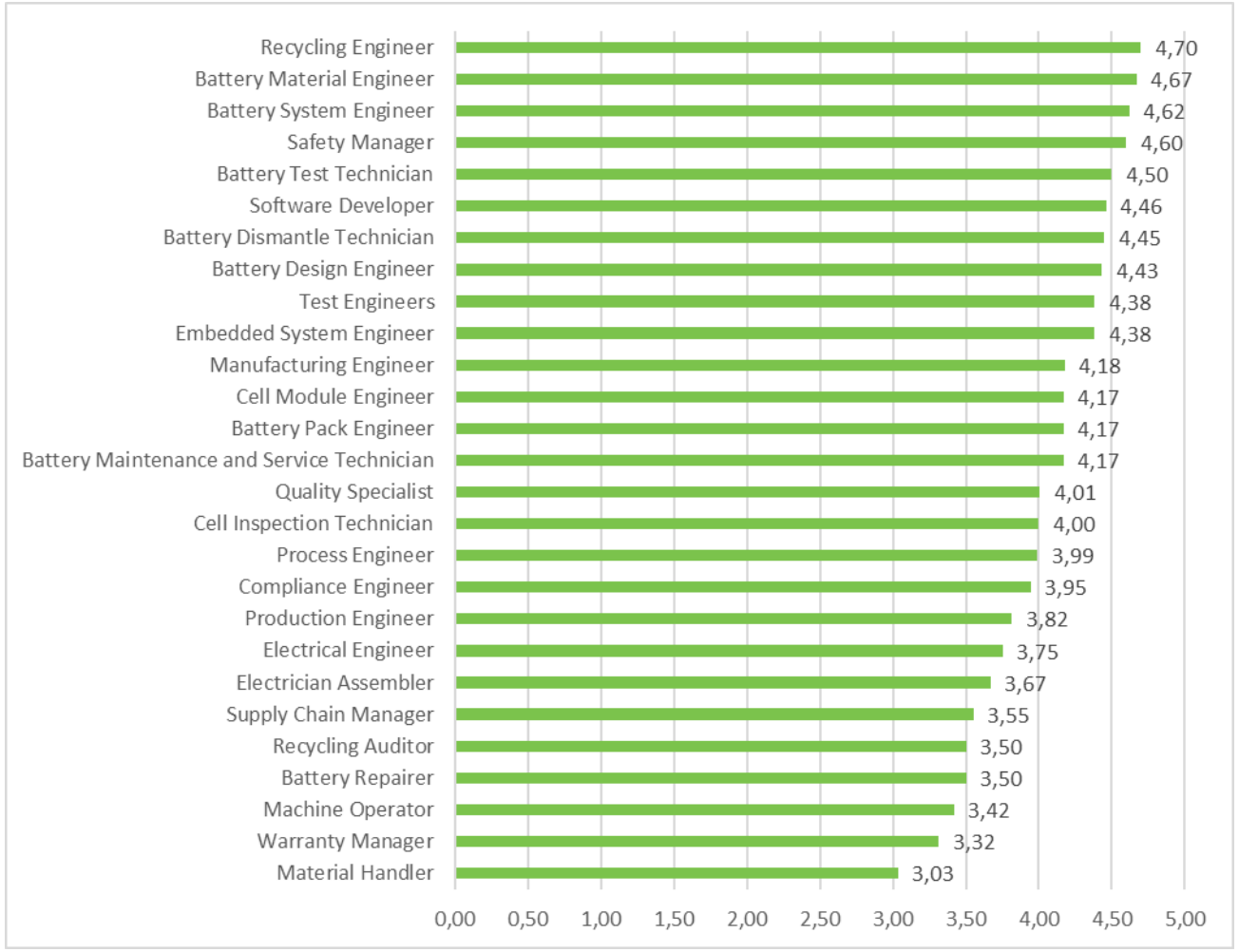

Figure 41 Stationary and Industrial Applications Sub-sector

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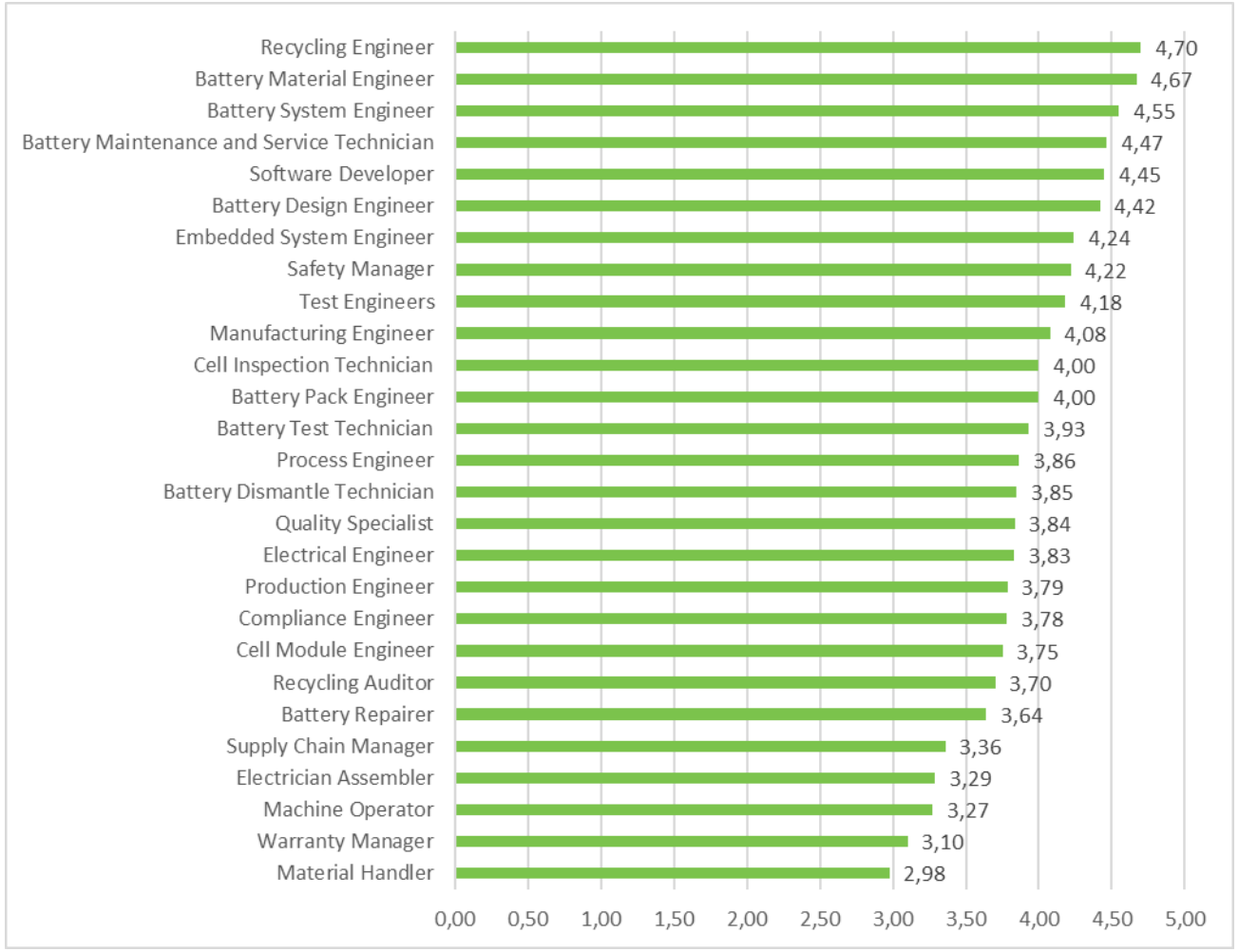

Figure 42 Mobile Applications Sub-sector

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Overall, the recycling engineer is valued as the most important job role in every application sub-sector. When comparing application sub-sectors, it is visible that battery maintenance and service technician are valued more in mobile application sub-sector (4,47) than in stationary/industrial applications sub-sector (4,17), whereas this is not the case for battery dismantle technician – being valued more in the stationary/industrial applications sub-sector (4,45) than in mobile applications sub-sector (3,85). Material handlers and machine operators are seen as the least important job roles.

2.3.1.1 Implications and Concrete Statements

According to the survey results:

- Machine operators and material handlers are seen as the least important by the majority of the respondents.
- Recycling engineer is seen as the most important job role by the majority of the respondents.

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2.3.2 Job Roles Index – Raw Materials and Processing

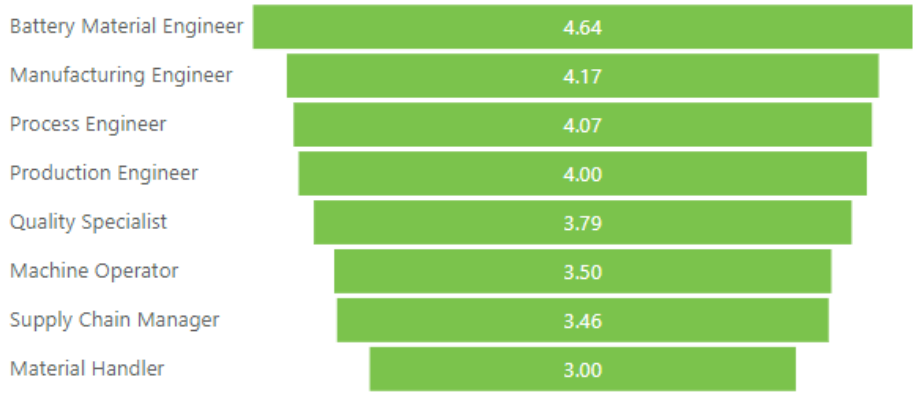

Figure 43 Overall Battery Sector

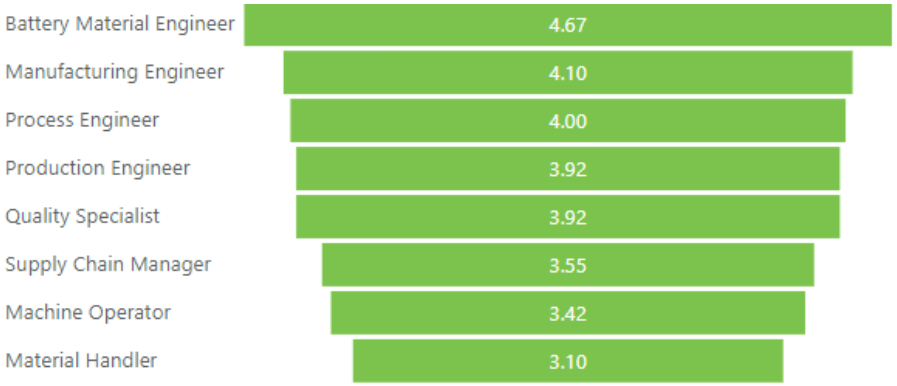

Figure 44 Stationary and Industrial Applications Sub-sector

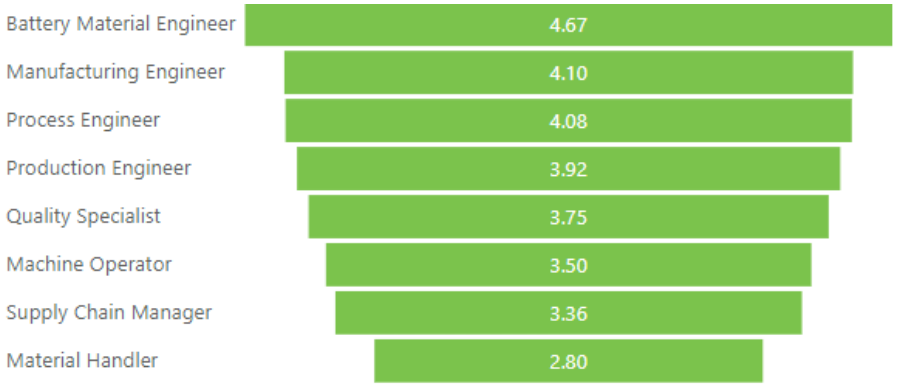

Figure 45 Mobile Applications Sub-sector

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From the overall point of view (Figure 43) and from the evaluation of selected job roles for the raw materials and processing battery supply chain it is clear that most of the respondents are active in both sub-sectors. **Material handlers**, on the other hand, are seen as more important in stationary and other industrial applications sub-sector (3.10 - Figure 44) in comparison to mobile applications (2.80 - Figure 45).

2.3.2.1 Implications and Concrete Statements

According to the survey results:

- majority of respondents active in the raw materials and processing are active in both battery application subsectors;
- machine operators are being considered more important in mobile battery applications subsector;
- battery material engineers and manufacturing engineers are considered the most important;
- machine operators and material handlers are considered the least important.

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2.3.3 Job Roles Index – Components and Cell Manufacturing

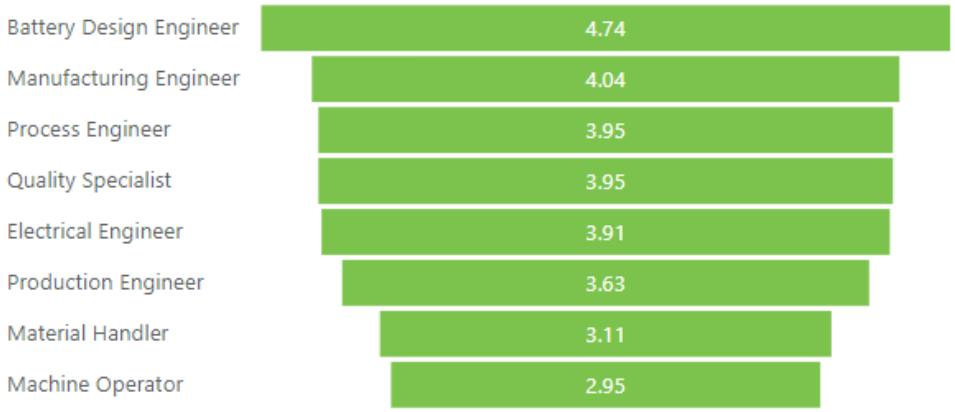

Figure 46 Overall Battery Sector

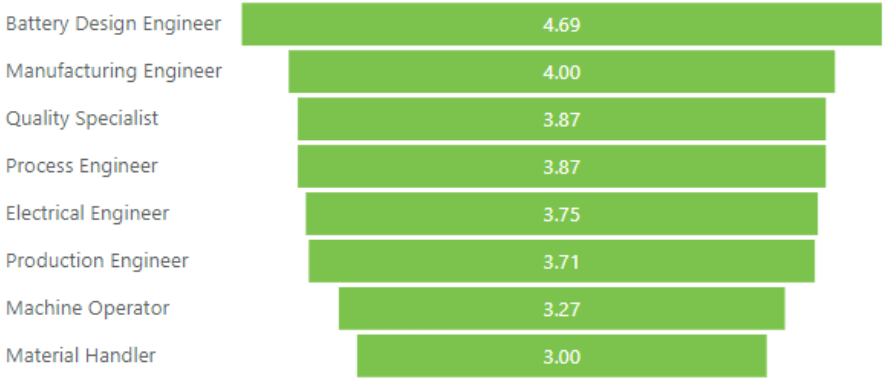

Figure 47 Stationary and Industrial Applications Sub-sector

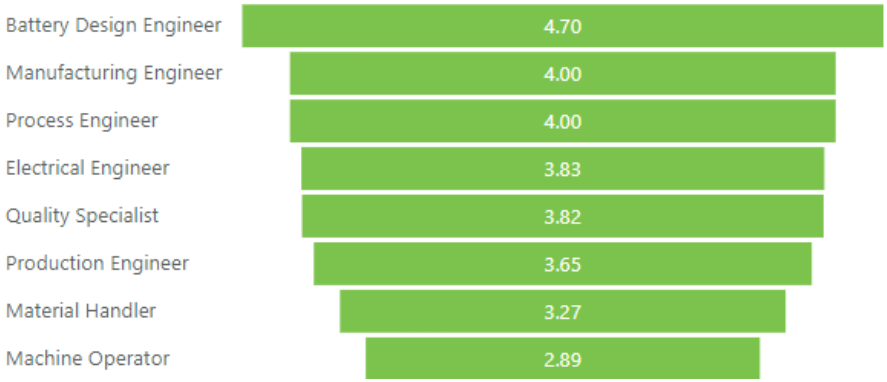

Figure 48 Mobile Applications Sub-sector

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Results for the importance of components and cells manufacturing job roles are consistent throughout the whole battery sector (Figure 46). The most important job roles would be battery design engineers (4,74) for the whole battery sector, as well as manufacturing engineers (4,04). There are differences between the order of process engineers, quality specialists and electrical engineers when it comes to the battery application sub-sectors (Figure 47, Figure 48).

2.3.3.1 Implications and Concrete Statements

According to the survey results:

- majority of respondents active in the raw materials and processing are active in both battery application subsectors;
- machine operators are considered more important in the mobile battery applications subsector;
- battery design engineers and manufacturing engineers are considered the most important;
- machine operators and material handlers are considered the least important.

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2.3.4 Job Roles Index – Module and Pack Manufacturing

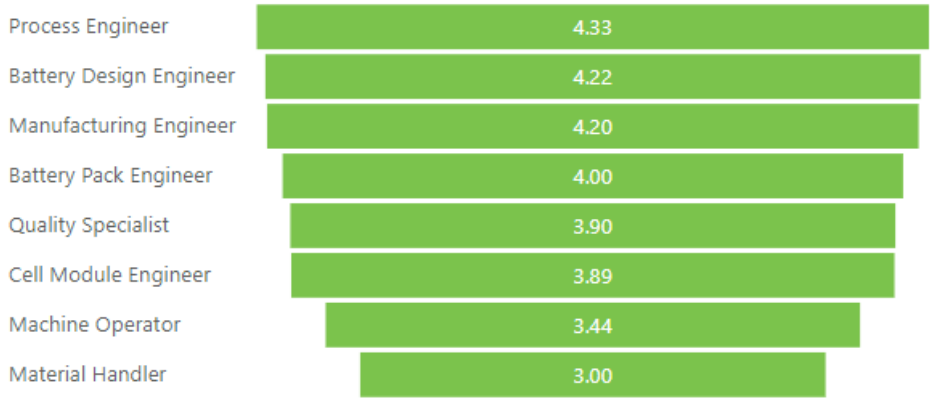

Figure 49 Overall Battery Sector

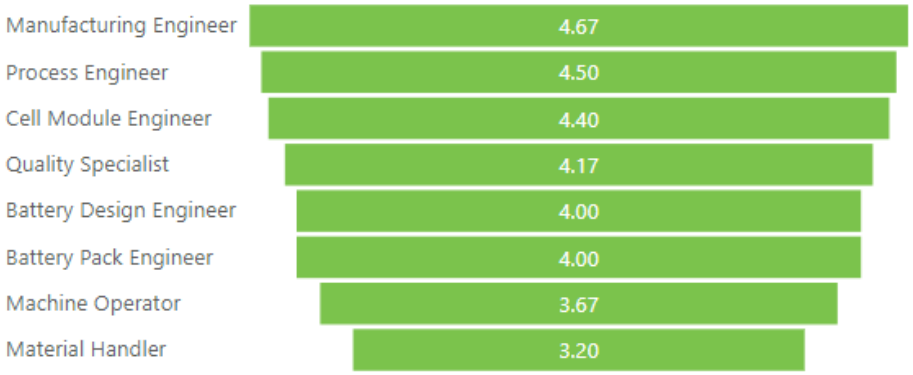

Figure 50 Stationary and Industrial Applications Sub-sector

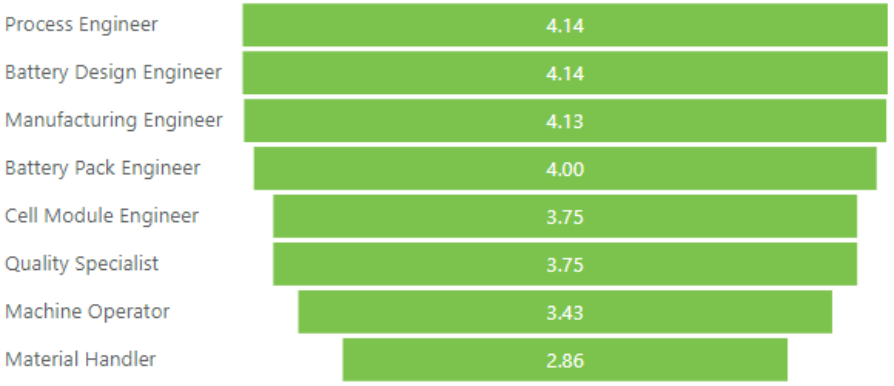

Figure 51 Mobile Applications Sub-sector

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Regarding the module and pack manufacturing, the process engineers are considered to be the most important throughout the application sub-sectors (Figure 50 and Figure 51). This differs in stationary and other industrial applications sub-sector (Figure 50), where the most important job role is considered to be manufacturing engineer (4,67).

2.3.4.1 Implications and Concrete Statements

According to the survey results:

- machine operators are considered more important in the mobile battery applications subsector;
- process engineers and battery design engineers are considered the most important for the whole battery sector and the mobile application sub-sector;
- manufacturing engineers, process engineers and cell module engineers are considered the most important for the stationary and other industrial applications sub-sector;
- overall, the job roles that are present in the module and pack manufacturing are considered more important in stationary and other industrial application than in the mobile sub-sector.
- machine operators and material handlers are considered the least important overall (Figure 49).

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2.3.5 Job Roles Index – Battery Integration

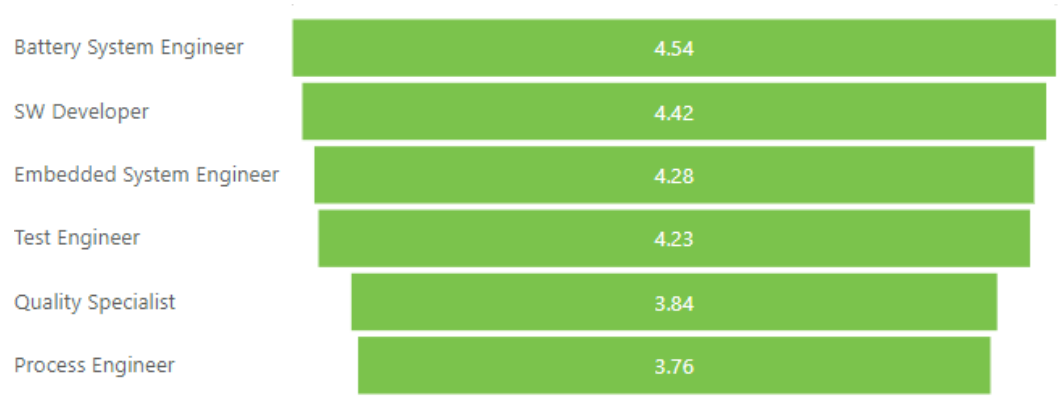

Figure 52 Overall Battery Sector

Figure 53 Stationary and Industrial Applications Sub-sector

Figure 54 Mobile Applications Sub-sector

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Battery integration shows consistent results throughout the whole battery sector (Figure 52). Battery system engineers are considered the most important, as well as the software developers.

2.3.5.1 Implications and Concrete Statements

According to the survey results:

- Battery system engineers and software developers are considered the most important throughout the whole battery sector;
- quality specialists and process engineers are considered the least important throughout the whole battery sector.

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2.3.6 Job Roles Index – Operation, Repair, and Maintenance

Figure 55 Overall Battery Sector

Figure 56 Stationary and Industrial Applications Sub-sector

Figure 57 Mobile Applications Sub-sector

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The results concerning the operation, repair, and maintenance job roles show the quality specialist as the most important overall (4,06 - Figure 55), and in the mobile applications sub-sector (4,14 - Figure 57), which is not the case for the stationary sub-sector and other industrial applications (3,67 - Figure 56), where the most important job role is considered to be the battery test technician (4,50). Overall, the second most important job role is cell inspection technician. The least important job role is considered to be electrician assembler overall (3,38), and in the mobile application sub-sector (3,29) (in stationary and other industrial applications this is not the case).

2.3.6.1 Implications and Concrete Statements

According to the survey results:

- Cell inspection technicians and quality specialists are considered the most important overall and in the mobile applications sub-sector;
- battery repairers are considered to be the least important overall.

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2.3.7 Job Roles Index – Second Life of Batteries

Figure 58 Overall Battery Sector

Figure 59 Stationary and Industrial Applications Sub-sector

Figure 60 Mobile Applications Sub-sector

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Second life of batteries had a lower response rate than other value chain steps. Battery dismantle technician is considered as the most important in overall (5 - Figure 58) with quality specialist (4,67) and battery maintenance and service technician (4,5) right behind. Results are consistent throughout the battery sector with warranty manager being the least important (3.33).

2.3.7.1 Implications and Concrete Statements

According to the survey results:

- Battery dismantle technicians, battery maintenance and service technicians and quality specialists are considered the most important overall;
- warranty manager is considered the least important.

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2.3.8 Job Roles Index – Battery Recycling

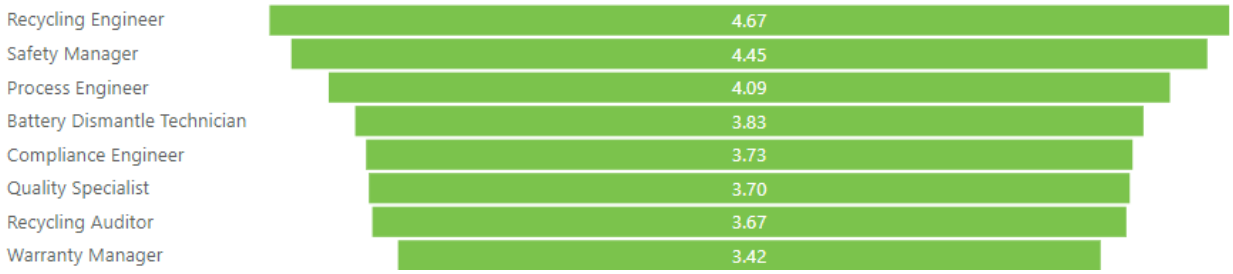

Figure 61 Overall Battery Sector

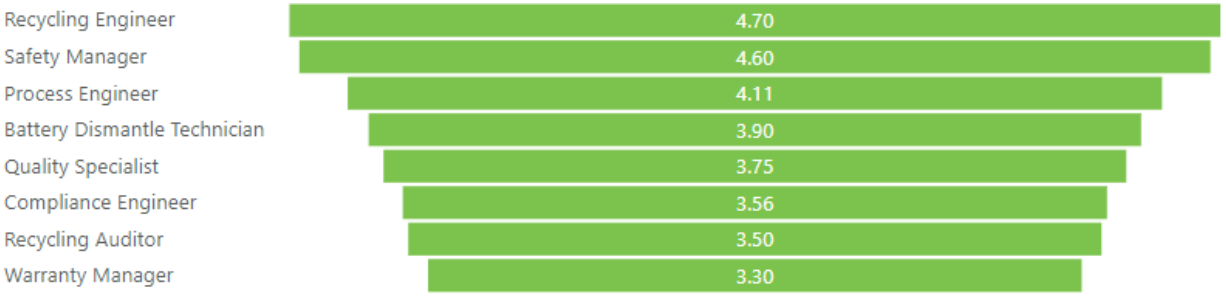

Figure 62 Stationary and Industrial Applications Sub-sector

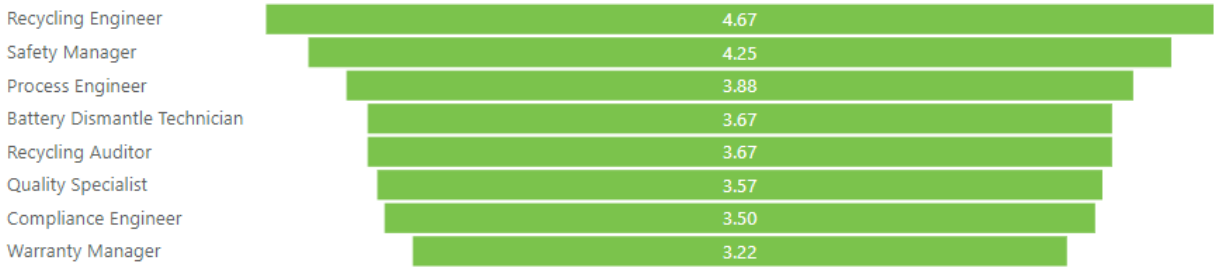

Figure 63 Mobile Applications Sub-sector

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Battery recycling shows very consistent results throughout the battery sector with recycling engineer (4,67 - Figure 61) being the most important and warranty managers being (3,3) the least important. Stationary and other industrial applications responses show higher scores than other applications (Figure 62).

2.3.8.1 Implications and Concrete Statements

According to the survey results:

- the most important job roles overall are the recycling engineers and safety managers;
- the least important job roles overall are the recycling auditors and warranty managers;
- all the job roles are more important for the stationary and other industrial applications than other sub-sectors.

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2.3.9 Suggested Job Roles and Additional Questions

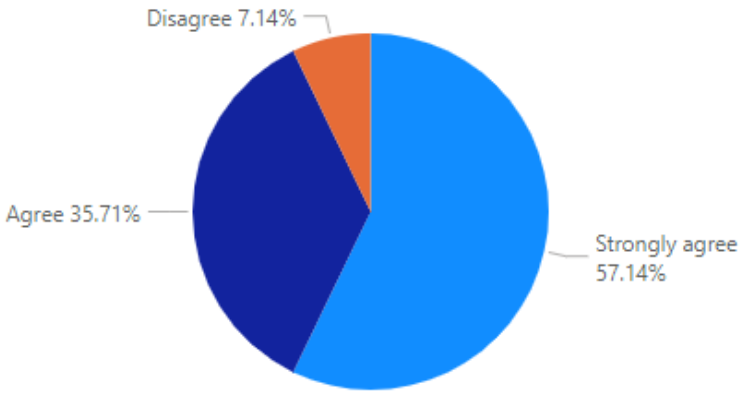

Figure 64 Fire Rescue and Risk Mitigation Job Roles Needed in the Future

Figure 65 Other Job Roles

Respondents had an opportunity to suggest other job roles (Figure 65) that are, in their opinion, highly demanded. Responses include the following job roles: data analysts, research and development related job roles, safety specialists, sales and purchasing, and many more. Additionally, we have asked if fire rescue and risk mitigation job roles will be needed in the future. Majority of the respondents strongly agreed (57,14%, responses for the overall sector in Figure 64).

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2.3.9.1 Implications and Concrete Statements

According to the survey results:

- Fire rescue and risk mitigation job roles will be needed in the future;
- other job roles important for the sector include following:
  - Research and Development,
  - safety,
  - development and sustainability,
  - human resources,
  - sales, purchasing and circular economy,
  - automation,
  - legislation.

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2.3.10 Skills Index – Soft and Transversal Skills/Competence and Knowledge

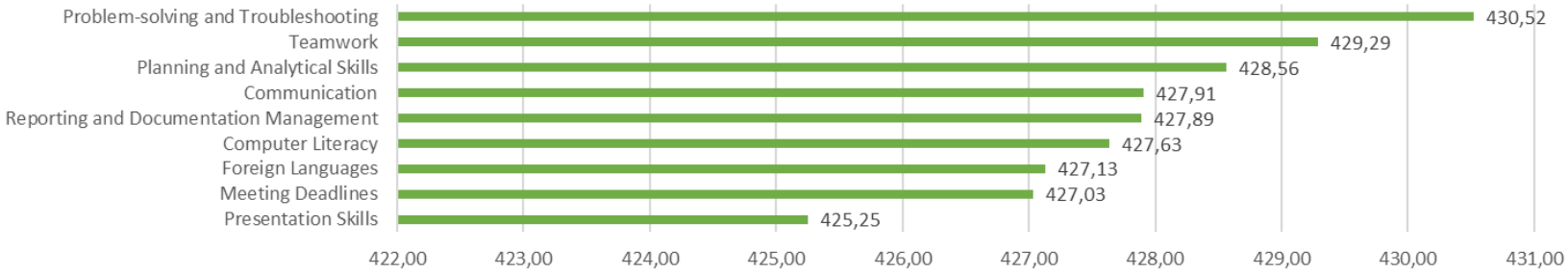

Figure 66 Overall Battery Sector

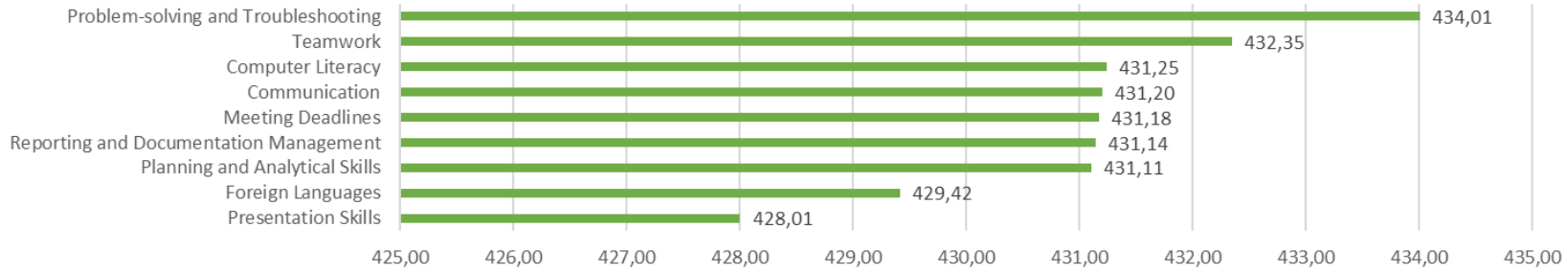

Figure 67 Stationary and Industrial Applications Sub-sector

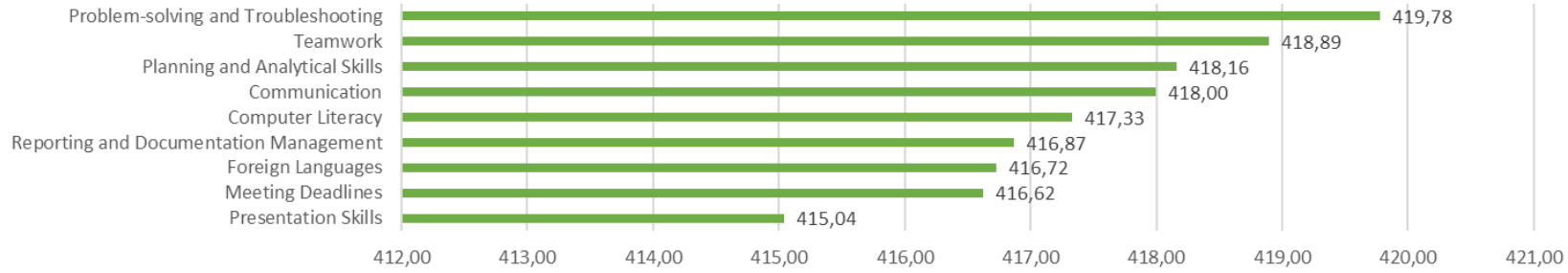

Figure 68 Mobile Applications Sub-sector

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Skills index for the soft and transversal skills/competence and knowledge shows the overall importance of problem-solving and troubleshooting followed by teamwork, planning and analytical skills (Figure 66). Planning and analytical skills are not as important in the stationary and other industrial applications sub-sector (Figure 67) as seen by stakeholders; more value is given to computer literacy. Presentation skills are seen as the least important overall.

2.3.10.1 Implications and Concrete Statements

According to the survey results:

- problem-solving and troubleshooting is perceived as the most important overall;
- presentation skills are considered the least important.

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2.3.11 Skills Index – Sector Specific Skills/Competence and Knowledge

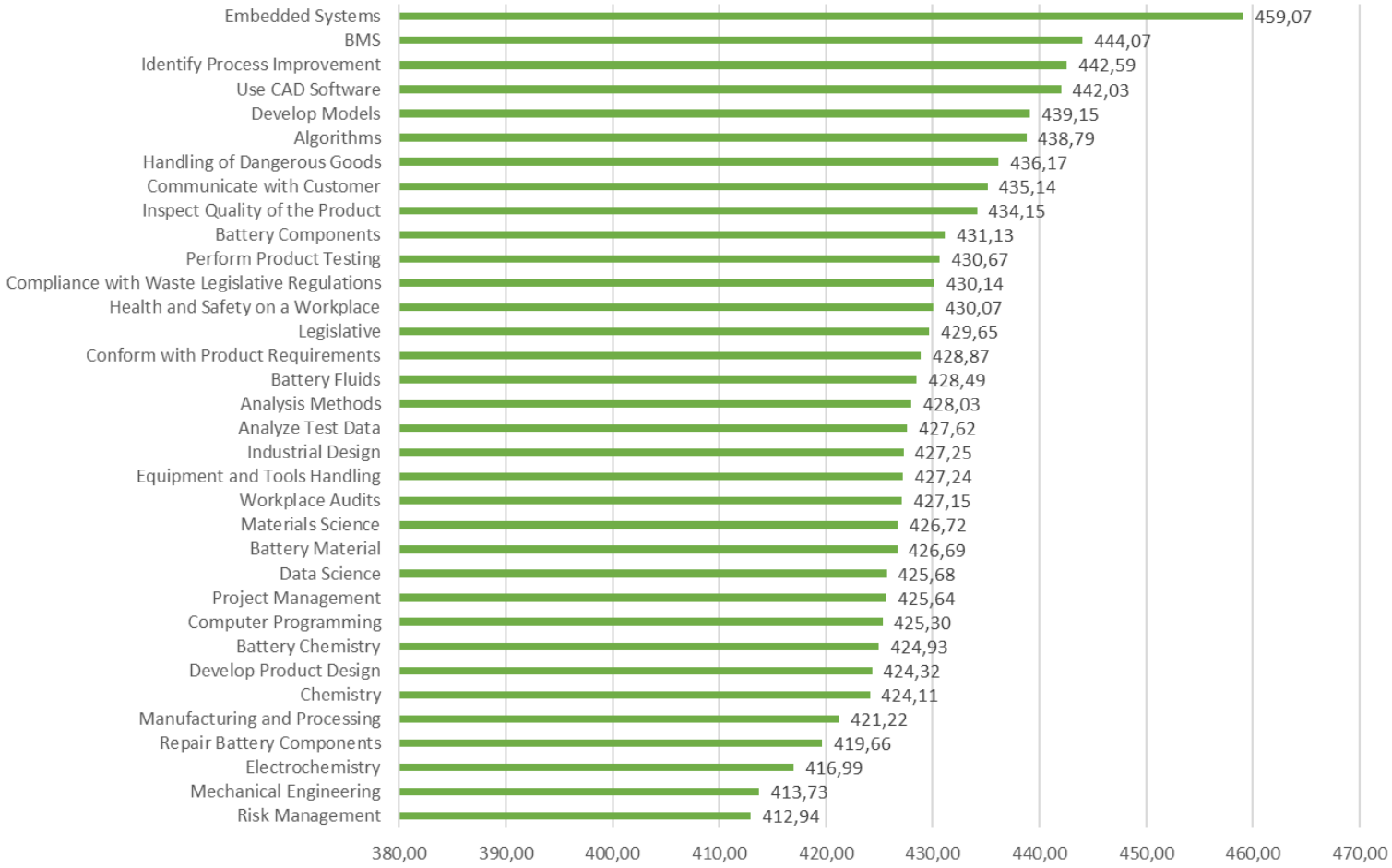

Figure 69 Overall Battery Sector

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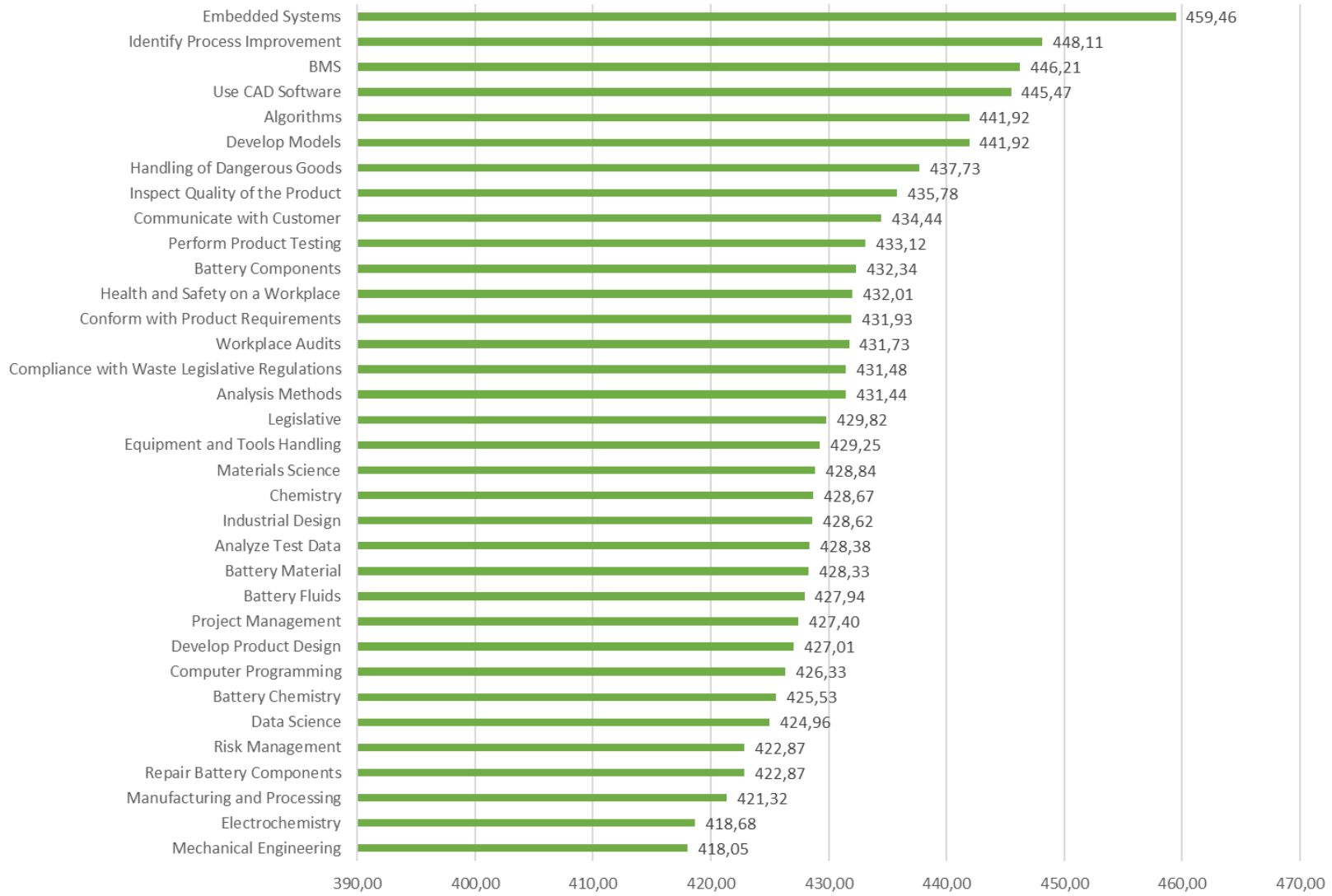

Figure 70 Stationary and Industrial Applications Sub-sector

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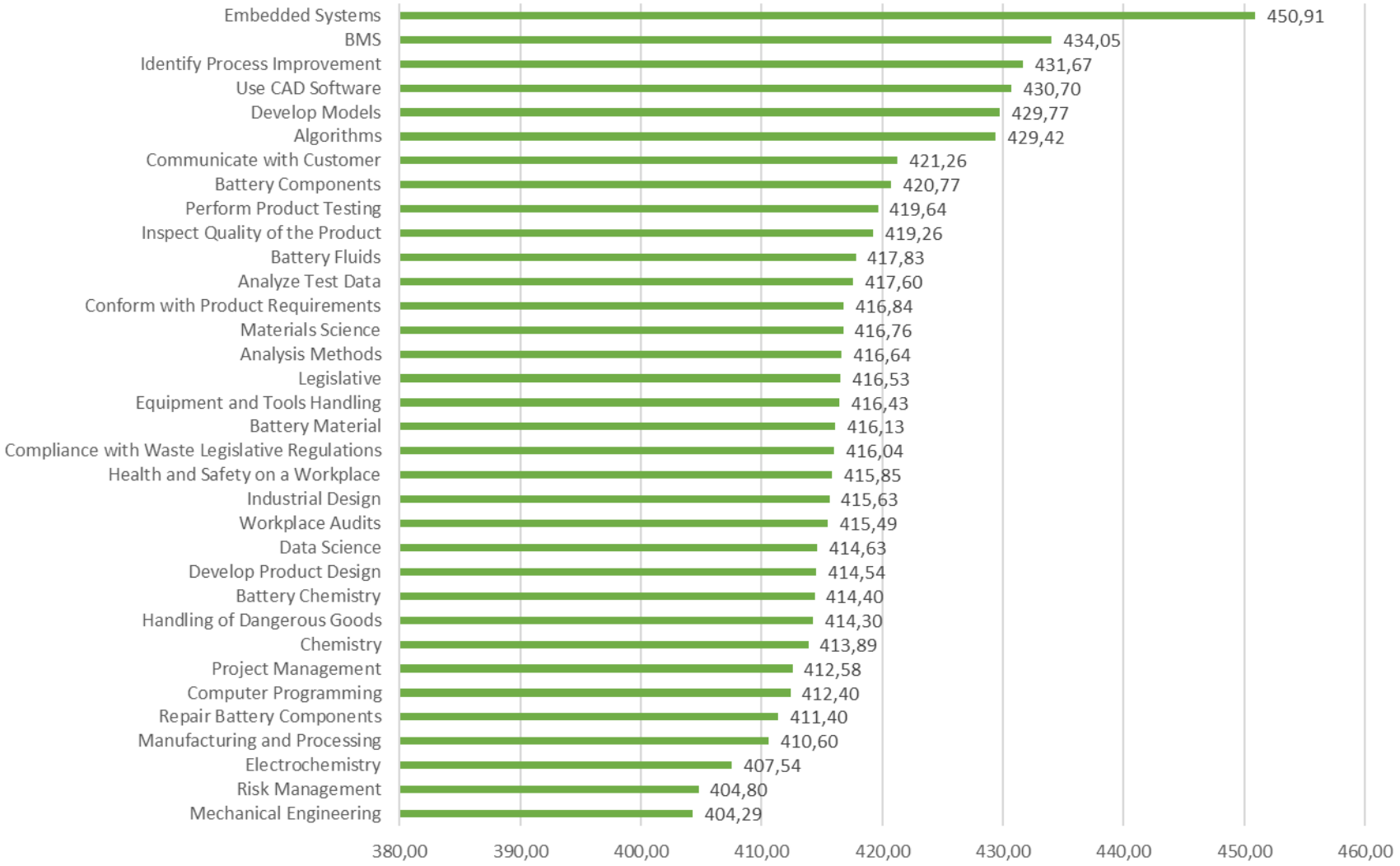

Figure 71 Mobile Applications Sub-sector

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Sector specific skills/competences and knowledge show that the embedded system and battery management systems are the most important throughout the whole sector; identification of process improvement is also important.

2.3.11.1 Implications and Concrete Statements

According to the survey results:

- embedded and battery management systems are in high demand;
- chemistry topics are valued more in the stationary application battery sector;

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2.4 SECTOR ATTRACTIVENESS

2.4.1 Attractiveness Factors

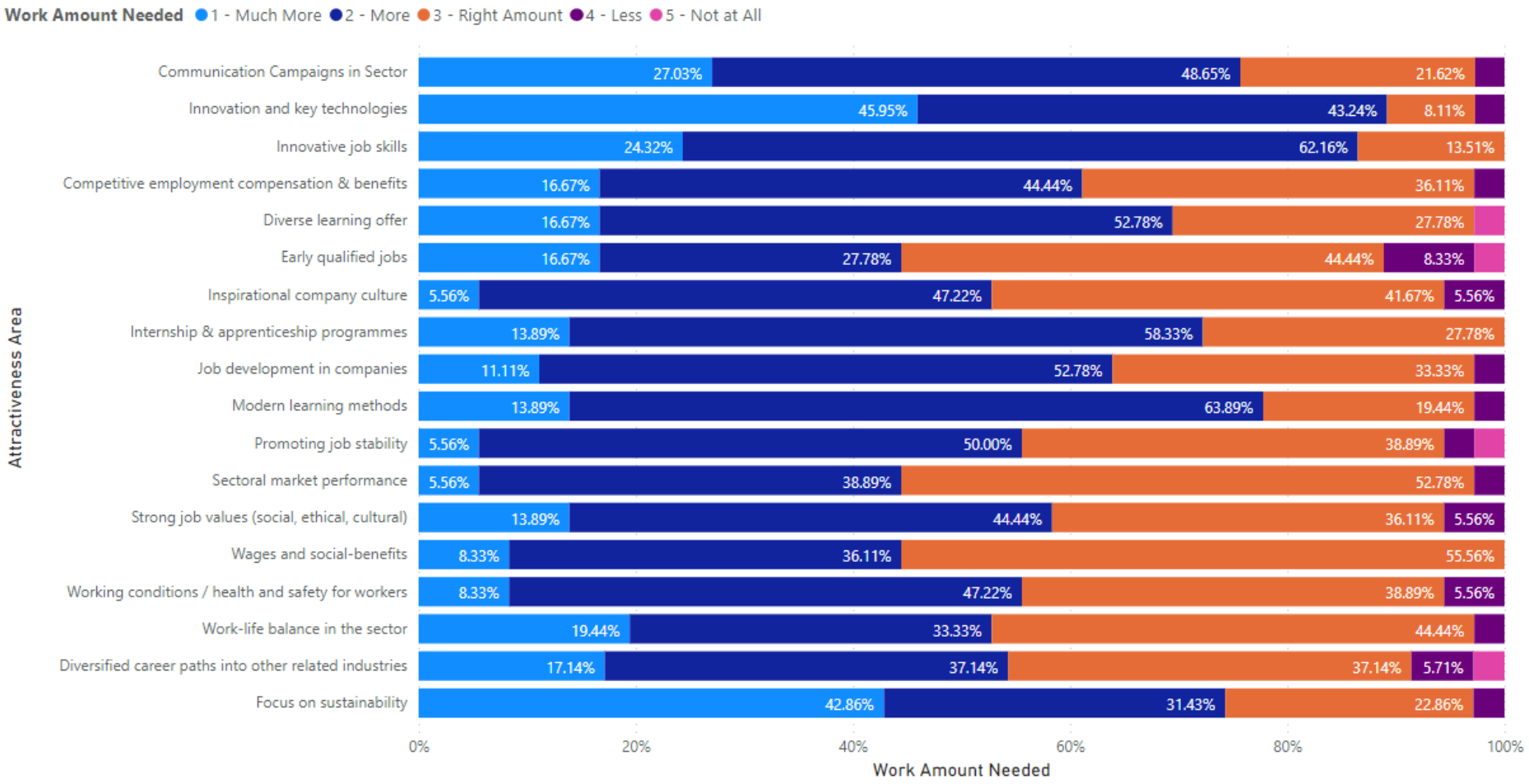

Figure 72 Overall Battery Sector

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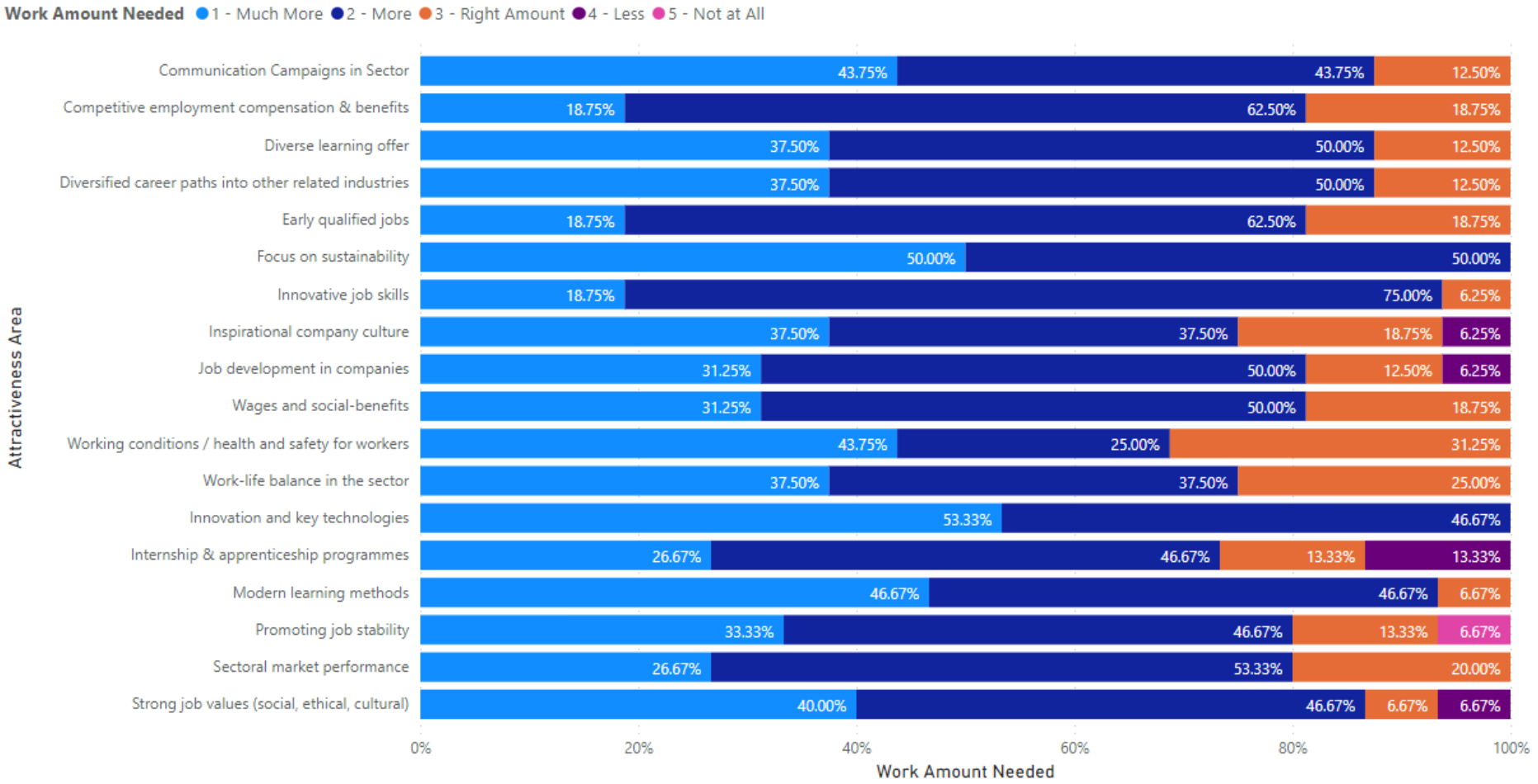

Figure 73 Stationary and Industrial Applications Sub-sector

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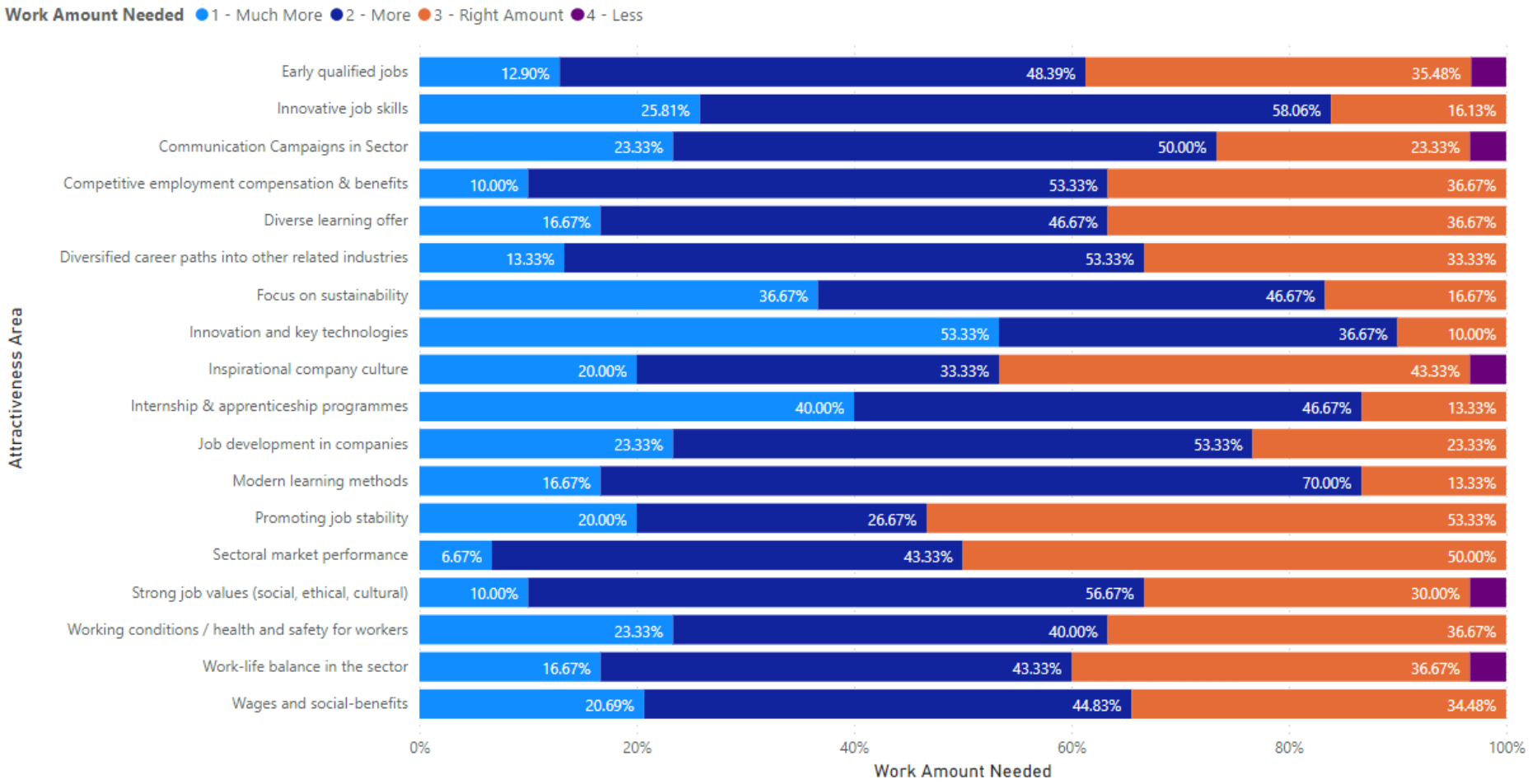

Figure 74 Mobile Applications Sub-sector

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To understand which areas the sector should focus on to improve its attractiveness, a matrix with some solutions was proposed and respondents were asked to evaluate them based on importance ("not at all", "less", "right amount", "more" and "much more").

According to the results from the overall battery sector, we see that respondents evaluated as "much more" (i.e., most important) **innovation and key technologies** (45,95%) followed by **focus on sustainability** (42,86%).

This is also reflected in the two sub-sectors. Regarding Stationary (Figure 73), results show that importance should be on **innovation and key technologies** (53,33%), **focus on sustainability** (50%) as well as **modern learning methods** (46,67%).

For Mobile applications, to boost the attractiveness of the sector, it is crucial again to concentrate on **new technologies** (53,33%) as well as **internships and apprenticeships programs** (40%) and **focus on sustainability** (36,67%).

2.4.1.1 Implications and Concrete Statements

According to the survey results:

- It is essential for the sector attractiveness to leverage on innovation and key technologies.
- At the same time, it is also important to dedicate time and commitment to sustainability issues, to the creation of modern methods of learning, to stimulate apprenticeship and internships programs to attract young people.

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2.4.2 Attractiveness – Additional Questions

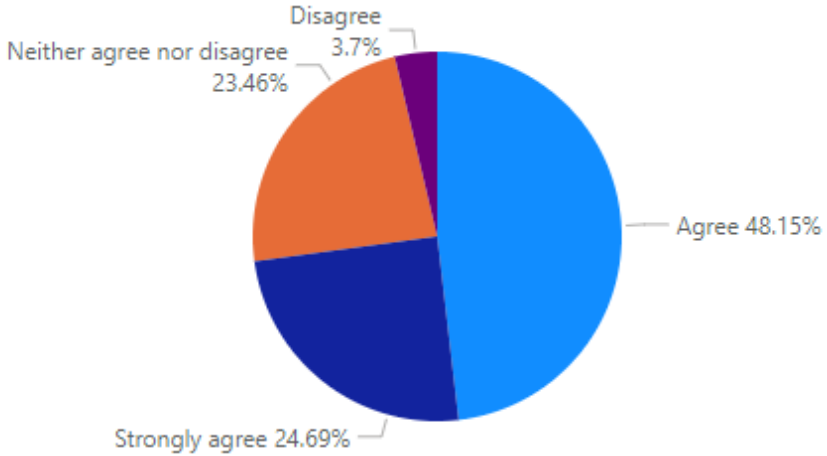

Figure 75 Need for Skills and Competence related to the Safety Topics in the Future

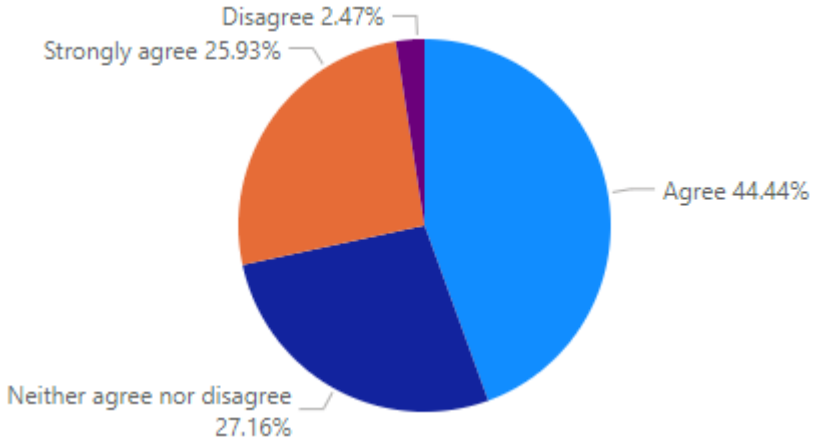

Figure 76 Challenge of Finding Skilled and Competent Workforce in Battery Related Topics

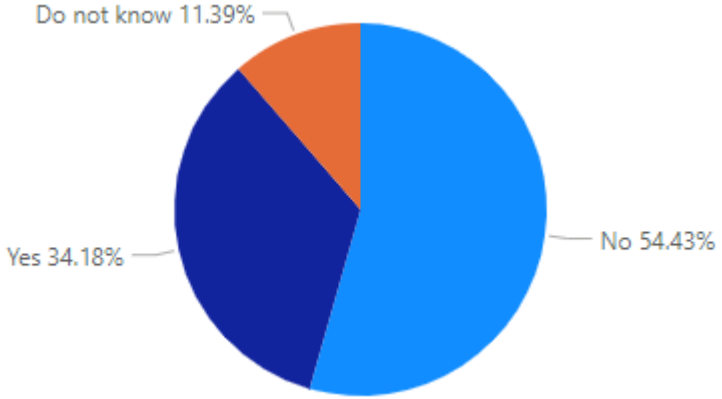

Figure 77 Respondent is Offering Technical Education in Battery Related Topics

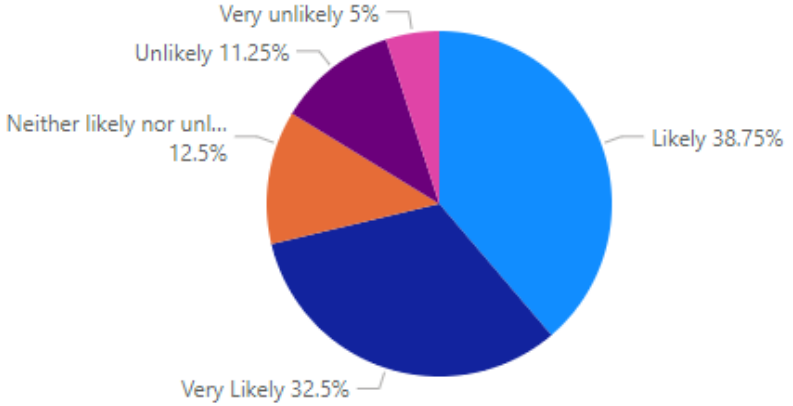

Figure 78 Respondent will Hire more Workforce with Battery Related Skills and Competence during the next 5 years

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As part of the attractiveness section, we asked respondents some additional questions:

- We investigated whether staff would need more skills and competences with **safety related topics**: most of the respondents agreed (48,15%) or strongly agreed (24,69%) on this topic (Figure 75).
- We asked whether it was challenging to find **battery related skilled and competent workforce** at the moment (Figure 76): most of the respondents agreed (44,44%) on this difficulty, while some others neither agreed nor disagreed (27,16%).
- We investigated if the respondent's **institution offered technical education** that provides skills and competences needed in a battery industry: 54,43% replied negatively (Figure 77).
- We asked whether the respondent's organization would **hire more workforce** with battery related skills and competences during the next 5 years (Figure 78): most of the respondents said that this would be likely (38,75%) and very likely (32,5%).

2.4.2.1 Implications and Concrete Statements

Based on the replies to the further questions on attractiveness, it is evident that:

- More skills and competences with safety related topics will be needed.
- Finding battery related skilled and competent workforce is a challenging task at the moment.
- The majority of the institutions respondents come from are not offering technical education providing skills and competences in the battery industry.
- It is likely that the respondents' organizations will hire more workforce with battery related skills and competences during the next 5 years.

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2.4.3 Battery Related Education

Respondents provided examples of the education that their institutions are currently offering:

- Answers ranged from provision of internal training for new employees and seminars for externals, to industrial PhD programs as well as masters and internships.
- Topics included recycling solutions, circular economy, materials engineering, chemical engineering and engineering physics and applied physics, electrical engineering, electrode manufacturing, environmental engineering, energy storage and energy harvest devices, and renewable electricity sources.
- Focus on e-mobility for mobile applications of batteries.

2.4.4 Skills Missing

Respondents provided more specific answers to the question related to demanded skills and competences:

- Industrial experience
- Batteries and project management
- Economical thinking
- Physics
- Chemistry
- Modelling
- System-level understanding
- Battery charge and discharge
- Battery repair
- Production
- Testing
- EV Repair
- High Voltage Qualifications
- Automation skills
- BMS
- Design
- Battery technology
- Physics engineering
- Electrochemistry
- Legislation
- Electrochemistry
- IT skills
- Safety
- Regulations
- Testing methods

As well as to the job roles that are in demand:

- Battery experts
- Data Scientists
- Software Developers
- Electrical Engineers
- Process Expert teachers
- Materials specialists
- Operators
- Recycling engineer
- Process Engineer
- Electrochemist
- Electrochemical Engineer
- EV diagnose and repair engineer
- VET Teachers – Batteries
- Maintenance technicians

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3 Results per Stakeholder Groups

In the following section, responses from industrial stakeholders are compared to the education providers. The following KPIs are used to map the outcomes of the survey, as seen in Table 2.

Table 2 Analysis based on the Stakeholder Groups - Industry and Education Providers

KPI	INDICATOR TITLE	UOM	Industry	EDU	By Supply Chain
1.1	N° OF RESPONDENTS	N°	X	X	
1.2	TYPE OF ORGANISATION	%	X	X	
1.3	NACE CODE	%	X	X	
1.4	SUPPLY CHAIN COVERAGE	%	?	?	
1.5	GEO - Respondents per Country	%	X	X	
2.1	IMPORTANCE OF DRIVERS OF CHANGE GROUPS - MACROCATEGORY	%	X	X	
2.2	URGENCY OF DRIVERS OF CHANGE GROUPS - MACROCATEGORY	%	X	X	
2.3	DoC CLIMATE GOALS, REGULATION, AND GREEN ENERGY - IMPORTANCE	%	X	X	
2.4	DoC CLIMATE GOALS, REGULATION, AND GREEN ENERGY - URGENCY	%	X	X	
2.5	DoC GLOBALIZATION - IMPORTANCE	%	X	X	
2.6	DoC GLOBALIZATION - URGENCY	%	X	X	
2.7	DoC NEW TECHNOLOGIES - IMPORTANCE	%	X	X	
2.8	DoC NEW TECHNOLOGIES - URGENCY	%	X	X	
3.1	JOB ROLES INDEX	INDEX	X	X	X
3.3	SKILLS INDEX	INDEX	X	X	
4.1	ATTRACTIVENESS FACTORS	%	X	X	

3.1 SAMPLE CHARACTERISATION

3.1.1 Number of Respondents

Overall number of respondents for both stakeholder groups was 78, out of which 50 were from industry and 28 from education providers.

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3.1.2 Type of Organisation

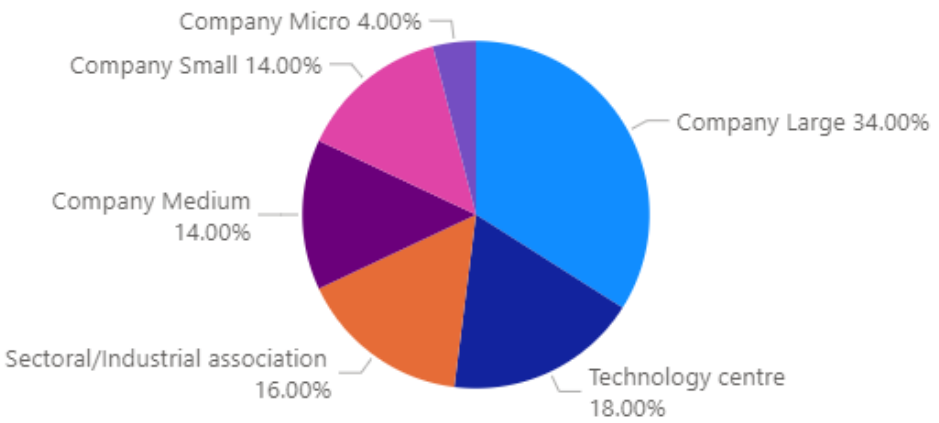

Figure 79 Industrial Stakeholders

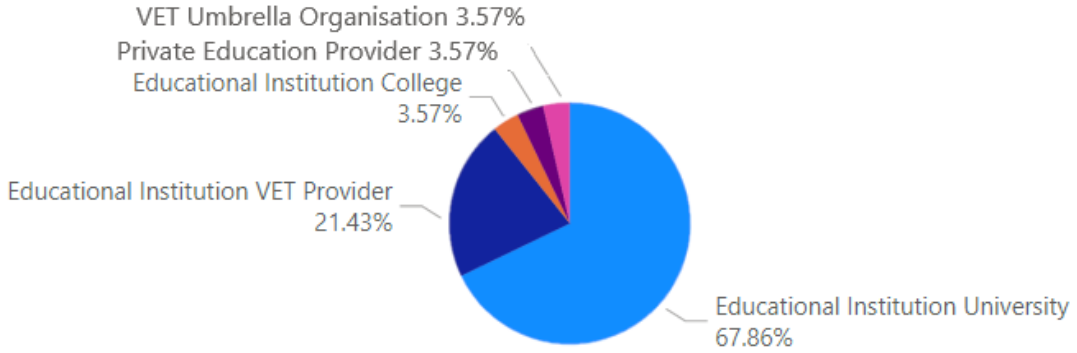

Figure 80 Education Providers

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Within the industrial stakeholders' group (Figure 79), the majority of respondents come from large companies (34%), followed by technology centres (18%).

As for the education providers' group (Figure 80), the majority of respondents come from universities (67,86%), followed by VET providers (21,43%).

3.1.2.1 Implications and Concrete Statements

According to the survey results:

- It is important to consider that replies tend to reflect the perspective of large companies from the industry side, and universities from the education side.

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3.1.3 NACE Codes

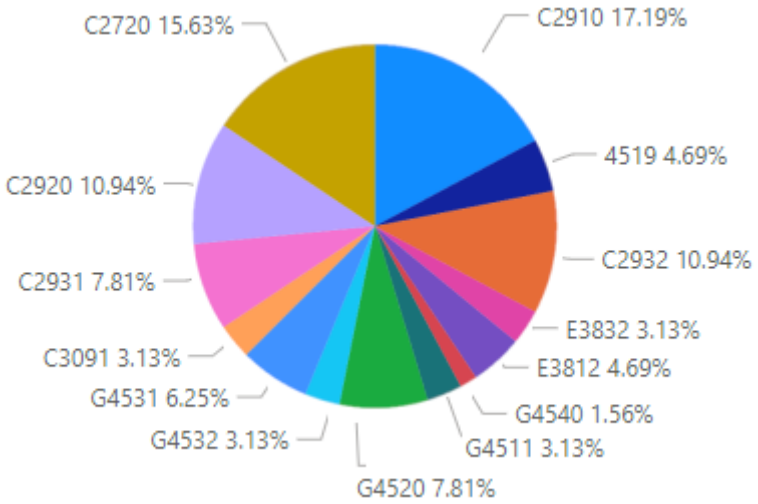

Figure 81 Industrial Stakeholders

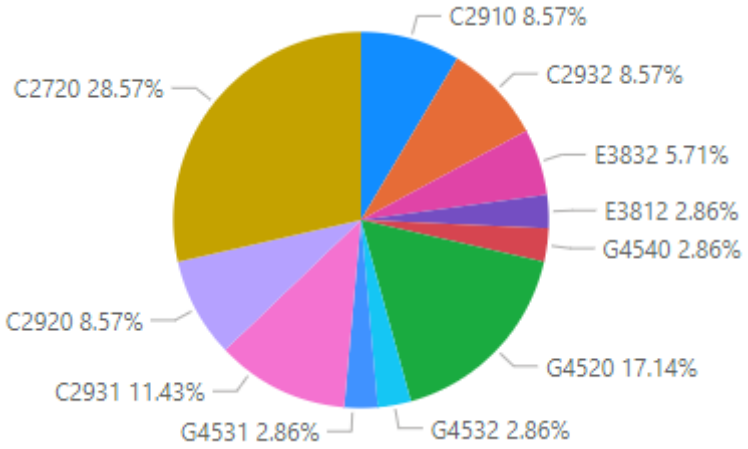

Figure 82 Education Providers

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Regarding NACE codes, industrial stakeholders referred to **C2910 Manufacture of motor vehicles** (17,19%) and **C2720 Manufacture of batteries and accumulators** (15,63%) - Figure 81.

As for education providers (Figure 82), respondents referred to **C2720 Manufacture of batteries and accumulators** to a greater extent (28,57%), followed by **G4520 Maintenance and repair of motor vehicles (electrical repairs, repair of motor vehicle parts – battery)** at 17,14%.

3.1.3.1 Implications and Concrete Statements

According to the survey results:

- When analysing the replies, it shall be taken into account that C2720 - Manufacture of batteries and accumulators and C2910 - Manufacture of motor vehicles are the most represented NACE codes for education providers and industrial stakeholders respectively.

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3.1.4 Supply Chain Coverage

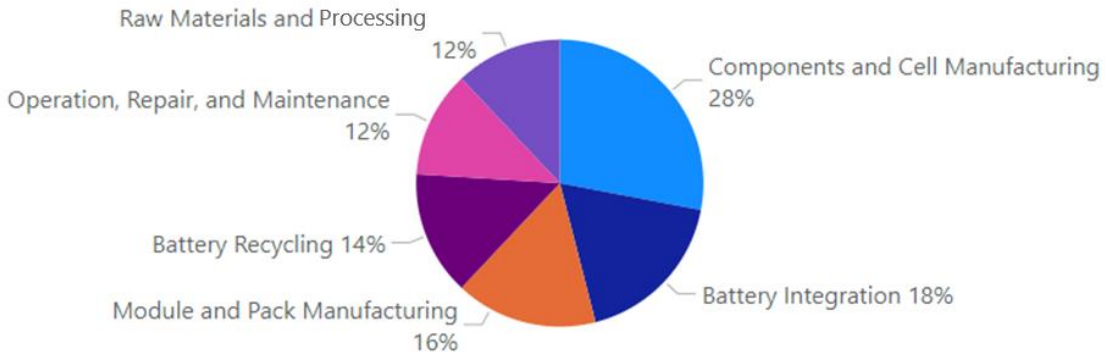

Figure 83 Industrial Stakeholders

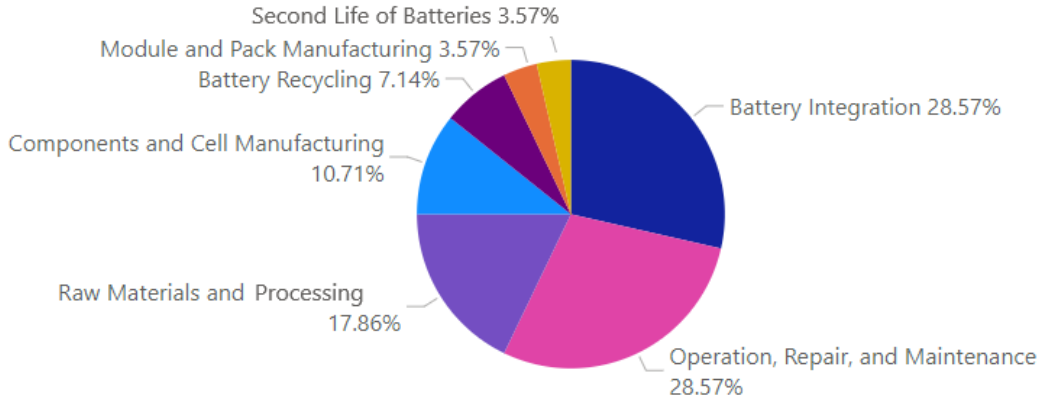

Figure 84 Education Providers

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Regarding the supply chain coverage, industrial stakeholders (Figure 83) mostly represent the **components and cell manufacturing** (28%), followed by **battery integration** (18%).

Figure 84, shows that from the education providers' perspective, **battery integration** and **operation, repair, and maintenance** (28,57% each) are the best covered value chain step.

3.1.4.1 Implications and Concrete Statements

According to the survey results:

- Components and cell manufacturing is the best covered supply chain step reported by industrial stakeholders, whereas for education providers, the battery integration and operation, repair, and maintenance are the most covered supply chain step.

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3.1.5 GEO – Respondents per Country

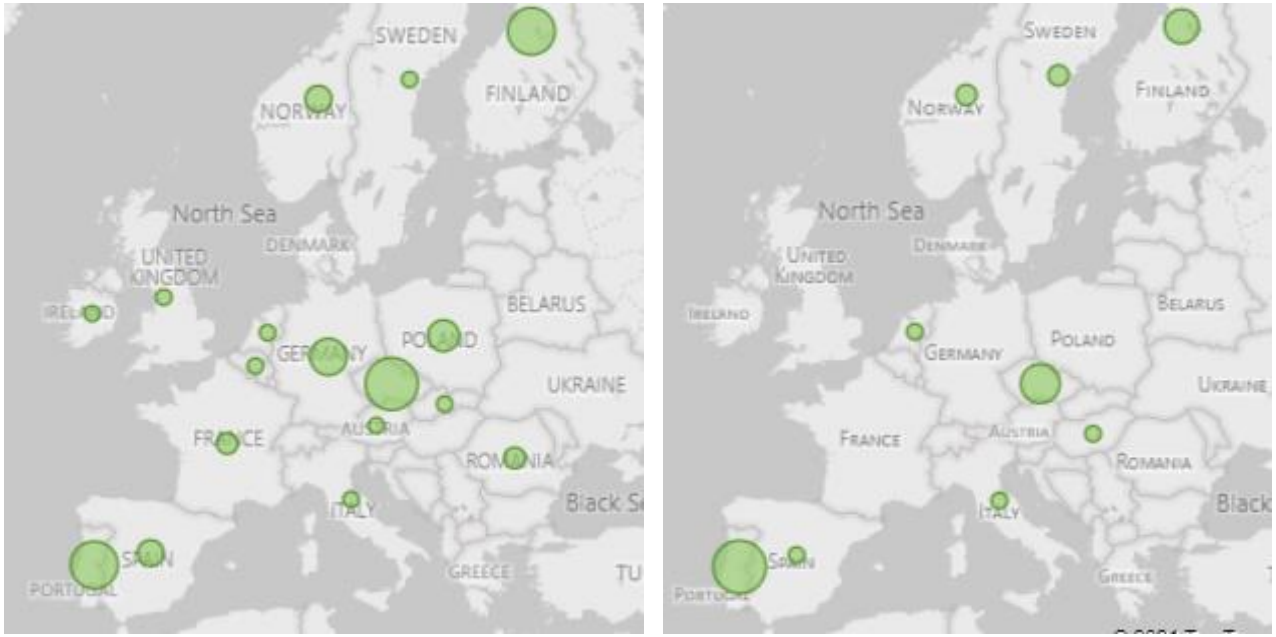

Figure 85 Industrial (left) and Education Providers (right) Stakeholders

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The majority of respondents from the industrial stakeholders' group come from the **Czech Republic** (16%), **Portugal** (14%) and **Finland** (14%).

With regard to education providers, most of the respondents come from **Portugal**, the **Czech Republic** and **Finland** as well, but with different distribution (32,14%, 21,43% and 17,86% respectively).

3.1.5.1 Implications and Concrete Statements

- Responses from both stakeholders' groups tend to primarily reflect the perspective of the following countries: the Czech Republic, Portugal, Finland. There are also some replies from other EU countries.

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3.2 DRIVERS OF CHANGE

3.2.1 Importance of Drivers of Change Groups – Macro Category

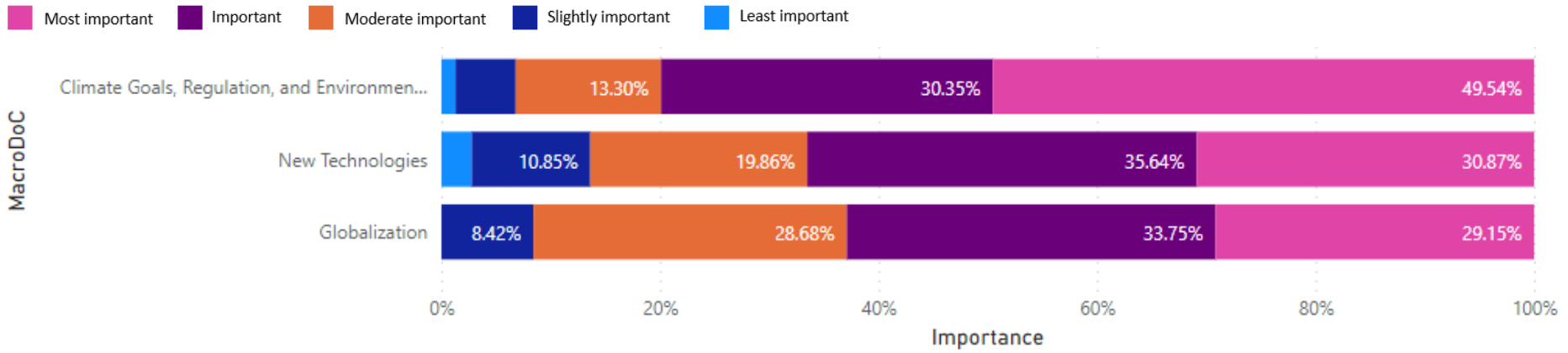

Figure 86 Industrial Stakholders

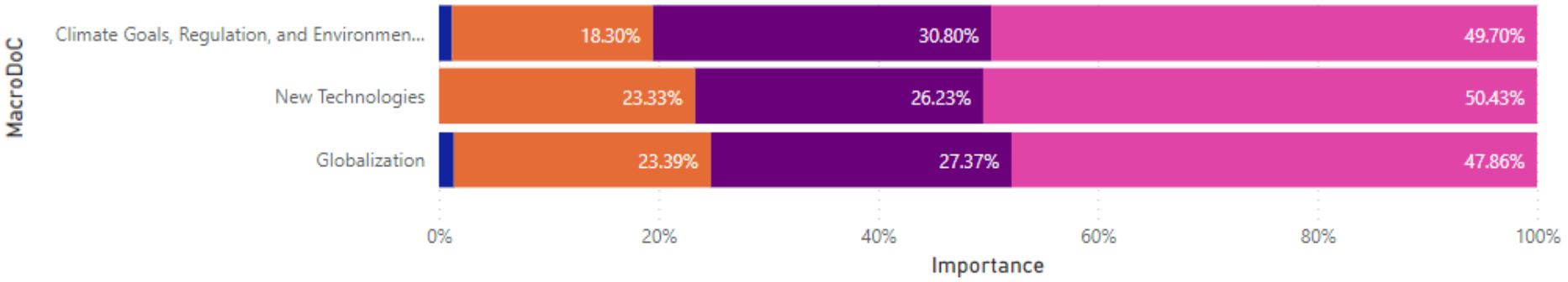

Figure 87 Education Providers

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A matrix with the three macro categories was proposed, and respondents were asked to evaluate them based on their importance (**1 - least important**; **5 - most important**). As we see in Figure 86, **climate goals, regulation and environmental challenges** is perceived as the most important category for industrial stakeholders (49,54%).

As illustrated in Figure 87, responses from education providers show that the three drivers of change have almost the same importance.

3.2.1.1 Implications and Concrete Statements

According to the survey results:

- Although it is clear that, for education providers, all three drivers of change are perceived as important, more focus shall be put on **climate goals, regulation and environmental challenges**, especially for industrial stakeholders.

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3.2.2 Urgency of Drivers of Change Groups – Macro Category

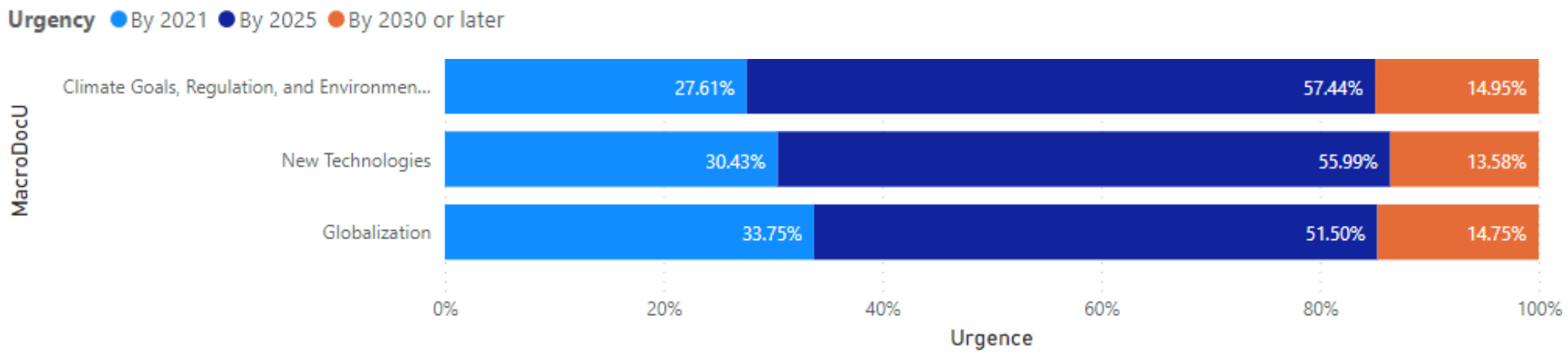

Figure 88 Industrial Stakeholders

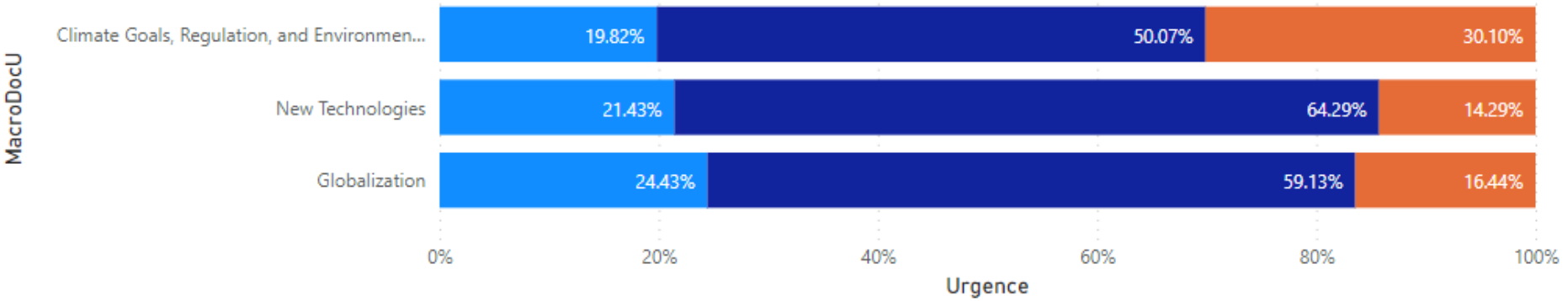

Figure 89 Education Providers

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Alliance for Batteries Technology, Training and Skills ALBATTS – Project number 612675-EPP-1-2019-1-SE-EPPKA2-SSA-B. The European Commission support for the production of this publication under the Grant Agreement Nº 2019-612675 does not constitute an endorsement of the contents which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Regarding the urgency of the three drivers of change, both industrial stakeholders and education providers consider **globalization** as the most urgent driver of change (33,75% and 24,43%), even if there is not a big gap within **new technologies** (30,43% and 21,43%).

3.2.2.1 Implications and Concrete Statements

According to the survey results:

- Globalization shall receive greater attention and it is going to have the greatest impact by 2021.

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3.2.3 Climate Goals, Regulation, and Environmental Challenges – Importance

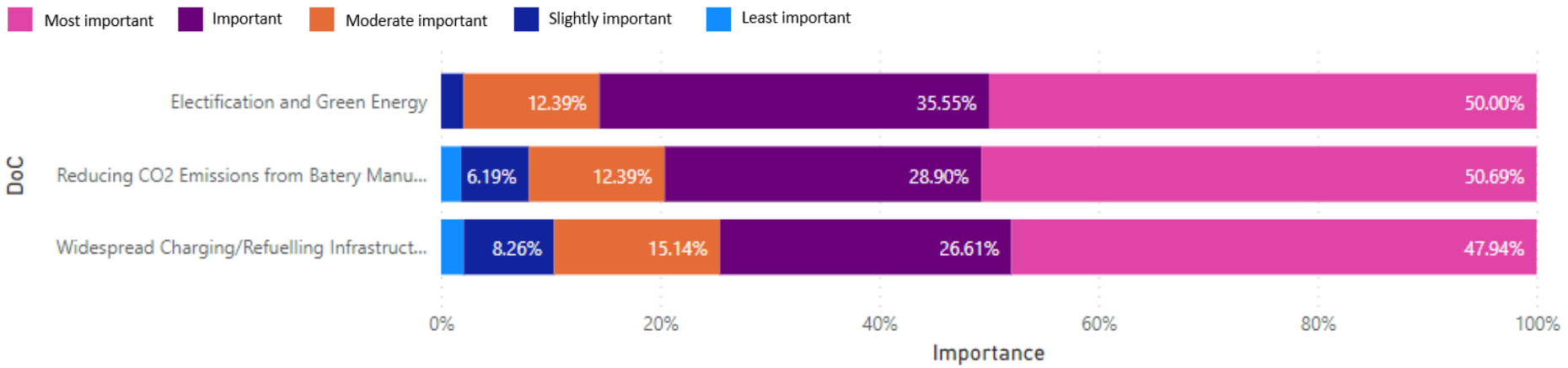

Figure 90 Industrial Stakeholders

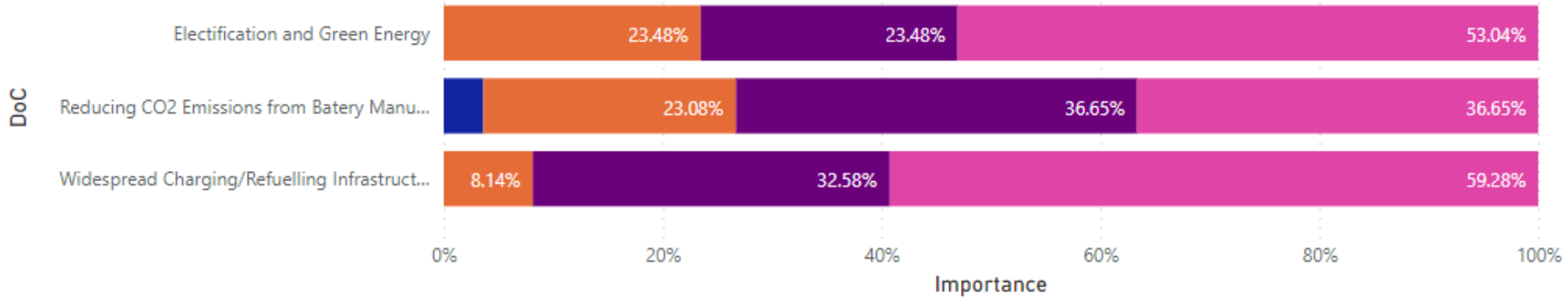

Figure 91 Education Providers

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Alliance for Batteries Technology, Training and Skills ALBATTS – Project number 612675-EPP-1-2019-1-SE-EPPKA2-SSA-B. The European Commission support for the production of this publication under the Grant Agreement Nº 2019-612675 does not constitute an endorsement of the contents which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Within the climate category, we have previously identified the three sub-categories: **electrification and green energy, reducing CO2 emissions from battery manufacturing** and **widespread charging/refuelling infrastructure.**

From the perspective of industrial stakeholders (Figure 90), the three sub-categories are almost equal in terms of importance – 50%, 50,69% and 47,94%.

With reference to education providers, it is instead perceived as most important to concentrate on **widespread charging/refuelling infrastructure** (59,28%) as shown in Figure 91.

3.2.3.1 Implications and Concrete Statements

According to the survey results:

- Within the category of climate goals, regulation and environmental challenges, we see that results tend to slightly change according to the perspective of each stakeholder. While for education providers the demand for widespread charging infrastructure is a key driver, for industrial stakeholders the three sub-categories are almost equal in terms of importance.

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3.2.4 Climate Goals, Regulation, and Environmental Challenges – Urgency

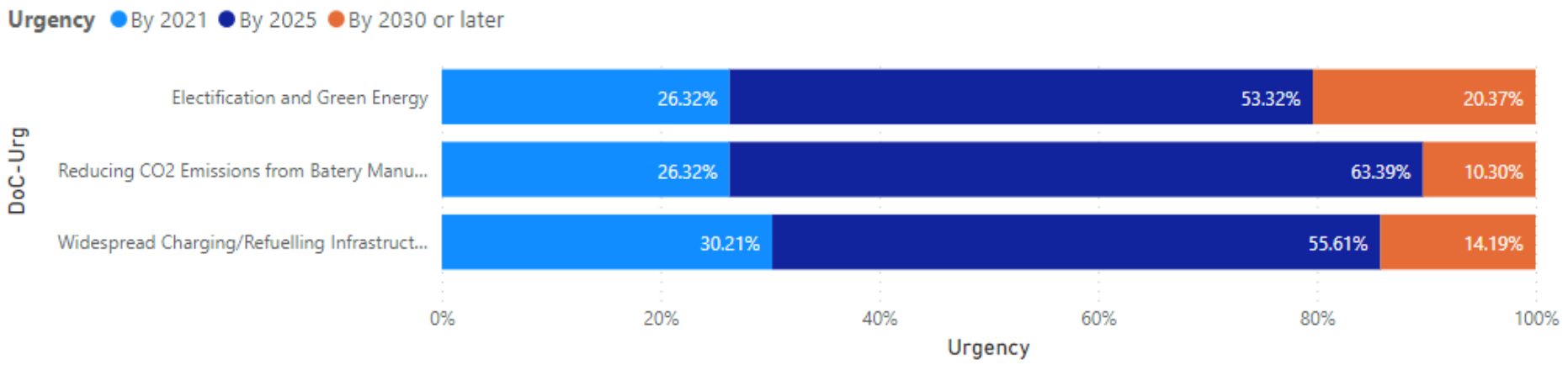

Figure 92 Industrial Stakeholders

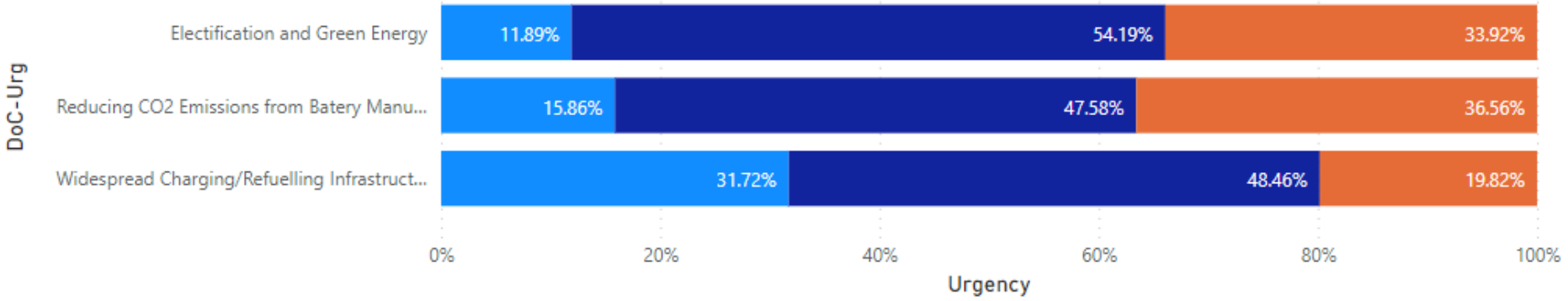

Figure 93 Education Providers

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In terms of urgency of the three sub-categories, for industrial stakeholders (Figure 92) **widespread charging/refuelling infrastructure** is considered the most urgent (by 2021), and this is also reflected in the viewpoint of the education providers' replies (31,72%).

3.2.4.1 Implications and Concrete Statements

According to the survey results:

- Both industrial stakeholders and education providers consider that **widespread charging/refuelling infrastructure** is the sub-category which should receive greater attention by 2021.

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3.2.5 Globalization – Importance

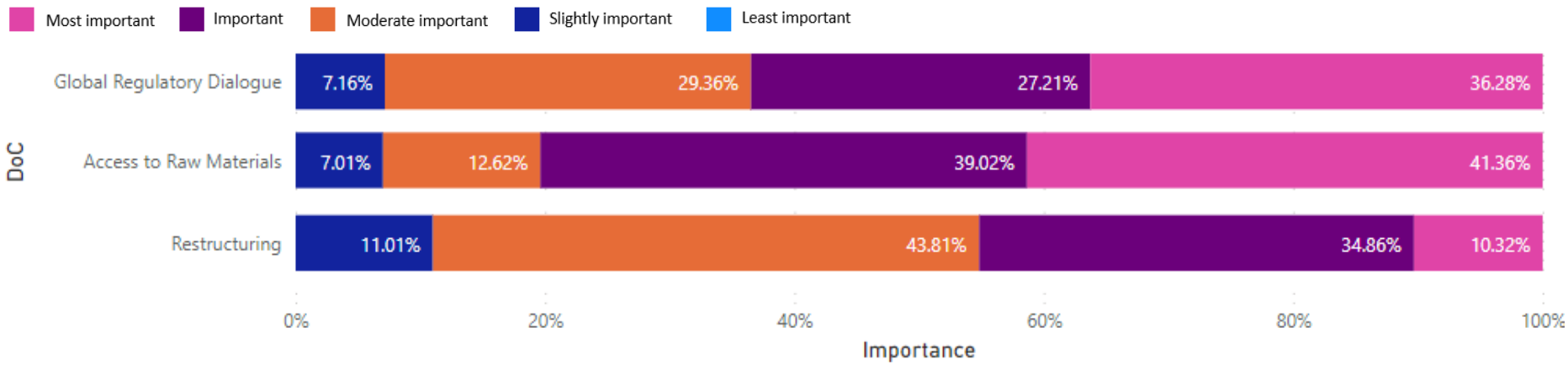

Figure 94 Industrial Stakeholders

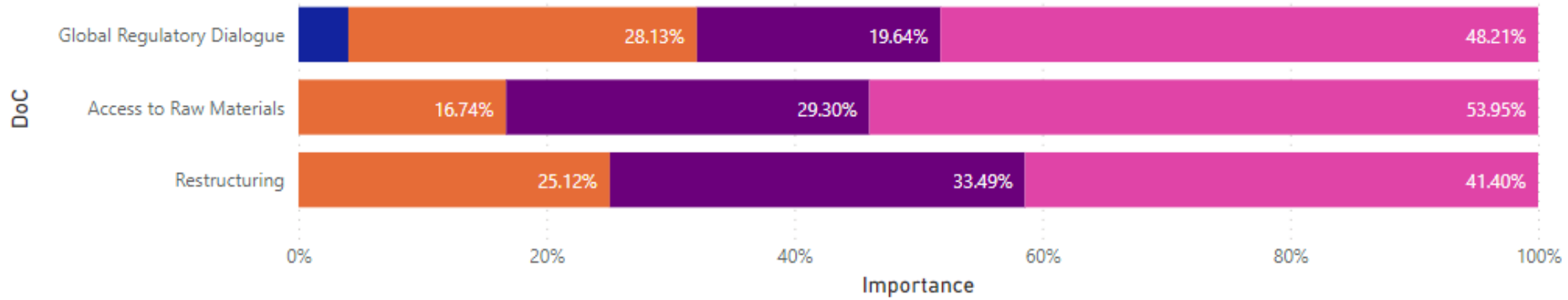

Figure 95 Education Providers

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Within globalization, we have previously identified the three relevant sub-categories: **access to raw materials, global regulatory dialogue** and **restructuring.**

Access to raw materials is considered the most important factor for industrial stakeholders (41,36% - Figure 94), and this is also reflected in the replies of education providers (53,95% - Figure 95).

3.2.5.1 Implications and Concrete Statements

According to the survey results:

- Activities linked to raw materials are becoming crucial and therefore require particular attention.

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3.2.6 Globalization – Urgency

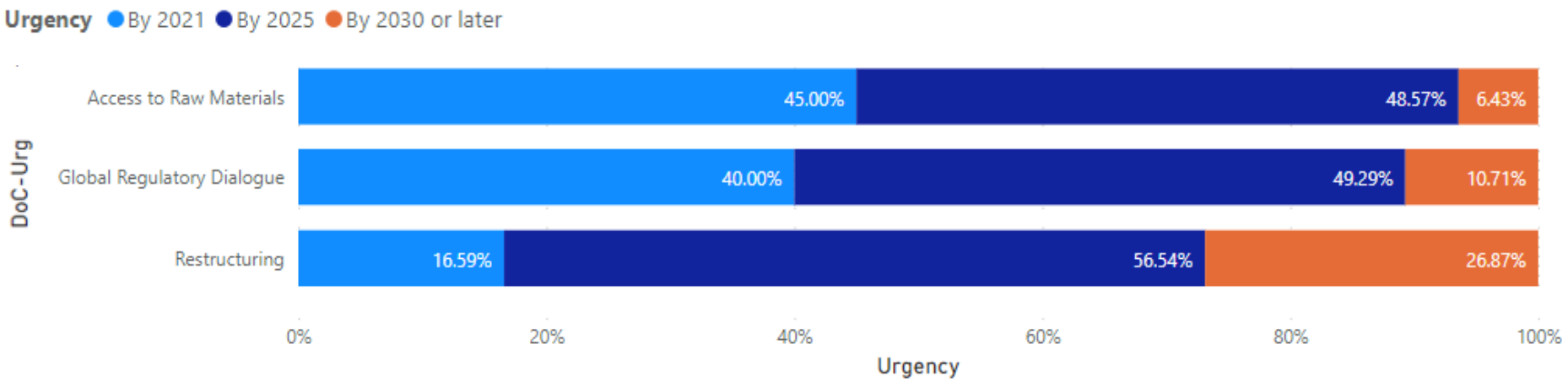

Figure 96 Industrial Stakeholders

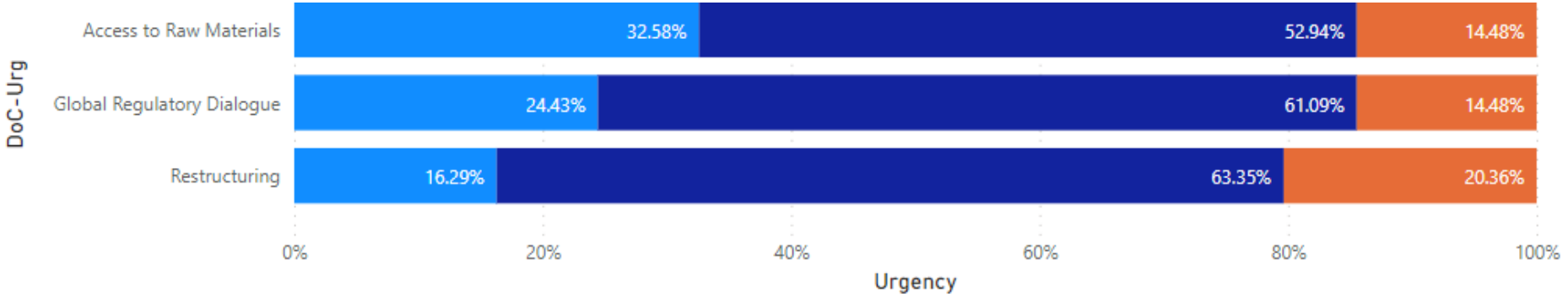

Figure 97 Education Providers

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In terms of urgency, it is again the **access to raw materials** which is perceived as the most urgent to focus on by 2021 both from industrial stakeholders and education providers perspective (45% and 32,58% respectively).

3.2.6.1 Implications and Concrete Statements

According to the survey results:

- Access to raw materials remains the most important and the most urgent driver to pay attention to, according to the replies of all stakeholders.

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3.2.7 New Technologies – Importance

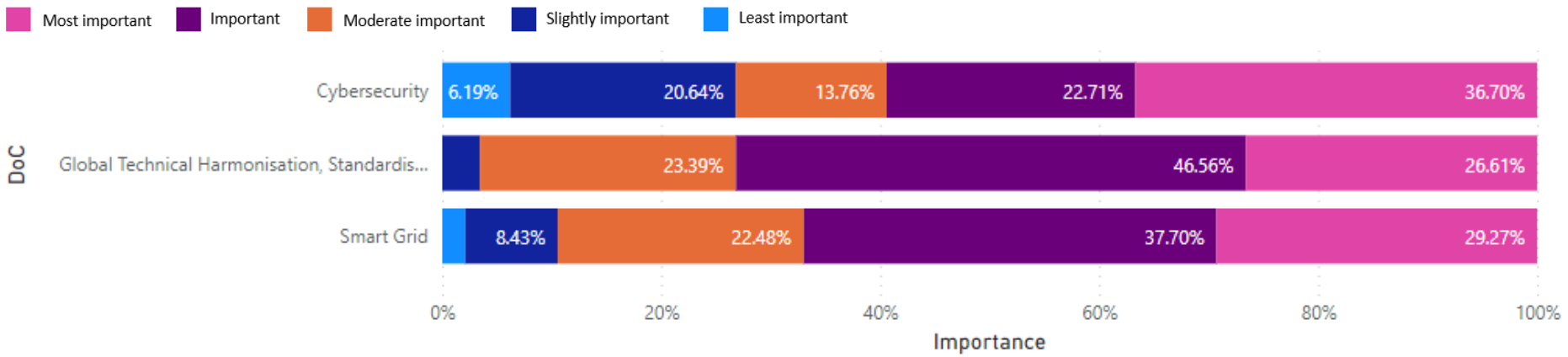

Figure 98 Industrial Stakeholders

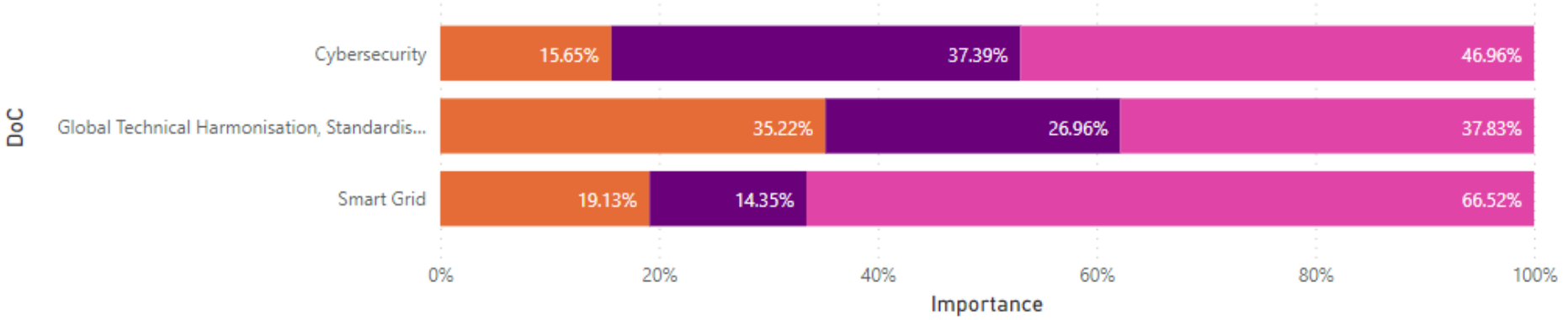

Figure 99 Education Providers

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Within new technologies, we have previously identified the three relevant sub-categories: **cybersecurity, global technical harmonization**, **standardization,** and **smart grid.**

Cybersecurity is the most important sub-category for industrial stakeholders (36,70% - Figure 98), while for education providers it is the **smart grid** sub-category that should receive greater attention (66,52% - Figure 99).

3.2.7.1 Implications and Concrete Statements

According to the survey results:

- Cybersecurity is relevant for both stakeholders, however education providers tend to emphasise the importance of smart grid, and this is reflected in the high number of votes this sub-category received.

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3.2.8 New Technologies – Urgency

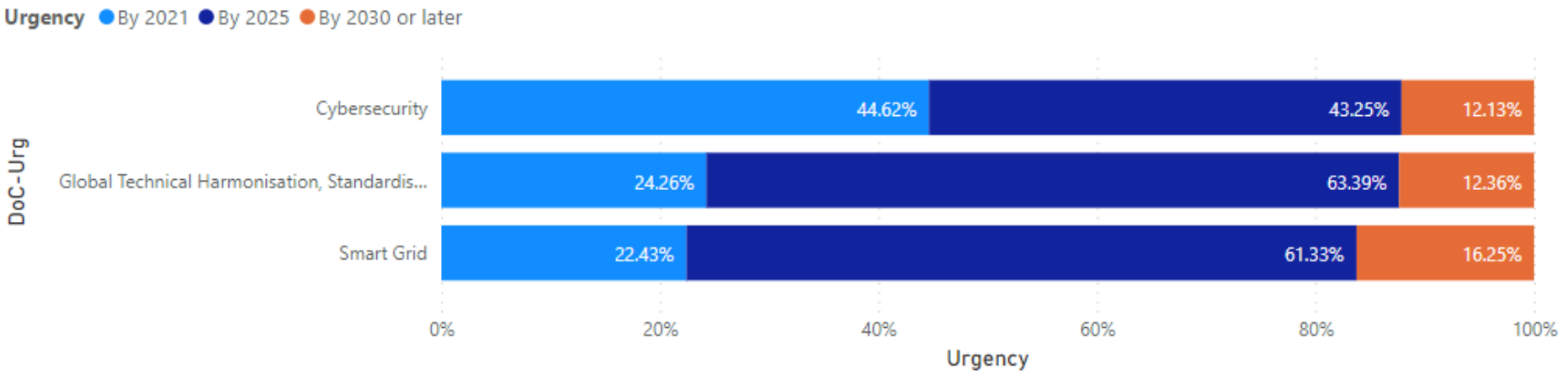

Figure 100 Industrial Stakeholders

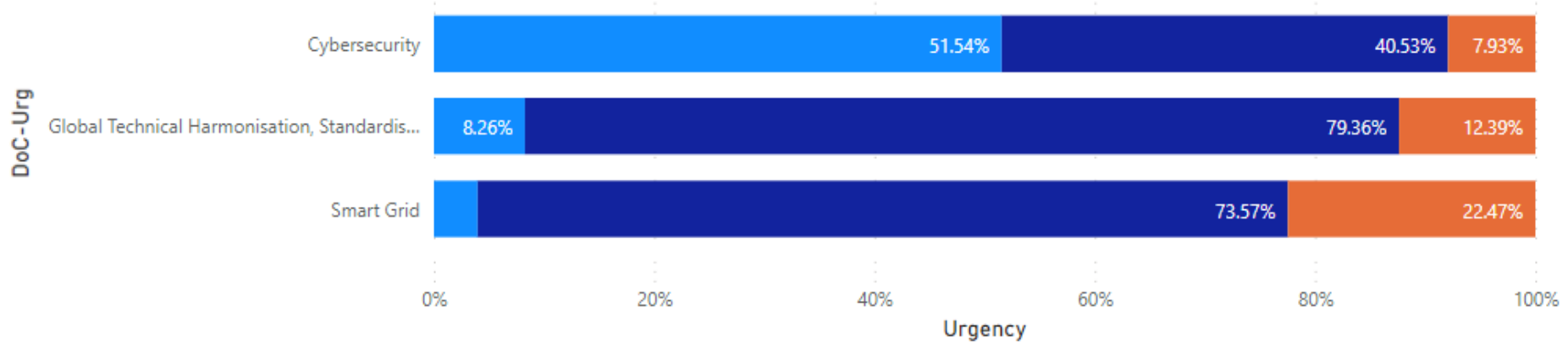

Figure 101 Education Providers

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In terms of urgency of the new technologies, both stakeholder groups agree on the urgency of tackling **cybersecurity** within 2021 (44,62% for industrial stakeholders and 51,54% for education providers).

3.2.8.1 Implications and Concrete Statements

According to the survey results:

- Both stakeholders perceive the need to address cybersecurity as most the urgent, to guarantee the resilience of infrastructure to cyber-attacks, as well as customer privacy and security.

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3.3 JOB ROLE AND SKILLS

3.3.1 Overview of the Job Roles

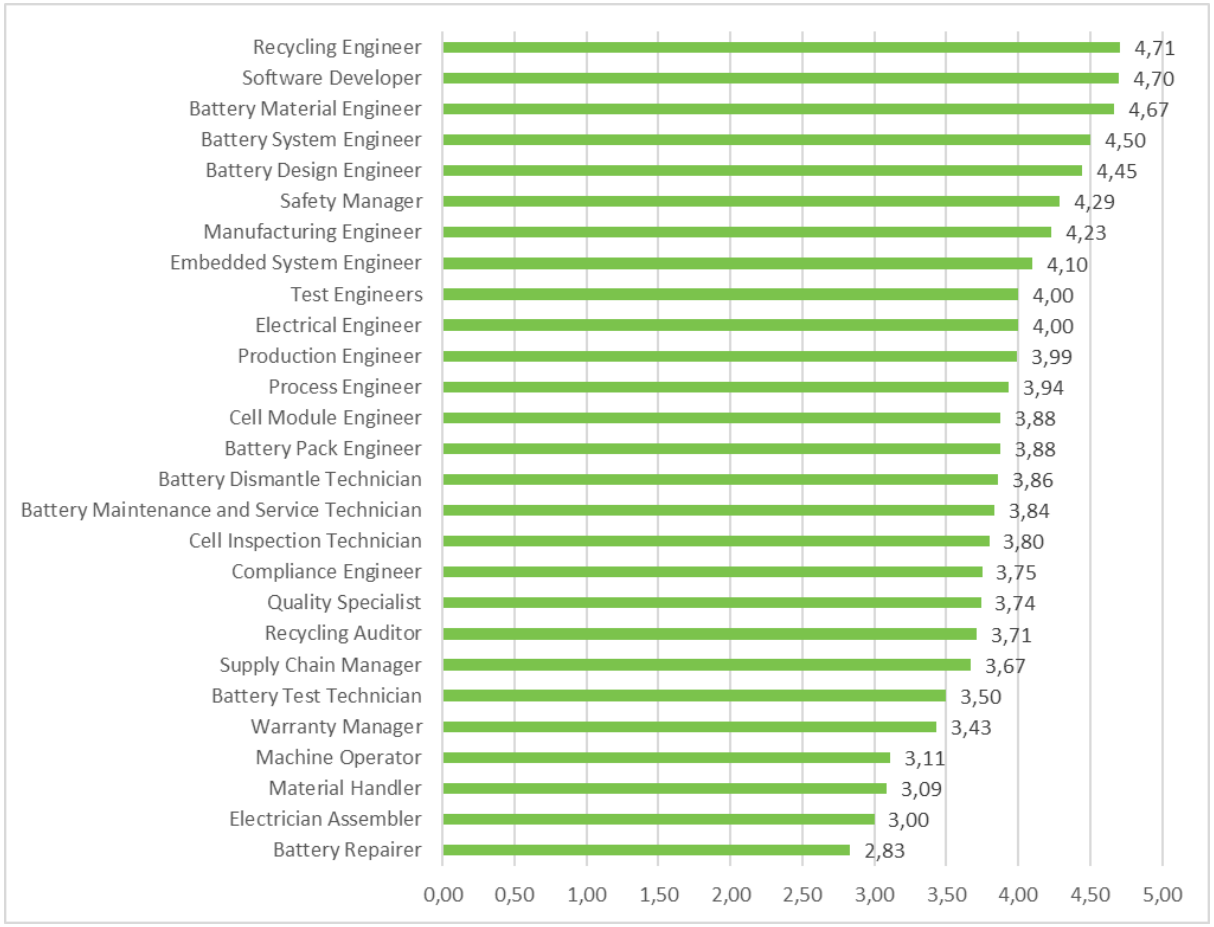

Figure 102 Industrial Stakeholders

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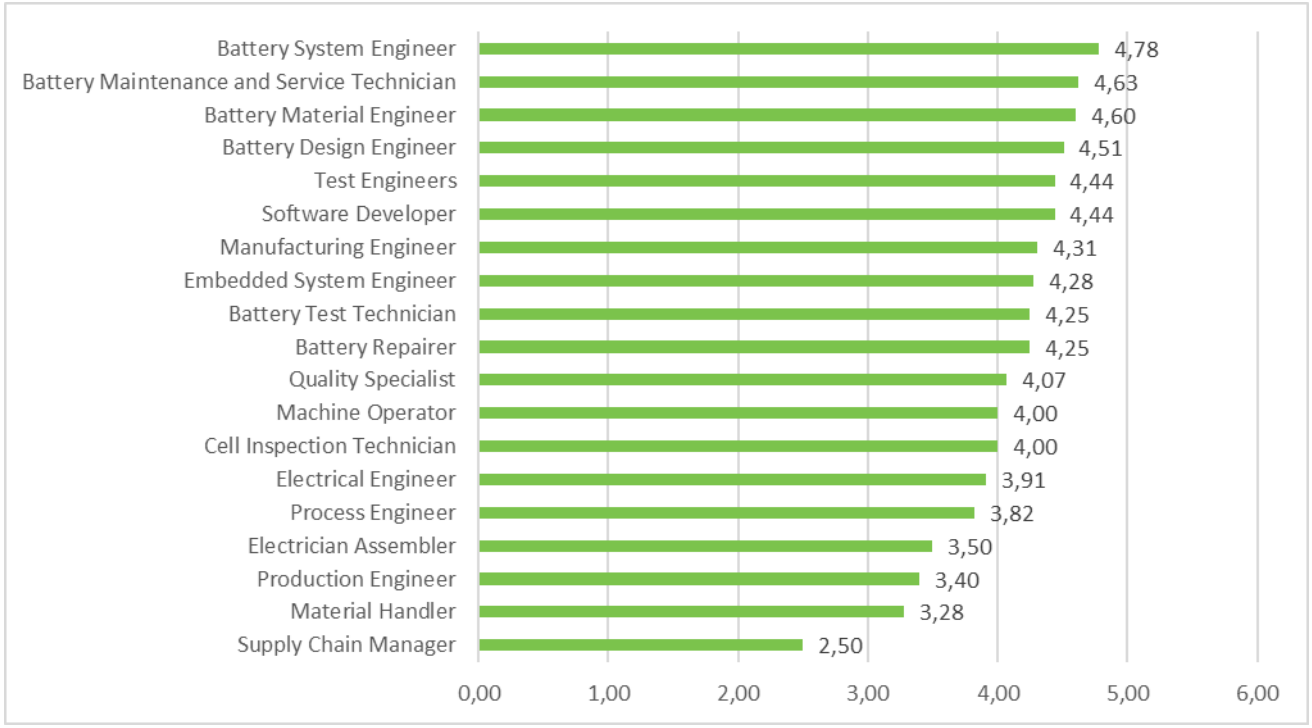

Figure 103 Education Providers

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Machine operators are seen as more important from education providers' standpoint (4) than from industrial stakeholders' point of view (3,11). Due to the lower number of responses, it was considered that some job roles should not be included into the analysis. Recycling engineer is considered to be the most important job role for the industrial stakeholders. Battery system engineers is seen as the most important job role for education providers. Battery maintenance and service technician are more important for education providers than for industrial stakeholders.

3.3.1.1 Implications and Concrete Statements

According to the survey results:

- Recycling engineer is considered to be most important for the industrial stakeholders.
- Machine operators are seen as more important for education providers than industrial stakeholders.

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3.3.2

3.3.3 Job Roles Index – Raw Materials and Processing

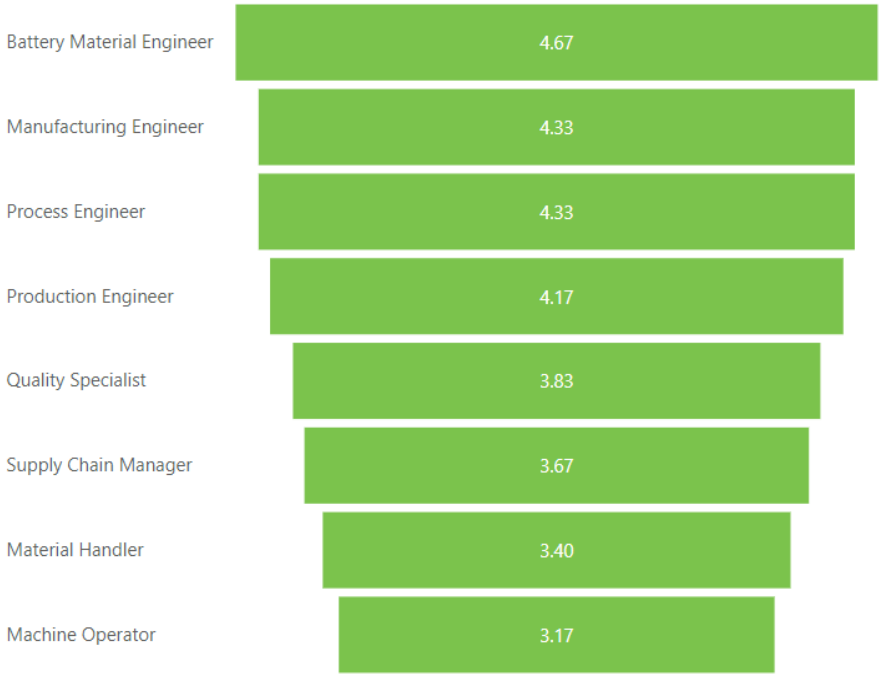

Figure 104 Industrial Stakeholders

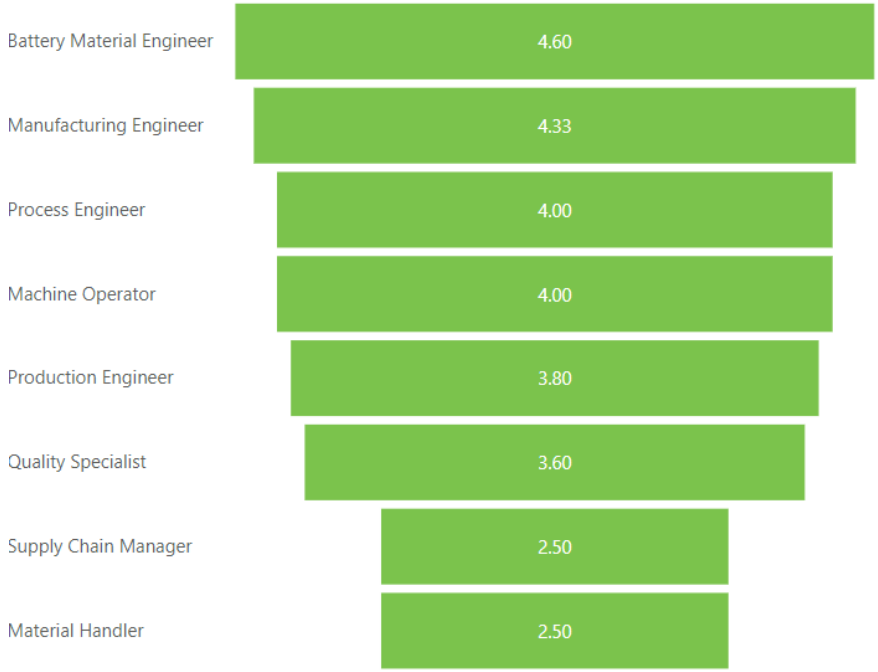

Figure 105 Education Providers

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When comparing the job roles from industry stakeholders' and education providers' point of view, the machine operators are much more valued by education providers (4.0 - Figure 105) than by industrial stakeholders (3.17 - Figure 104), where the machine operator is in last place. Battery material engineer is the most important job role for both stakeholder groups (4.6 – industrial stakeholders and 4.67 – education providers), followed by manufacturing engineer (4.33 – both samples).

3.3.3.1 Implications and Concrete Statements

According to the survey results:

- battery material engineers and manufacturing engineers are seen as the most important;
- machine operators are more valued by education providers compared to industry stakeholders;
- industrial stakeholders gave higher scores on average for raw materials and processing job roles.

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3.3.4 Job Roles Index – Components and Cell Manufacturing

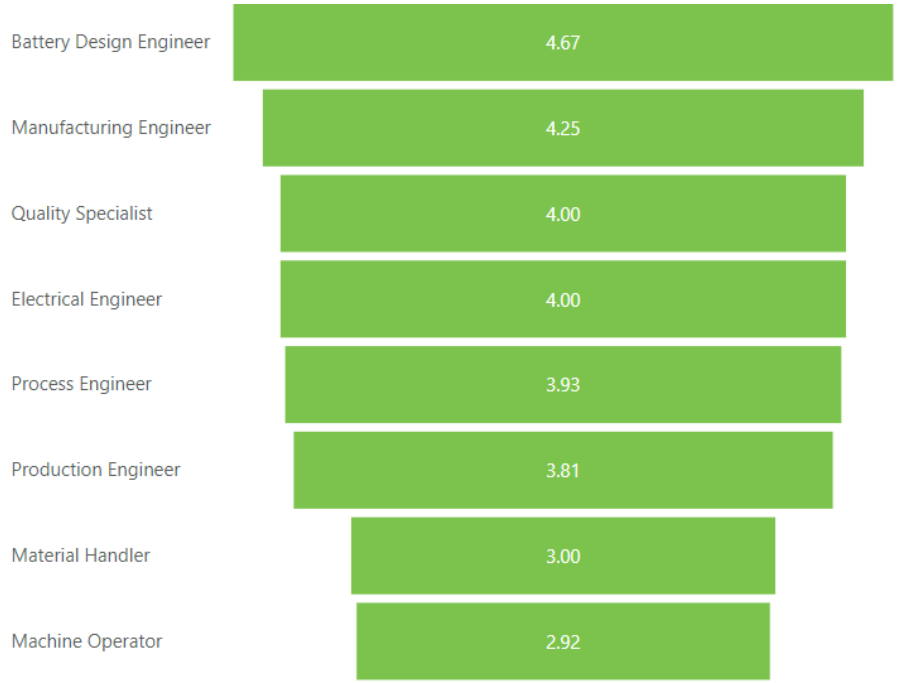

Figure 106 Industrial Stakeholders

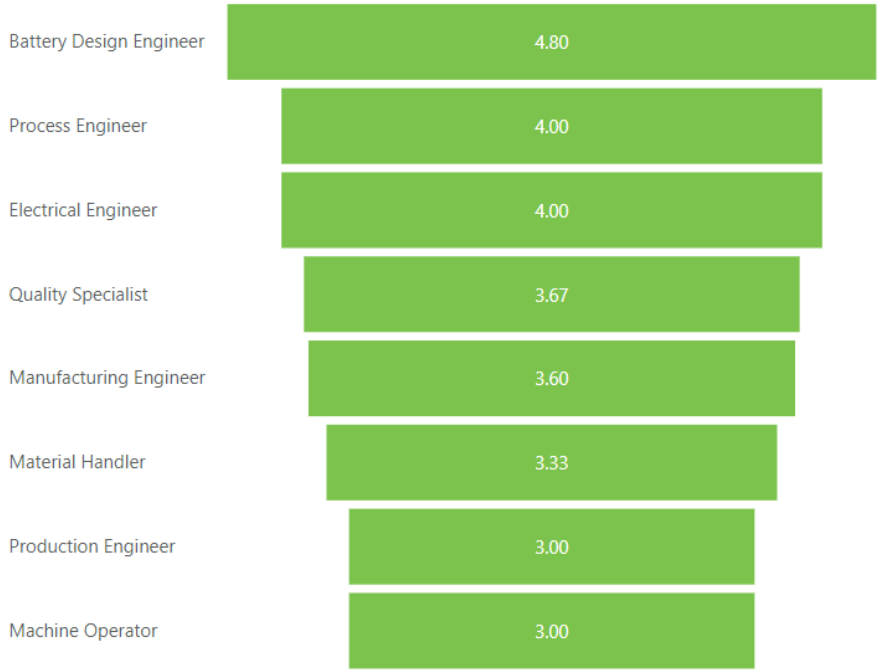

Figure 107 Education Providers

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When comparing the results of components and cell manufacturing, the battery design engineer is seen as the most important job role by both samples, whereas manufacturing engineers are rated as more important by industrial stakeholders (4.25 - Figure 106) than in the case of education providers (3.60 - Figure 107). When it comes to other job roles, the results are consistent.

3.3.4.1 Implications and Concrete Statements

According to the survey results:

- battery design engineers are seen as the most important;
- manufacturing engineers are more valued by industrial stakeholders;

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3.3.5 Job Roles Index – Module and Pack Manufacturing

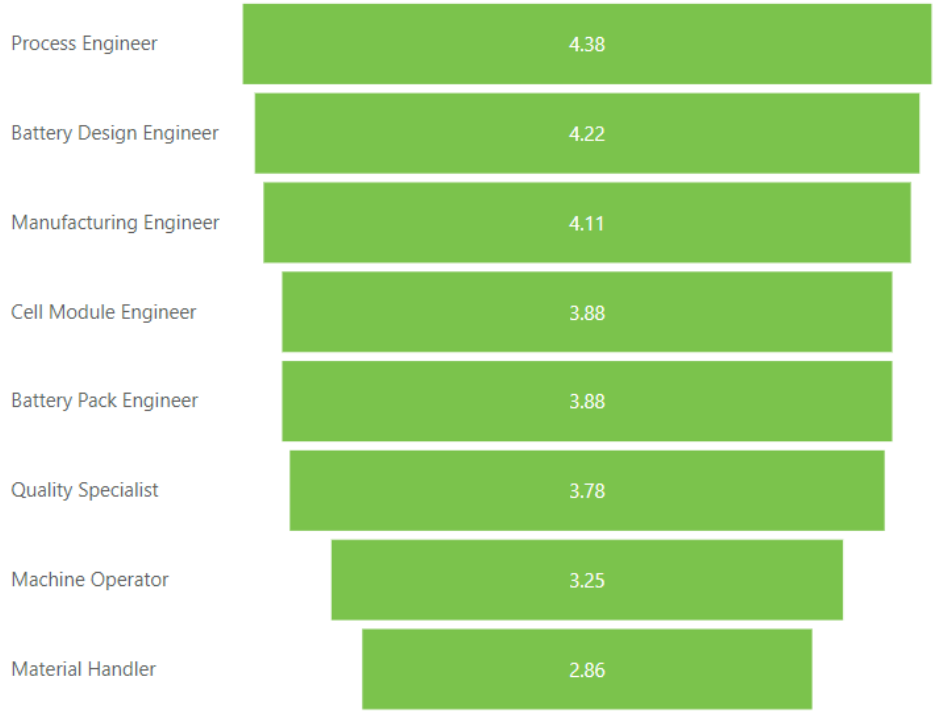

Figure 108 Industrial Stakeholders

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Module and pack manufacturing received a number of replies from industrial stakeholders. There are not enough responses in the case of education providers. Industrial stakeholders see the process engineer as the most important job role (4.38), followed closely by battery design engineer (4.22), manufacturing engineer (4.11) and cell module engineer (3.88), as seen in Figure 108.

3.3.5.1 Implications and Concrete Statements

According to the survey results:

- process engineers are seen as the most important;
- machine operators and material handlers seen as the least important;

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3.3.6 Job Roles Index – Battery Integration

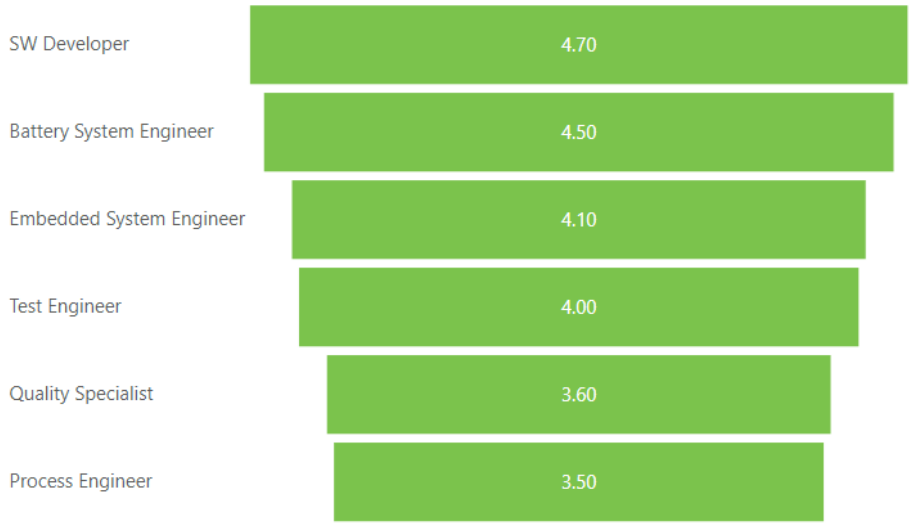

Figure 109 Industrial Stakeholders

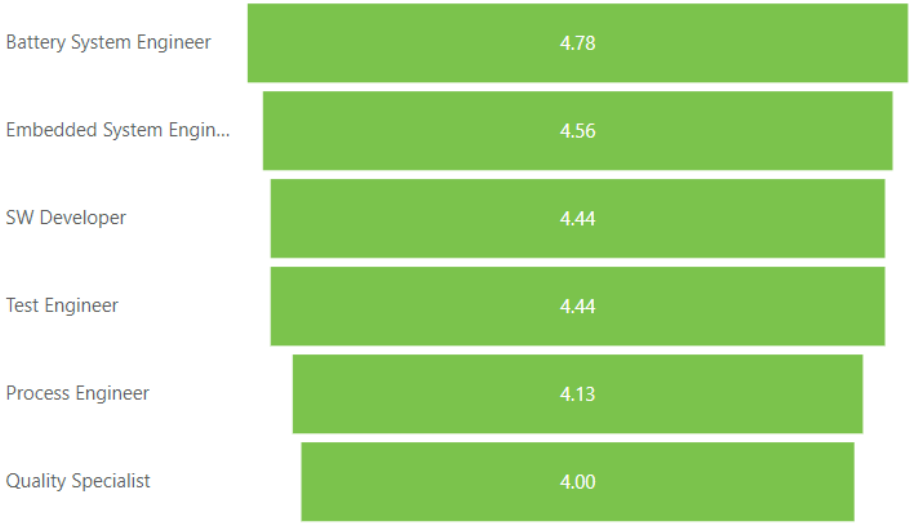

Figure 110 Education Providers

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Industrial stakeholders perceive the software developer (4.70) as the most important job role for the battery integration followed by the battery system engineer (4.50) and embedded system engineer (4.10), as seen in Figure 109. Results were similar for the education providers where the most important job role is a battery system engineer (4.78), embedded system engineer (4.56) and software developer (4.44), as seen in Figure 110.

3.3.6.1 Implications and Concrete Statements

According to the survey results:

- software developers are seen as the most important for industrial stakeholders;
- battery system engineers are seen as the most important for education providers;

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3.3.7 Job Roles Index – Operation, Repair, and Maintenance

Figure 111 Industrial Stakeholders

Figure 112 Education Providers

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In the case of **operation, repair, and maintenance**, the education providers (Figure 112) see the job roles as more important overall; they also perceive the battery repairer to be much more important than the industrial stakeholders do, scoring battery repairer at 4.25 as the most important job role for the education providers, whereas battery repairer is the least important job role for industrial stakeholders, only scoring 2.83 (Figure 111). Results show that **battery maintenance, testing and servicing** job roles are important for both samples.

3.3.7.1 Implications and Concrete Statements

According to the survey results:

- battery repairer is the most important job role according to education providers;
- battery repairer is the least important job role according to industrial stakeholders;
- education providers perceive operation, repair, and maintenance job roles as more important on average.

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3.3.8 Job Roles Index – Battery Recycling

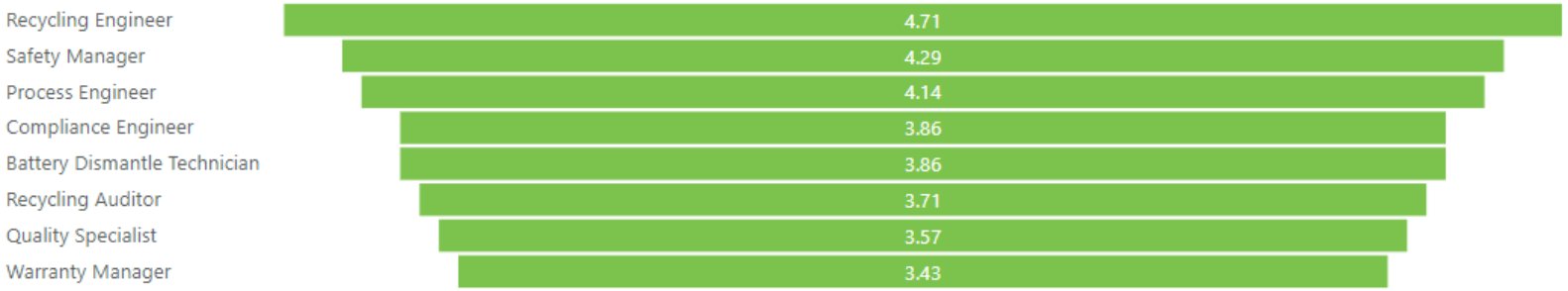

Figure 113 Industrial Stakeholders

In the case of battery recycling, there were sufficient replies from the industrial stakeholder's sample only (Figure 113). Industrial stakeholders perceive the recycling engineer as the most important (4.71) and safety manager being the second most important (4.29), whereas the warranty manager is perceived as the least important (3.43).

3.3.8.1 Implications and Concrete Statements

According to the survey results:

- recycling engineer is the most important job role according to industrial stakeholders;
- warranty manager is the least important job role according to industrial stakeholders.

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3.3.9 Skills Index – Soft and Transversal Skills/Competence and Knowledge

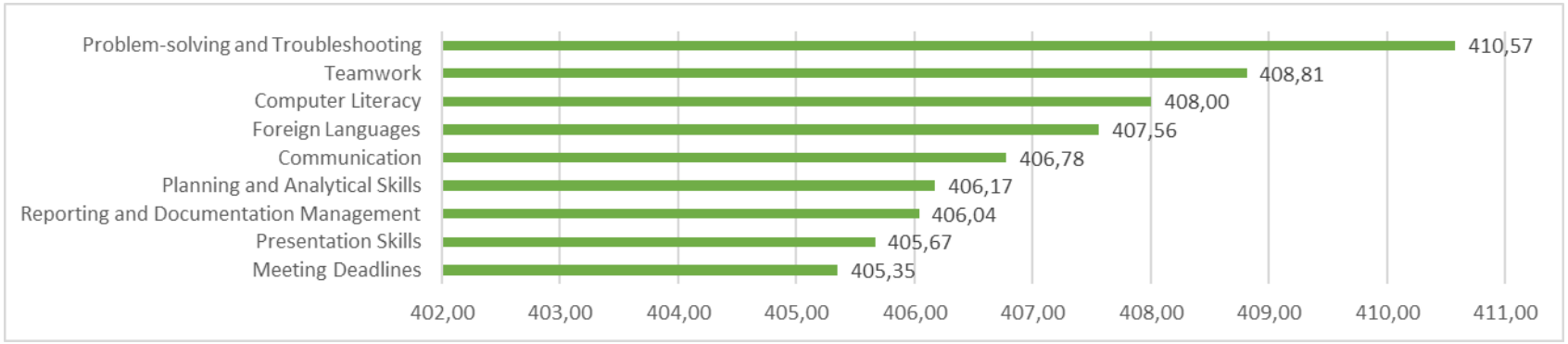

Figure 114 Industrial Stakeholders

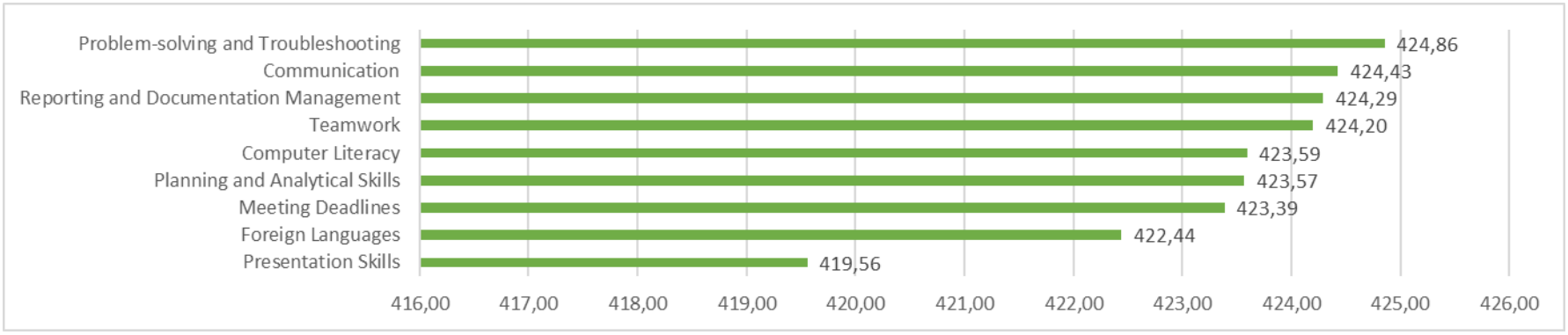

Figure 115 Education Providers

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When it comes to the soft and transversal skills/competences and knowledge, both samples perceive problem-solving and troubleshooting as the most important. Communication, reporting, and documentation management is seen as more important by the education providers (Figure 115) than by industrial stakeholders, whereas computer and foreign languages literacy are seen as more important by industrial stakeholders (Figure 114) than by education providers.

3.3.9.1 Implications and Concrete Statements

According to the survey results:

- problem-solving and troubleshooting and teamwork are seen as important by both samples;
- computer literacy is seen as important by industrial stakeholders, not as much by education providers;
- communication, reporting, and documentation management is seen as important by education providers, not as much by industrial stakeholders.

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3.3.10 Skills Index – Sector Specific Skills/Competence and Knowledge

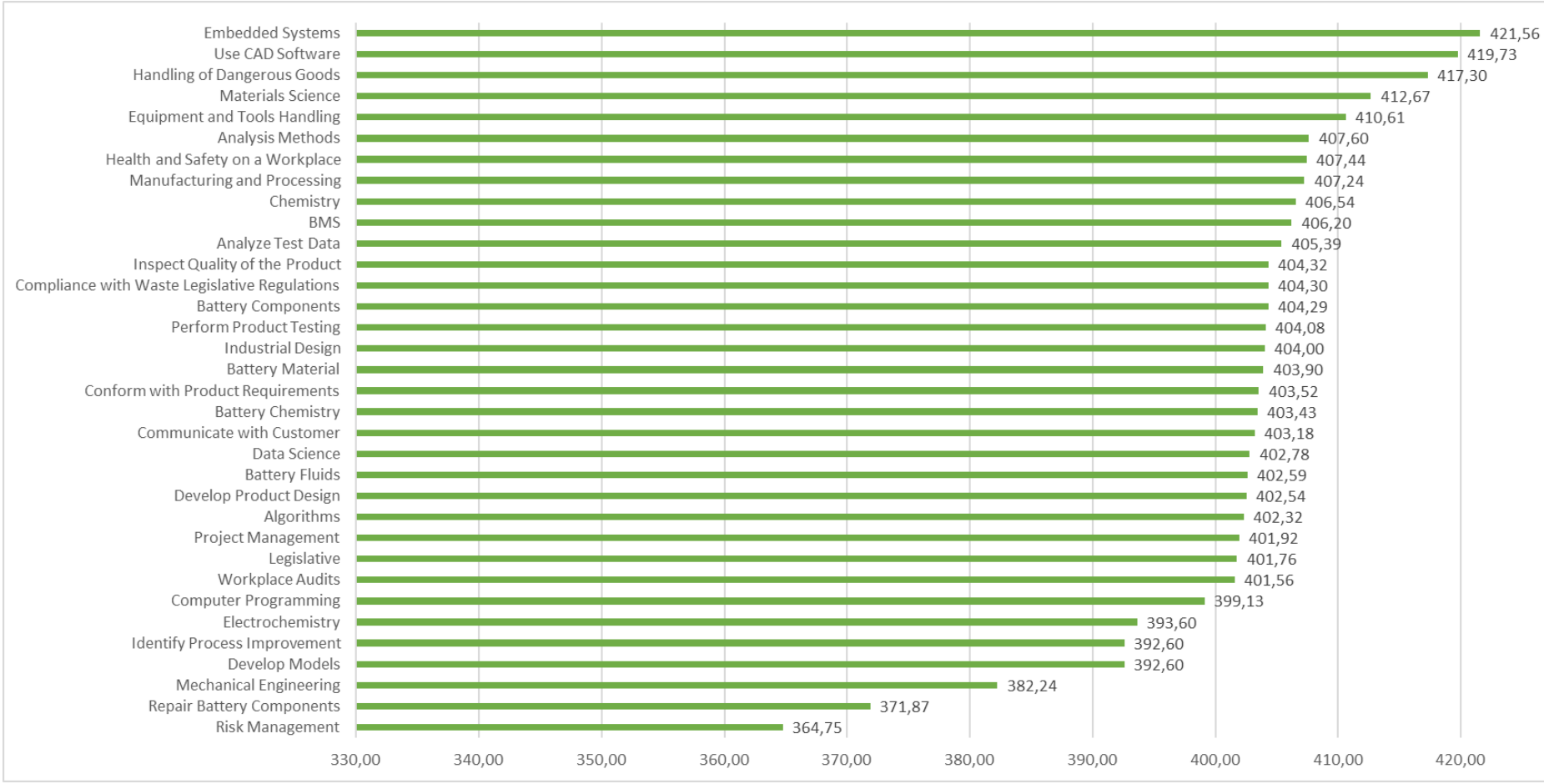

Figure 116 Industrial Stakeholders

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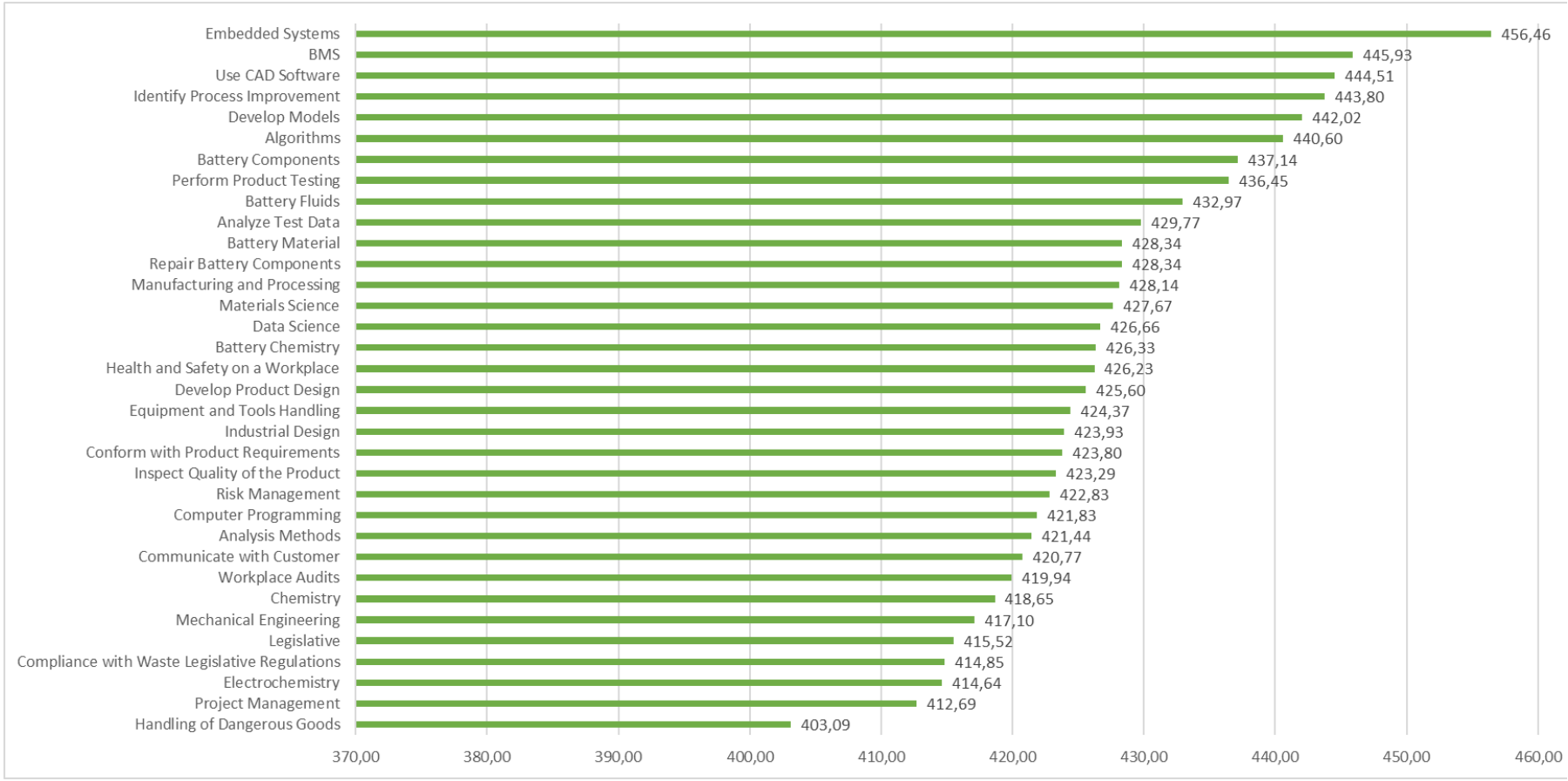

Figure 117 Education Providers

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Sector specific skills/competences and embedded systems are perceived as the most important by both samples. Education providers (Figure 117) perceive the BMS as much more important than the industrial stakeholders (Figure 116). Handling of dangerous goods, chemistry or compliance with waste legislative framework are seen as important by industry whereas not as much by education providers.

3.3.10.1 Implications and Concrete Statements

According to the survey results:

- industrial stakeholders perceive as important the following concepts:
  - embedded systems,
  - CAD software,
  - handling of dangerous goods and waste legislative framework,
  - methods of analysis,
  - chemistry,
  - manufacturing and processing,
  - data analysis and product quality.
- education providers perceive as important the following concepts:
  - embedded and battery management systems,
  - CAD software and development of models and algorithms,
  - Identification of process improvement,
  - Battery components and their repair, fluids, and battery material.

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3.4 SECTOR ATTRACTIVENESS

3.4.1 Attractiveness Factors

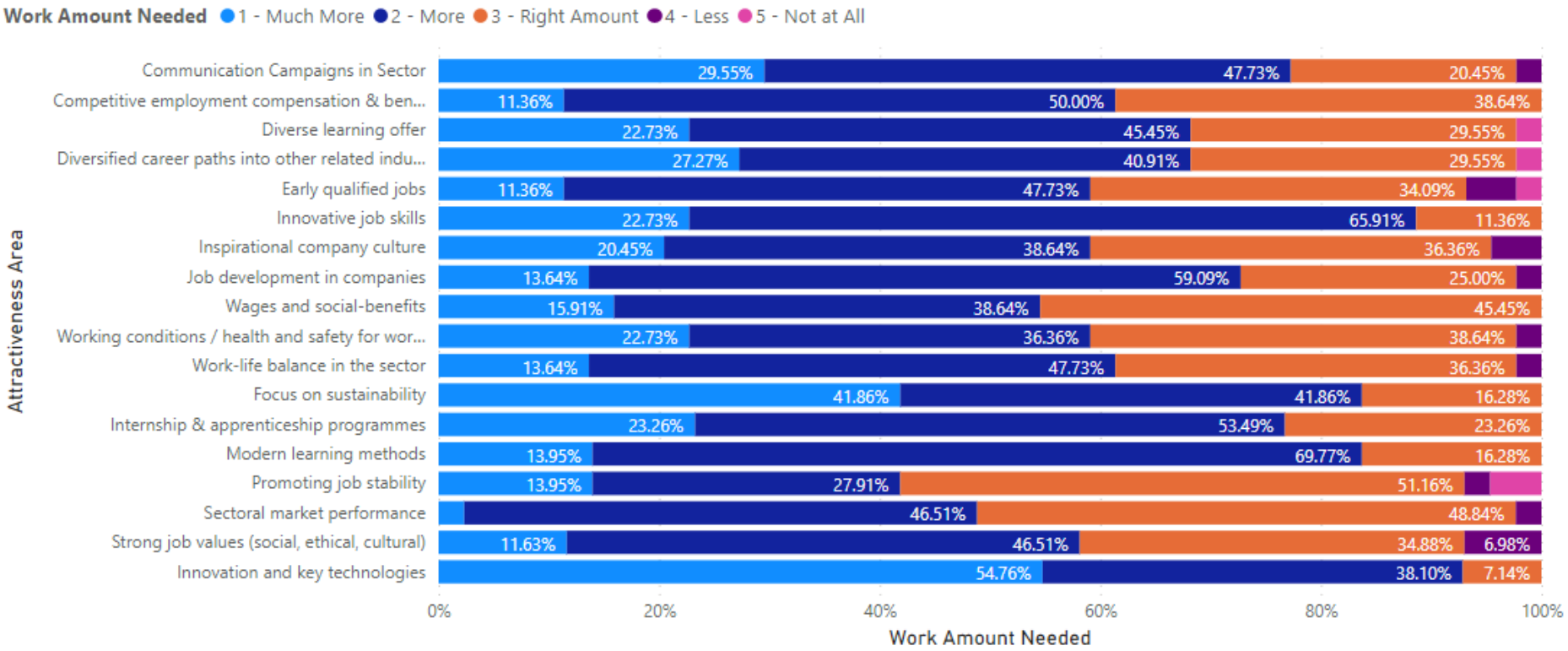

Figure 118 Industrial Stakeholders

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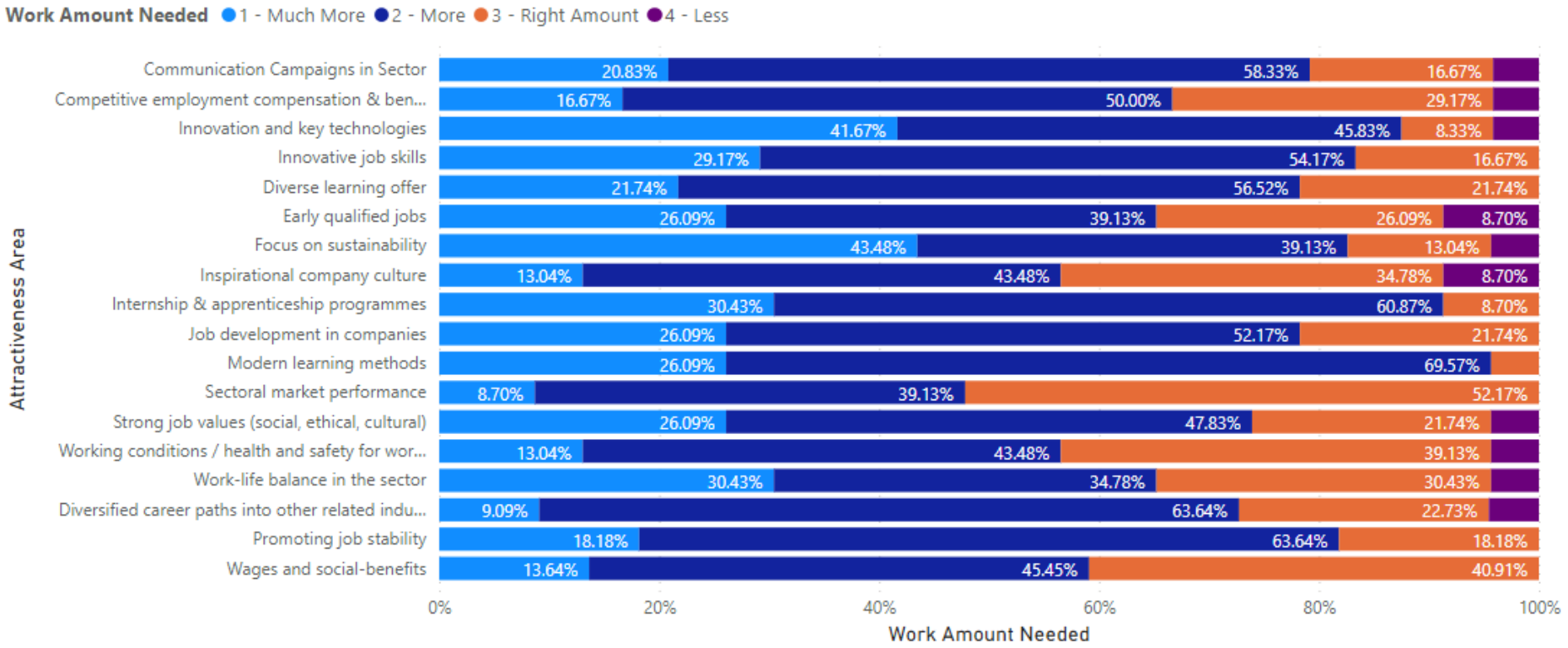

Figure 119 Education Providers

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In Figure 118 and Figure 119 we can see which areas the sector should focus on to improve its attractiveness from the perspective of industrial stakeholders and education providers.

Based on the results, industrial stakeholders voted as “much more” (i.e. most important) **innovation and key technologies** (54,76%) followed by **focus on sustainability** (41,86%).

This is also reflected in the replies from education providers, where **focus on sustainability** received slightly more votes compared to **innovation and key technologies** (43,48% and 41,67% respectively).

3.4.1.1 Implications and Concrete Statements

The similar results of industrial stakeholders and education providers show that the sector should increase leverage on innovation and key technologies, as well as paying attention to sustainability issues. This will ultimately improve and strengthen the attractiveness of the sector for potential newcomers.

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4 Semi-structured Offline Interviews

This section provides results of an additional activity – semi-structured offline interviews which targeted industrial stakeholders and education providers as well as selected ALBATTS partners.

4.1 INTERVIEW QUESTIONS

The number of questions was kept low to keep the interview simple and effective. General structure of the interview consisted of 8 main questions with several sub-questions. The base structure was adjusted depending on the recipient – either for companies, as seen below, or education providers (or research and development institutions):

- **Main trends and factors of the battery section transition and development:**
  - How do you see the EU battery sector development and its main drivers of change?
  - What affects your business the most?
- **Which workers are important for your business?**
  - What are the education requirements?
  - Do you see any influence from the automotive sector or other related industries?
  - Skills and competence needed:
    - Manufacturing processes and different stages of production.
    - The ratio between blue- and white-collar workers.
- **How do you approach the training of your employees?**
  - Do you provide education or training?
  - How do you approach workforce outsourcing?
- **Which competences and workers are lacking in the EU battery sector?**
- **What are the hot topics of battery production when it comes to education and competence?**
- **What does the EU battery sector lack the most?**
- **In which perspective is the battery sector strong (focus on education and competence).**
- **How does the workforce demand change as the EU battery sector is progressing?**

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Questions targeting the education providers and research and development were structured in a similar way the target being the research and development domain and education provision instead of industry and company business.

- **Main trends and factors of the battery sector transition and development:**
  - How do you see the EU battery sector development and its main drivers of change?
  - What affects the battery industry the most?
- **Which workers are important in the battery industry and its research and development?**
  - What are the education needs?
  - Do you see any influence from the automotive sector or other related industries?
  - Which skills and competences are needed – especially in research and development?
- **How do you approach education and training?**
  - Which curricula and programs do you provide and what would you pinpoint about them?
- **Which competences and workers are lacking in the EU battery sector?**
- **What are the hot topics of battery research and development?**
- **What does the EU battery sector lack the most?**
- **In which perspective is the battery sector strong (education and competence)?**

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4.2 RESULTS

The results section is elaborated according to the interview structure and provides a qualitative summary of the answers.

4.2.1 Main Trends and Factors of the Sector Transition and Development

The importance of the automotive industry was stressed as being the main driver in the EU battery sector development. This influence helped to automatize the production flow and provided the need for more advanced technologies to be used to satisfy the evolution of the automotive industry. Although the risk of over automation could be present, there will always be need for people to supervise the production (e.g., random testing, quality checks, and preventive maintenance).

Sustainability awareness and requirements in an ESG context are increasingly important in the decision making of the European Union and its member states. According to one respondent, this drives the legislative transformation and the changes in the battery sector, which is additionally supported by an increasing number of customers and a growing battery system market (mainly automotive and non-road mobile machinery OEMs). This also leads to new business opportunities for many companies.

Other drivers of change that should, according to respondents, be considered are: the scarcity of critical raw materials, ethical usage, outsourcing and cost; CO2 emissions reduction regulations (particularly the Regulation (EU) 2019/631 for passenger cars and vans; Regulation (EU) 2019/242 for heavy duty vehicles) and possibly the US infrastructure program that includes the boosting of green energy and electrification in the USA with the possible implications on the EU battery industry. Important pieces of legislation include the Euro standards (pollutant reduction) or charging infrastructure related (Directive 2014/94/EU and Directive 2018/844/EU). EU, national and regional incentives, low/zero-emission vehicles purchase and infrastructure subsidies, battery value-chain build-up in Europe, tax framework and other factors should be taken into consideration as well.

When it comes to the electromobility the requirements for longer range of electric vehicles and higher battery capacity, increased safety and other aspects drive the research and development in this field including research and development in competing technologies such

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as hydrogen fuel cells and others. Other than mobile applications, it is also important to take into consideration stationary applications of batteries.

4.2.2 Importance of Workforce

The need for specialists and experts – mainly engineers (e.g., production, manufacturing, chemistry, recycling); experts in automation, maintenance, and logistics; as well as the so-called volume category – technicians, operators (production, quality), material handlers or maintenance crew was mentioned. It was stressed that experience might be valued more than formal education; this includes work experience, personality traits and willingness to learn. More specifically work experience in automotive sector or similar industry would be valued. Support roles; HR; economy, purchasing, finance and legal departments are needed as well – examples include (project management, product development, supplier management).

Specifically for the automotive sector and electromobility, the need for integration experts, purchasing experts, process engineers, quality engineers, high voltage experts and technicians to ensure safety (servicing, battery diagnosis and testing) should be taken into consideration. The average ratio between blue- and white- collar workers is generally around 72,5% for blue-collar workers and 27,5% for white-collar workers. With the increasing production of batteries, there will be an increasing need for qualified workers in the future years.

4.2.3 Skill and Competence Needs

Skill and competences needs are dependent on the manufacturing processes: **(1) Chemical/up-stream production** – the operators should possess a good knowledge of control systems, calibration, and chemical processing, as well as manual skills such as testing, sampling, and material filling. Flexible and attentive staff is demanded, as the quality and characteristics of incoming raw materials can vary, but the quality of the slurry must in the end be the same, for the final characteristics of the batteries to be consistent. **(2) Slurry mixing** requires handling recipes according to customer demands, quality sampling tests and handling of relevant instruments. Attention to detail is very important. **(3) The slurry coating and drying process** resembles the paper and pulp industry in many aspects – cleanliness and risk awareness should be the priority at this stage. There are also resemblances to the advanced coating industry, as the coating of glass for specific characteristics or coating of high-quality

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tools and wear parts in machinery. **(4) The assembly stage** requires operators to check machines, coordination, and ability to solve problems in higher tempo working environment. Preventive maintenance is being done constantly. **(5) The formation (testing and battery aging) stage** where batteries are charged and discharged in a specific order to develop the specified characteristics requires data processing work to identify unexpected behaviour of assembled batches of batteries and identify its explanation. This includes big data, statistics, generalisation of the issue, and conclusion drawing. This data driven processing step demands higher education of the employees overall, but the experience, practical skills and awareness of trial and error is needed as well. It was also mentioned that the whole production chain should be scalable.

It is also important to evaluate different organisation scopes. This includes common skills and knowledge: safety and environment, clean area and ways of working, quality processes and continuous improvement, ergonomics, and work health. Specific areas include: **(1) logistics** – 5S, multiple IT systems, forklift driving, and daily operations (unloading and receiving, shelving or order handling); **(2) quality** – usage of laboratory equipment, quality measurements, defect investigation and material inspection; **(3) production** – production machine usage skills, analysis of faults and errors, HT8 operation and other; **(4) maintenance** – robotics knowledge (programming, documentation, coordination systems, manual operation, PLC interface), general electrical knowledge (hardware and software structure, data backup, automation system components), and general mechanical engineering knowledge of production equipment. As automation was mentioned, there is a need of machine learning and industry 4.0. Mechatronics and overall software and IT skills will be more needed.

4.2.4 Education Needs

Up-to-date curricula that will satisfy the needs of fast emerging sectors will be needed as soon as possible especially for VET and its internships and apprenticeships. Work-based learning should be strengthened – (1) practical machine operator skills; (2) demo lines and systems for VET schools with the focus on IT skills and automatization of production lines; (3) apprenticeships and internships contracts; (4) dissertation/thesis done in companies; (5) provision of training equipment for learning; and (6) proper skills assessment over the fixed study/working time.

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4.2.5 Training Provision, Re-skilling and Up-skilling of Workforce

Course provision for employees was mentioned to develop skills and up-skill into higher positions as well as onboard training provision with the planned education provision in the future.

Provision of training programs was also mentioned. Employees and new production (jobs with no previous experience needed) are trained by internal experts or, in specific cases, external partners provide training (production equipment providers, customers or training organisations).

Cooperation with secondary and tertiary education institutions was mentioned as something that should be strengthened with the use of internships and apprenticeships.

4.2.6 Important Topics for Battery Production, Education, Training and R&D

According to the respondents, the most important topics are considered to be:

- greening of the battery manufacturing process in terms of pollution and CO2 emissions;
- safety of batteries while in use;
- battery material mining and processing;
- battery material production;
- battery packs.

4.2.7 Weaknesses of Battery Sector

Compared to Asia, Europe, in the long-term, lacks skills and competences of battery cell production and proper education base.

Lack of relevant experience or documented skills is an issue in a new, developing industry such as the battery industry – this leads to more general job advertisements. Importance of internal training and the need for improvement in automation and digitalisation knowledge in the future was stressed. Despite the low volumes of end-of-life electric vehicles and decommissioned traction batteries, the critical needs for competences are observed in the second life and recycling sectors as well.

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4.2.8 Strength of Battery Sector

The strong footprint of automotive OEMs with resources and the will to fill in the gaps within the EU battery value chain is one of the main strengths of the EU battery sector. It is important to catch up with the cell manufacturers from outside Europe (due to the lack of battery production until recently). This also affects the competences of universities and other education providers. The trainers must be trained as well.

4.2.9 Workforce Demand

When it comes to the staff outsourcing, this is being done for different projects, although this is not the case for operations.

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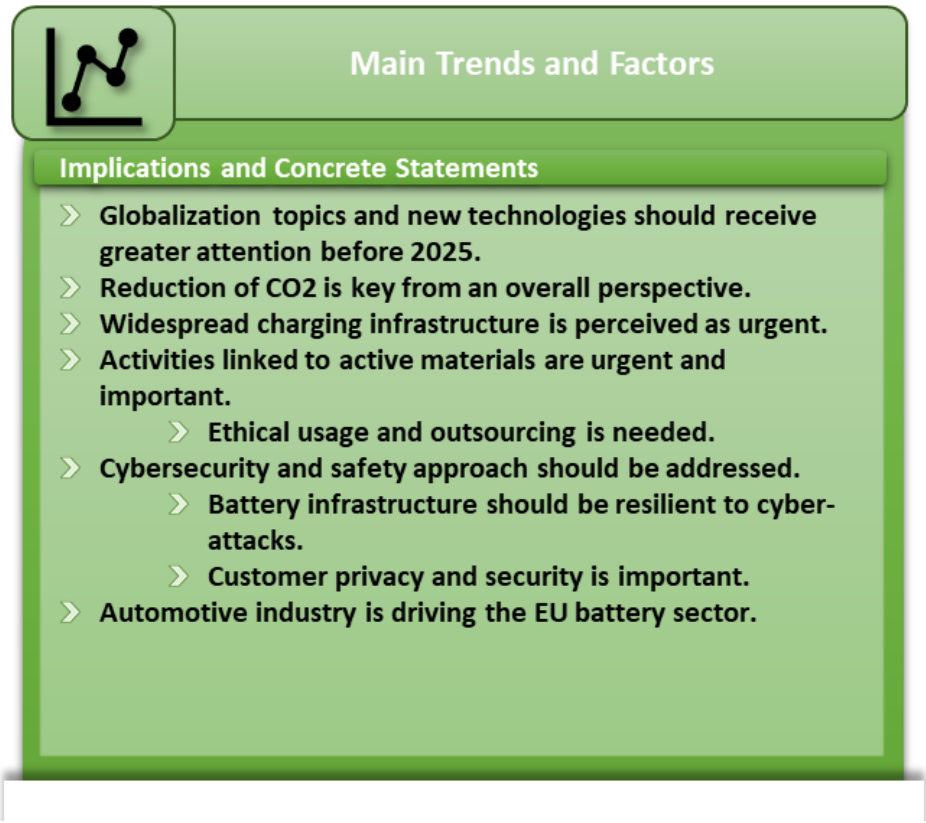
4 Concrete Statements and Implications

This section provides the evaluation of the concrete statements and implications for the battery sector in a structured way. Concrete statements and implications are categorised by main trends and factors; and by skills agenda, training, and education topics. The information outlined here is based on the views of the respondents of the survey and interviews, and will be a valuable resource for the development of the roadmap for the EU battery sector.



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Skills Agenda, Training and Education

Implication and Concrete Statements

- Work experience, personality traits and willingness to learn are important aspects when hiring new employees.
- Ratio between blue- and white- collar workers is generally 72,5 to 27,5%.
- Knowledge on automation; manufacturing and production processes; data-oriented skills and competence; and digital skills are valued.
- Up-to-date curricula to satisfy the demand is needed.
  - Especially for VET, internships and apprenticeships.
- Work-based learning should be strengthened.
- Training opportunities and training for employees should be strengthened:
  - onboard training;
  - provision of training programs;
  - training by internal or external experts;
  - strengthening the cooperation with secondary and tertiary education;
  - apprenticeships and internships.

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