Workforce Foresighting Hub

# Lithium Ion Battery Module & Pack Assembly for transport applications in the UK

Workforce Foresighting Hub findings report
in collaboration with WMG, University of Warwick.

**Date: March 2025**

Innovate UK

Right skills, right time, right place

## Acknowledgements

The Workforce Foresighting process integrates data from the following international data sets:

*IfATE – Institute for Apprenticeships and Technical Education, England*

*ESCO – European Skills, Competencies, Qualifications & Occupations, EU*

*ONet – Occupational Networks Online, USA*

In accordance with licence and publishing requirements of these organisations for the use of their data sets, the Workforce Foresighting Hub team states that –




*Any errors, omissions and incorrect data are the responsibility of the Workforce Foresighting Hub team, and all queries should be addressed to info@iuk.wf-hub.org*

*The method and process used in the Workforce Foresighting process is under development and there may be errors and omissions in the data provided.*

*This report was produced following workshops undertaken October 2024 – January 2025 using the data set and tools available at that time.*

# Contents

# Executive Summary

# Executive Summary

This report outlines findings from the Workforce Foresighting cycle focussing on **receipt of cell and components to the assembly of lithium-ion battery modules and packs for transport**. The study is sponsored by UK Battery Industrialisation Centre (UKBIC) and conducted by the WMG, University of Warwick (WMG) in collaboration with the Workforce Foresighting Hub, an Innovate UK initiative.

Workforce foresighting is a systemic approach to planning ahead and anticipating future skills and capability needs associated with new technologies and government transformation targets. It involves identifying and understanding the skills required for tomorrow's jobs, ensuring our education and training systems are prepared so that our workforce is ready to adopt new technologies and support future industrial growth.

This report sets out the findings of the workforce foresighting study and suggests the next recommended actions required by various stakeholders to ensure a workforce is created that is prepared to effectively implement these new technologies in the sector.

## Workforce Foresighting Topic

The UK's transition to battery electric vehicles (BEVs) presents a critical shift for vehicle manufacturers like JLR and Mini, requiring a fundamental transformation in production lines, workforce capabilities, and supply chain strategies. To remain competitive and achieve climate targets, manufacturers must rapidly reconfigure assembly operations, particularly in battery module and pack integration, while navigating significant workforce reskilling demands. This shift will have a profound impact on human resources, requiring new expertise in electrification technologies, as well as on production infrastructure, necessitating investment in retooling existing lines to accommodate BEV manufacturing at scale. The previous cycle examined the complexities of cell manufacturing whereas this cycle examined the consolidation of the cells into modules and packs which would be specific to each vehicle manufacturer.

This section outlines key insights from the research, highlighting the scale of demand growth, the current capacity gap, and the critical workforce needs associated with module and pack assembly manufacturing. These findings provide a foundation for understanding the national and sectoral challenges in battery production and its associated supply chains.

It is anticipated that the dip in vehicle manufacture that occurred during the COVID 19 Pandemic will return to previous levels within the next year. Previous research by WMG assumed that around 80% of all vehicles manufactured in the UK will be electric by 2030 considering those manufactured for export to countries where EV mandates are not yet impacting upon purchasing behaviour. As such the majority of drivetrain manufacturing will need to shift from the producing of internal combustion engines, transmissions and associated mechanical systems to electric drivetrains with modules and packs being assembled and integrated into vehicles alongside associated hardware and software systems. This represents a significant shift for manufacturers in terms of competencies.

The passenger automotive sector is not the only one impacted by the changes with other transport modes also requiring module and pack assembly capabilities to include rail, aerospace, marine, light, and heavy commercial, and micromobility solutions such as e-scooters and bikes. A number of these areas will also continue to grow over the coming years and the presence of capabilities within the employment market will support this growth significantly. Re-training for module and pack assembly will require retraining for a workforce number in the tens of thousands and aligns with broader estimates that up to 40% of the UK's automotive workforce, approximately 80,000, work in legacy drivetrain roles and will need to re-skill into activities such as module and cell assembly alongside motor and drivetrain integration.

This Foresighting cycle has focused on the assembly of lithium-ion battery modules and packs for transport applications in the UK. The choice of lithium-ion reflects the most widely used application for batteries in transport and the competencies will be transferable if, and when, chemistries change. The process of module and pack assembly considers competencies needed to take battery cells and produce a functioning battery system for a transport application. This includes all the component parts of the pack itself. It was also decided to include quality assurance and elements of logistics and compliance to reflect the battery cell manufacturing cycle in recognition that whilst these activities are likely to take place in different facilities there will be manufacturers that will manufacture the entire battery.

The maintenance and repair of the manufacturing environment itself is not considered within this cycle as it was assessed that sufficient capability exists and further can be provided by existing programmes of learning, to meet needs. In addition, the manufacturers and integrators of equipment installed in facilities are better placed to provide that training. It was also decided that re-work of modules and packs would be included with a subsequent cycle focusing on battery recycling to maintain a focus on best-case manufacturing.

Both technical and industrial experts recognised that there was a greater need to focus on automation and logistics to meet the needs of future manufacturing methods. In addition, the importance of sustainable practices is clear with an integration of competencies across the workforce. The aim is to provide development for a workforce to handle the complex task of integrating battery cells into a battery pack.

In established manufacturing sectors the solutions proposed focus on the need to rapidly re-skill and up-skill an existing workforce to enable the shift to electric mobility. This is clear in the need to support automotive manufacturers to ensure they can retain experienced workers and enable them to transition to new roles. There are also several growing transport areas where capabilities will be required so there is a need to consider re-skilling programmes for engineers and technicians who are transitioning from one area of manufacture to another with a new employer. Longer course programmes, and the integration of appropriate knowledge, will also be required to future-proof the workforce. This has already been seen in the L3 Battery Manufacturing Technician apprenticeship but will require extending to other qualifications and modes of learning. Importantly the training of new engineers will need to include competencies in this area. Recognising competencies and skills with an established professional register would facilitate recognition without introducing unnecessary regulatory burdens.

This report underscores the need to act not just in the future but also in the shorter term to enable the skills transition. Competencies are evolving, and this report demonstrates this, but the challenge for some time will be scale and speed of the shift therefore rapid industry, Government and provider buy in will be required. This report provides employers with guidance on what they need to look for in provision, it supports providers to identify what provision is needed and what capabilities they need to acquire to meet industry needs and it enables Government to better understand the needs of both parties to better support them with informed policy.

## Participants and stakeholders

- *Aston Martin*
- *Automotive Technology*
- *Batri*
- *City & Guilds*
- *Electrification Skills Network*
- *Ford*
- *Fortescue Zero*
- *HVM Catapult*
- *Illston Authoring*
- *Institute of the Motor Industry*
- *Newcastle College*
- *North Warwickshire and South Leicestershire College*
- *Pro Moto*
- *Recovolt*
- *SIAS*
- *SectorTech*
- *Telford College*
- *UKBIC*
- *VOLKLEC*
- *WMG, University of Warwick*

## The Findings and Insights

The changes in module and pack assembly are more nuanced than those observed in battery cell manufacturing. Whereas battery cell manufacturing is new and there are no existing employers that need to pivot, the assembly of modules and packs is likely to happen within established manufacturers who have been working with different technologies for the entirety of their operations. Automotive manufacturers will need to pivot from the manufacture of combustion engine powertrains to designing, manufacturing, and installing electric powertrains. A sizeable portion of that activities will be associated with batteries.

The challenges associated with the make-up of manufacturing activities and how that impacts on predicting numbers, and therefore workforce composition, makes it challenging to fully understand the actual demand. The "best case" scenario is that the whole of the UK vehicle manufacturing transitions to electrified power training. This would, in the case of automotive, give an estimated 1.5 million vehicles being produced each year. However, there is the consideration of export and the demands of those markets. Therefore the 80% outlined earlier is a more conservative estimate. Even a 50% shift to EV powertrain manufacture would need at least 50% of the workforce to make the transition. However, the demands of maintaining the infrastructure to manufacture two types of powertrains in the long term may be cost prohibitive driving behaviour.

The ongoing growth of module and pack assembly, and the embedding of new technologies and processes, will necessitate a shift in the types of organisational capability required. These are split into the five key areas shown below.

- **Design –** There is an enhanced focus on new product engineering with OEMs designing their own module and pack solutions to meet their requirements. There is a much greater emphasis on the evaluation of practice and integration of sustainability as a cross-cutting theme both in manufacturing process and in the nature of the products themselves.

- **Implementation –** Manufacturing processes will benefit from much greater use of automation to meet increased volume demand a need for standardisation and quality. This will, in turn, enhance the role of data gathering, analytics and visualisation across a broad range of roles. This will range from a basic awareness through to expert data analytics specialists.

- **Logistics –** Across the entire battery manufacturing ecosystem there is need to ensure that streamlined supply chain management in in place to ensure that procurement and handling of material, at volume, is undertaken effectively. The role of logistics within the manufacturing environment is also increasing in importance. This is reflected in a wider range of occupational profiles included in the report.

- **Support –** There is an increase associated with in-service support capability. There is a need to pay closer attention to product lifecycle management and the importance of recycling processes as part of the wide ecosystem.

- **Enterprise Functions –** This report identifies a trend towards an expansion in strategic planning to support the rapid growth in demand that has already started and will continue over the coming decade. The importance of regulatory compliance has been further emphasised and complements the work undertaken in the Battery Cell Manufacture cycle. Finally, workforce development is identified as a key manufacturing capability to support the workforce to remain ahead of sectoral developments.

The below summary highlights the key Future Occupational Profiles that have emerged from the work underpinning this report. These profiles reflect the distribution of profiles from the Battery Cell Manufacture cycle and demonstrate a high degree of alignment in the potential workforce structure. This is highly relevant as there are likely to be instances where the entirety of battery manufacturing, from cell to pack, is undertaken in the same facility. Having alignment will make this integration much easier.

- **Senior Engineers –** Within the occupational structure these profiles are focused on systems design, automation, and sustainability leadership. With an emphasis on combining deep technical knowledge and a strategic outlook senior engineers form a critical link between functions.

- **Graduate Engineers –** These occupational profiles are focused on data interpretation, project integration and quality assurance. Graduate Engineers provide day to day leadership of manufacturing teams and bring specialist domain knowledge to the process.

- **Supervisors/ First-Line Managers –** The roles of occupational profiles within this group have increased significantly. These roles are responsible for day-to-day management of operations, logistics and compliance. Having worked in specialist technical manufacturing roles they are able to bring deep knowledge and experience to the manufacturing teams.

- **Technicians –** The most abundant of all occupational profiles, technicians specialise in assembly, maintenance and quality control across a range of functions such as cell handling, module integrations, logistics and recycling. The importance of roles at this level cannot be emphasised enough due to their highly specialist nature and critical importance to the manufacturing process.

To fulfil the requirements of these occupational profiles there are certain existing standards that can be used to fulfil requirements. For technician roles the existing Quality Assurance Technician and Electro-Mechanical Technician do provide some alignment with identified need. This makes them suitable as a start point for up-skilling and curriculum development. However, there are several competencies that are not covered within these standards.

More concerningly there are significant gaps in areas such as logistics and engineering leadership. Many of the existing standards targeted at logistics, for example Dispatch and Distribution Managers and Logistics Supervisors, exhibit incredibly low auditability for use. This is due to the presence of a substantial number of redundant competencies and a lack of competencies in the areas identified in this report. Therefore, for apprenticeships there is a pressing need for new standards and there is also a lack of a ready start point for development.

For more advanced roles there is also a lack of alignment with existing standards. This poses two problems, the development of new leaders within the full-time education system, and via apprenticeships, and the re-skilling of existing engineers. The greatest impact is in technical areas as experienced engineers will possess much of the leadership capabilities required but will lack the domain knowledge at the appropriate level.

There is a need to close the gaps by developing new apprenticeship standards, longer-term education programs—such as degree courses—and rapid reskill and upskill initiatives for those already in the workforce or transitioning into new roles. Professional bodies play a critical role in upholding standards and promoting excellence across the sector by certifying skills through professional registers like the IMI Professional Register, driving the adoption of recognised safety standards such as IMI TechSafe recognition for high-voltage automotive applications, and ensuring continuous workforce development through comprehensive training frameworks and industry collaboration.

***Data Capture Overview***

## The Next Steps

The transition to battery electric vehicle (BEV) manufacturing represents one of the most significant industrial shifts in the UK's transport sector. As highlighted in this Workforce Foresighting cycle, the challenge is not just technological but deeply rooted in workforce capability and skills readiness. Addressing these skills gaps is crucial to ensuring the UK remains competitive, sustainable, and capable of supporting its net-zero ambitions. The time for action is now, requiring coordinated efforts across industry, government, professional bodies, and education providers to build a workforce fit for the future.

### Summary of Next Steps

1. **Leverage the Electrification Skills Network (ESN) as the Primary Forum for Action**
   - Rather than establishing a new working group, champion the use of the ESN as the central platform for discussion, coordination, and dissemination of workforce foresighting insights.
   - Strengthen the ESN's role in aligning industry, education, and government stakeholders to drive a unified skills agenda.
   - Ensure ESN facilitates clear, actionable pathways for addressing workforce challenges, leveraging its existing network and expertise.

2. **Validate Future Occupational Profiles (FOPs)**
   - Conduct industry-wide consultation to ensure the proposed workforce profiles align with employer needs.
   - Assess existing training standards and qualifications for suitability against emerging roles.

3. **Identify a Sector Champion for Workforce Development**
   - Appoint a recognised industry leader or professional body to drive skills development in the sector.
   - This champion will act as a convener for collaboration between employers, education providers, and policymakers to ensure skills readiness and delivery.

4. **Develop an Action Plan for Immediate and Mid-Term Needs**
   - **Short-Term (0–2 years):**
     - Identify priority upskilling/reskilling initiatives for existing workers by working closely with existing manufacturers who are re-deploying their workforce.
     - Work with education providers to integrate BEV module and pack assembly skills into existing qualifications.
     - Establish funding mechanisms and incentives for rapid training deployment.
     - Encourage uptake of a professional register to facilitate continuous professional development.
   - **Mid-Term (3–5 years):**
     - Develop new qualifications and apprenticeship routes specific to battery module and pack assembly.
     - Expand workforce development programs to ensure a pipeline of engineers and technicians.
     - Encourage continuous professional development through a professional register for industry recognition.

5. **Evaluate Opportunities for Further Workforce Foresighting Studies**
   - Assess adjacent workforce gaps such as those in battery recycling, next-generation chemistries, automation, and logistics to inform future planning.
   - Determine the feasibility of expanding foresighting efforts to address gaps in supply chain resilience and sustainability.

Failure to act decisively will have long-term consequences for the UK's industrial competitiveness, workforce sustainability, and ability to meet net-zero targets. If these skills gaps are not addressed, UK-based manufacturers risk falling behind global competitors, and supply chain resilience will be compromised. Urgent collaboration is needed to ensure that the workforce transition keeps pace with technological advancements - securing jobs, investment, and leadership in module and pack assembly.

# 1. Introduction

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## 1.1 Background to Workforce Foresighting

The report "Manufacturing the Future Workforce" (Collier et al., 2020) recommended the Skills Value Chain as an approach to avoid shortfalls in workforce capabilities relating to future innovations (see Figure 1). This is the genesis of the workforce foresighting programme, which is sponsored by Innovate UK and delivered through the Innovate UK Catapult Network.

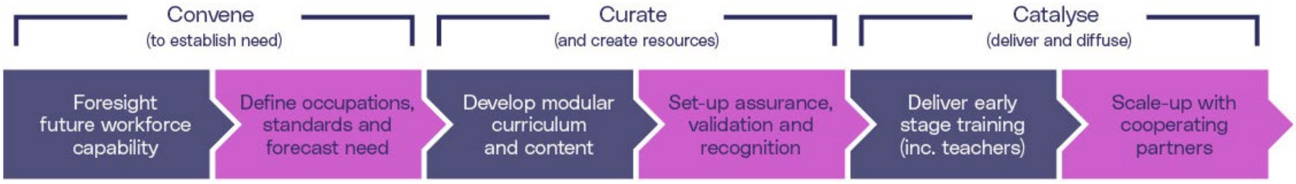



*Figure 1: The Skills Value Chain*

The first step of the skills value chain is to "Foresight future workforce capability": This calls for technology, industry, education, and training partners to convene using government as a focal point, to "foresight and articulate future skills needs, standards and qualifications associated with emerging technologies" (Collier et al., 2020).

## 1.2 Workforce Foresighting - Process Overview

The core of workforce foresighting is convening three groups of relevant specialists to conduct structured, Delphi-style, facilitated workshops to capture and discuss the set of organisational capabilities that will be required to respond to and exploit technology innovation.

Organisational capabilities are captured using a bespoke classification that has been developed by the Workforce Foresighting Hub. The classification uses a structured common language to enable cross sector and cross centre collaboration and integration of data. Additionally, the classification enables data from several other national and international open-source workforce datasets to be integrated through the same common language. The data is held in a cloud based "data-cube" that is dynamically growing as each workforce foresighting cycle adds to the shared data relating to future workforce capabilities.

Using innovative AI and Large Language Model data tools, the data-cube is used to undertake detailed analysis to 'map' future workforce capability requirements against the current education and training provision to identify where existing provision can be used and where new provision, CPD or qualifications are required.

As an agile development project, the Workforce Foresighting Hub team are constantly evolving and improving the detailed workshop process and workshop approach, but always consists of the following stages:

**Considering** – Clarifying the Challenge to be met (the 'what' and the 'when') and collating solutions (the 'how') as foresighting topic suggestions align with strategic priorities

**Identifying** – Gain clarity and consensus about the solutions to be put forward – make the case for foresighting

**Preparing** – The convening of specialists and scheduling of workshops

**Carrying out** – Run foresighting workshops with experts, collate and analyse data

**Communicating** – Insights, findings and recommendations gathered from all research in report

**Causing action** – The driving of action based on the recommendations (promoting progress down the rest of the skills value chain) built on the findings and recommendations of foresighting

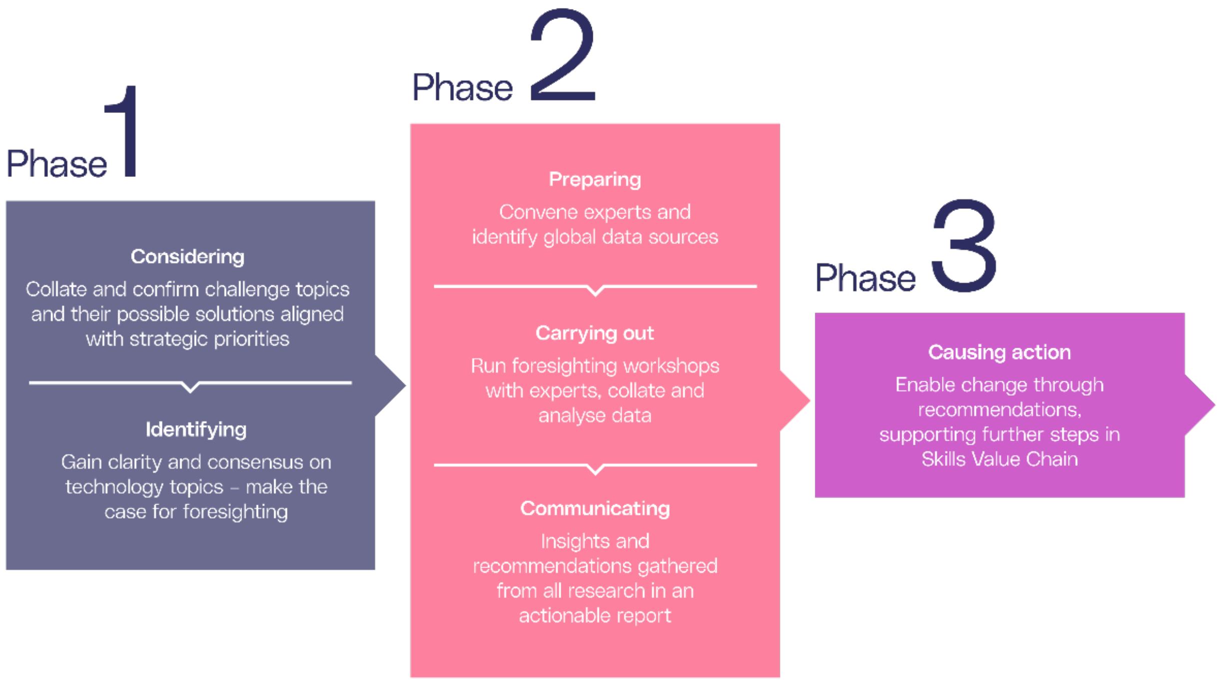



*Figure 2 - The workforce foresighting process*

## 1.3 Foresighting vs forecasting

Although this study is focussed on workforce foresighting (capabilities required) it is important to keep in mind parallel findings from forecasting (required capacities and numbers). Forecasting, alongside foresighting, provides vital input to the sector, feeding into recruitment and development targets for employers, and consideration of economic class sizes and recruitment targets for educators. However, it is beyond the scope of the foresighting study to carry out independent forecasting, and as such readers should refer to referenced studies for detail on forecasting.

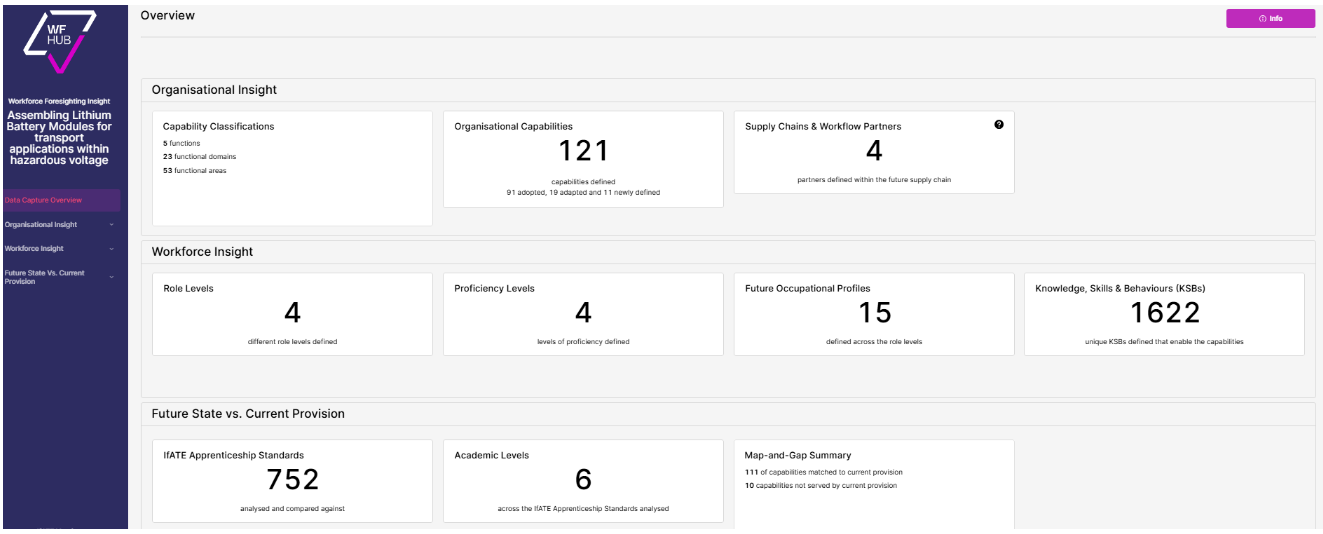
## 1.4 Introducing the Visualisation Tool

The Workforce Foresighting Hub's Visualisation Tool is a powerful, innovative system, which will enable the reader to explore and analyse foresighting data to determine the capabilities required for future roles. Links throughout this report make it easy to identify existing standards which meet the needs of these future roles and pinpoint where new standards are necessary to develop a skilled workforce equipped to adopt new technologies.

The data is generated by the foresighting cycles, integrating the expertise of technologists/domain specialists, employers, and educators.  The data informs the development of future curriculums and course content as determined by the action plan.  Using AI tools validated by human oversight, and by linking to external data sources, the tool identifies differences at the level of occupation/role as well as detailed changes required to help update/refresh knowledge, skills and behaviours thus delivering insights for learners, providers, creators, and assurers of skills.

Detailed instructions on how to use the Visualisation Tool can be found in the appendix.

***Data Capture Overview***



# 2. Aligning the Challenge and Solutions with national priorities

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| **Section** | **Title** |
|---|---|
| 2.1 | Positioning and context of challenges |
| 2.2 | Potential and prioritised solutions to challenge |
| 2.3 | Workforce foresighting for chosen prioritised technology solution |
| 2.4 | Current and predicted scale of technology deployment in UK |
| 2.5 | Participants in the cycle |

## 2.1 Positioning and context of national challenge

The UK government aims to achieve **zero tailpipe emissions for all new vehicles through the Zero Emission Vehicle Mandate**, a critical part of its broader commitment to net-zero emissions by 2050. This target will require automotive, light, and heady goods vehicles, aerospace, rail, and marine manufacturers to transition parts of their workforce to design, assemble, test, and deploy modules and packs. This is most present in the automotive sectors where an estimated one million vehicles are produced each year. To meet the targets of the zero-emission vehicle mandate automotive manufacturers will need to re-deploy significant numbers of their powertrain manufacturing workforce to design, manufacture and assemble electric drivetrains. A critical part of this is the battery pack which are often bespoke to each brand, and often model, of vehicle.

Automotive related manufacturing contributes c£93 billion turnover and £22 billion value added to the UK economy annually. Around 198,000 people are employed in manufacturing roles in the UK as of 2023. The UK is also one of the largest combustion engine manufacturers with around 1.62 million produced in 2023. There is likely to be a decrease in this as the sector shifts to manufacturing battery electric vehicles. However, many of those engines are manufactured for export. The wider automotive sector is extremely valuable to the UK, and it is critical that manufacturing roles are retained and that manufacturers have access to the capabilities they need to enable them to remain competitive. It is also important that capabilities are developed to enable manufacturers to meet Rules of Origin regulations when they are fully deployed. According to the SMMT there are four mainstream car manufacturers, four commercial vehicle manufacturers, five bus and coach manufacturers and seven premium and sport car manufacturers currently operating in the UK.

**Technologies changes:**

**Current Technological Shifts**:

- **Automation**: Increased adoption of robotics and AI-driven systems in manufacturing and logistics to enhance productivity and quality.
- **Recycling**: Development of advanced processes to recover critical materials from end-of-life batteries, essential for sustainability.

**Future Outlook**:

- **Battery Chemistry**: Transitioning to solid-state batteries, which promise higher energy densities and faster charging.
- Widespread adoption of **modular and scalable manufacturing technologies** to cater to diverse applications, from EVs to grid storage.
- Integration of lifecycle management tools to track battery performance and recycling.
- Expansion of UK capabilities in cell chemistry innovation, driven by research at facilities like UKBIC and partnerships under the Faraday Challenge.

**Related reports or studies**

- **Faraday Institution**: Comprehensive analysis of the UK's battery industry challenges and opportunities.
- **Innovate UK Reports**: Insights into workforce foresighting and skills development for electrification.
- **Department for Business, Energy & Industrial Strategy (BEIS)**: Strategies for achieving net-zero emissions through industrial decarbonisation.

*BEIS existed until 2023 when it was split to form the Department for Business and Trade (DBT), the Department for Energy Security and Net Zero (DESNZ) and the Department for Science, Innovation and Technology (DSIT). Responsibility for national security and investment policy has gone to the Cabinet Office.*

These resources emphasise the critical need for collaboration across government, industry, and academia to secure the UK's position as a competitive global player in the battery manufacturing sector.

- *UK battery strategy https://www.gov.uk/government/publications/uk-battery-strategy*
- *Batteries for electric vehicle manufacturing: Government Response to the Committee's First Report of Session2023-24 https://publications.parliament.uk/pa/cm5804/cmselect/cmbeis/547/report.html*
- *Faraday Battery Challenge https://www.ukri.org/what-we-do/browse-our-areas-of-investment-and-support/faraday-battery-challenge*
- *Call for Evidence: Batteries for electric vehicle manufacturing Response: UK Battery Industrialisation Centre (UKBIC), Rowley Road, Coventry https://committees.parliament.uk/writtenevidence/118542/pdf/*

## 2.2 Potential and prioritised technology solutions to the challenge

The evaluation of technology solutions was conducted through a systematic process involving:

- **Identifying Key Challenges**: Aligning solutions with the UK's battery manufacturing demand, sustainability goals, and workforce skills gaps.
- **Stakeholder Engagement**: Input from industry experts, academia, and policymakers to understand technological feasibility and scalability.
- **Criteria Assessment**: Solutions were ranked based on cost-effectiveness, compatibility with existing infrastructure, potential to close supply chain gaps, and alignment with environmental goals.
- **Pilot Testing**: Feasibility trials to evaluate performance under real-world conditions.

**Technology solution options**

| Technology Solution | Description | Scope | Relevance to Challenge | Timing |
|---|---|---|---|---|
| **Advanced Cell Assembly** | Automation of cell stacking and integration. | High-volume production with precision. | Addresses production efficiency gaps. | Short-term (1-2 years). |
| **Solid-State Batteries** | Next-gen batteries with higher energy density. | R&D for enhanced safety and range. | Reduces reliance on lithium-ion batteries. | Medium-term (5-7 years). |
| **Battery Recycling** | Recovery of critical materials from old cells. | Scaling recycling plants for closed-loop supply. | Supports sustainability goals. | Medium-term (3-5 years). |
| **Modular Manufacturing** | Flexible systems for multiple applications. | Cater to EVs, grid storage, and other sectors. | Increases versatility and reduces waste. | Long-term (7-10 years). |
| **AI and Robotics** | Automated quality control and assembly. | Deployment of machine learning tools. | Enhances productivity and accuracy. | Short-term (1-3 years). |
| **Lifecycle Management** | Monitoring batteries from production to recycling. | Software integration with tracking systems. | Supports efficient end-of-life processes. | Medium-term (3-5 years). |

**Case for each solution and relevance to challenge**

- Advanced **Cell Assembly**: Critical for scaling production to meet demand; automation reduces errors and production times.
- Rapid **developments in Battery Chemistries**: Offers a transformative leap in energy density and safety, addressing range anxiety for EVs.
- Battery **Recycling**: Essential for reducing material imports and promoting sustainability in line with circular economy principles.
- Modular **Manufacturing**: Provides flexibility to adapt production to diverse market demands, reducing capital expenditure risks.
- AI **and Robotics**: Improves operational efficiency, addressing the workforce skills gap and ensuring consistent quality.
- Lifecycle **Management**: Enables effective tracking, reducing waste, and improving recycling rates.

**Current state and supply chain impacted**

- The UK's battery supply chain currently lacks domestic sourcing for raw materials, recycling facilities, and production capacity. The adoption of these technologies will:

  - Improve local manufacturing capabilities.
  - Reduce dependency on international suppliers, particularly for critical materials like lithium and cobalt.
  - Streamline the recycling process, closing the supply chain loop.

**Timing considerations of each solution**

- **Advanced Cell Assembly and AI/Robotics**: Immediate focus to address the urgent production capacity shortfall.
- **Recycling and Lifecycle Management**: Mid-term investments to align with the rising volume of end-of-life batteries.
- **Solid-State and Modular Technologies**: Long-term strategies to future-proof the industry against evolving market demands and technological advancements.
- These solutions provide a roadmap for the UK to establish a competitive edge in the global battery manufacturing industry while addressing national challenges.

## 2.3 Workforce Foresighting for chosen prioritised technology solutions

Lithium-ion based battery packs are currently the most prolific solutions for transport. This battery chemistry offers the best balance between capacity by weight and volume, performance and safety and is mature enough for industrialisation on a large scale. The assembly of modules and packs is a key step in manufacturing process which will allow OEMs to address their product solutions effectively. At present this is the most appropriate technology for industrialisation as it will enable the UK to meet its needs for module and pack products without pausing to wait for emerging technologies.

Therefore, the cycle prioritised lithium-ion module and pack assembly for transport applications in the UK. The context of transport was chosen as there is a clearly identifiable mandate from government to achieve zero tail pipe emissions on the sale of new vehicles by a given date. This clear mandate allows for a clearer route for workforce planning.

The implementation of the findings of this report will be realised over the next 10 years as the assembly of module and packs to meet transport needs scales up. There will be necessary determining factors on this progression in the form of the ability to manufacture cells to meet the demand of OEMs. Therefore, the wider supply chain for this activity is critical. This cycle is underpinned by the previous cycle looking at battery cell manufacture and will be augmented by a cycle covering battery recycling.

Cycle 1 The manufacturing of Lithium-Ion cells for transport applications in large-scale gigafactories.

**Cycle 2 From receipt of cell and components to the assembly of Lithium-ion battery modules and packs for transport applications.**

Cycle 3 Battery recycling and expertise in recycling processes, especially as it is projected that by 2035, the UK will need to recycle or repurpose 148,000 Tonnes of automotive batteries annually. There is also a need to recover products that fail during manufacturing and to handle the waste from gigafactory activities.

## 2.4 Current and predicted scale of technology deployment in UK

Based upon current manufacturing levels there may up to one million electric vehicles per year produced in the UK by 2035.The UK's Battery Strategy identifies that the ability to manufacture batteries domestically is critical in meeting this need and to secure supply chain security. The Faraday Institution further identified that there is a high reliance on imports to meet manufacturing needs and that a domestic supply chain is critical. All of this supports the broader work to reduce emissions and support net-zero goals.

It has been identified that around 200 GWh of battery manufacturing capability is required to meet the UK's needs by 2040. Whilst this refers primarily to cell manufacture these cells will need to be assembled into modules and packs to be used for transport applications. This will require a specialised workforce which has a culture of professional development. The growth of this activity is already seen in the UK with more of the domestic manufacturers transitioning manufacturing workers to electric drivetrains which include the design and assembly of battery modules and packs. At present, it is estimated that around 5% of the automotive workforce is involved in these roles but that these numbers will rise to around 40% for specific manufacturing and that a higher number will require competencies related to this activity. This projection is consistent with earlier estimates highlighting the need to retrain a workforce in the tens of thousands, underscoring the urgency and scale of intervention required.

## 2.5 Participants in the cycle

**Industry and Automotive Manufacturers**
Aston Martin
Ford
Fortescue Zero

**Battery and Electrification Sector**
Batri
Electrification and Skills Network
HVM Catapult
Recovolt
UK Battery Industrialisation Centre
VOLKLEC

**Education, Training Providers, Professional Bodies and Consultants**
Automotive Technology
City & Guilds
Illston Authoring
Institute of the Motor Industry
Newcastle College
North Warwickshire and South Leicestershire College
Pro Moto
Telford College
WMG, University of Warwick

**UK Government and Policy Bodies**
Department for Business and Trade
Department for Education
Innovate UK
Skills England
Office for Zero Emission Vehicles
Department for Energy Security and Net Zero

The UK's transition to battery electric vehicle manufacturing represents one of the most significant industrial shifts in recent history, impacting the automotive, logistics, energy, and training sectors. As this Workforce Foresighting cycle highlights, the challenge is not merely technological, it is fundamentally a skills and workforce issue that requires coordinated action across industry, government, and education. Without decisive action, the UK risks falling behind global competitors, missing the net zero targets, and undermining domestic manufacturing.

To ensure a sustainable, competitive, and futureproof workforce, an integrated skills and policy framework is necessary, bringing together manufacturers, training providers, professional bodies, policymakers, and sector leaders.

**Key Stakeholder Roles**

**Industry and Employer Led Action**
Vehicle manufacturers such as Aston Martin and Ford will lead the transition to electric powertrains, while the supply chain, including battery manufacturers like UKBIC, will ensure the scalability of the UK battery ecosystem and contribute to a circular economy by incorporating recyclability by design from the outset.
The Electrification Skills Network will serve as the industry's key collaborative forum, and awarding organisations will be responsible for the regulated qualifications necessary for working with high-voltage components.

Industry standards will be communicated through professional registers, such as the Institute of the Motor Industry's TechSafe registration, ensuring compliance within continuous professional development.

Furthermore, professional bodies will play an integral role by ensuring the credibility of skills, upholding quality standards, and promoting excellence across the sector.

**The Role of Government and Policy Bodies**
The UK Government must commit to long-term funding and strategic policy alignment to ensure the workforce transition keeps pace with industrial advancements. This includes investment in **skills development, training infrastructure, and workforce reskilling initiatives** to support the automotive and battery sectors.

**1. Policy Alignment & Funding Mechanisms**

- Department for Business and Trade (DBT) must align industrial strategy with workforce readiness, ensuring that UK-based manufacturers can compete globally.
- Department for Education (DfE) should provide funding for apprenticeships, short courses, and further education pathways to upskill the workforce in battery module and pack assembly.
- Innovate UK should continue to drive research-led workforce foresighting, ensuring training provision aligns with emerging battery technologies and automation trends.
- Skills England should integrate battery manufacturing into national skills priorities, ensuring that qualifications and training frameworks reflect evolving industry needs.

**2. Supporting Electrification Workforce Transition**

- Office for Zero Emission Vehicles (OZEV) should facilitate financial incentives for employers investing in workforce upskilling.
- Department for Energy Security and Net Zero must ensure that workforce planning aligns with the UK's sustainability goals, including the circular economy and battery recycling initiatives.
- Public-Private Collaboration is essential—government and industry must co-invest in retraining initiatives to prevent skills shortages from delaying the electrification transition.

**3. Strengthening Industry-Government Collaboration**

- Establish the Electrification Skills Network (ESN) as the primary skills coordination platform, ensuring that manufacturers, training providers, professional bodies, and policymakers work together to define skills needs and training solutions.
- Support the development of new apprenticeship standards in battery technology, automation, and logistics, addressing gaps in workforce capabilities.
- Provide funding for modular, fast-track training programs to upskill existing automotive workers transitioning from combustion engine production to battery module and pack assembly.

By committing to these actions, the UK Government will play a critical role in ensuring the nation remains competitive in battery technology, supporting job retention, economic growth, and industrial leadership in the global electric vehicle market. Without urgent collaboration, the UK risks falling behind, jeopardising jobs, supply chain resilience, and its net-zero commitments.

# 3. Findings and Results

# 3. Findings and Results

| Section | Title |
|---|---|
| 3.1 | Methodology and findings |
| 3.2 | Step One – How will the supply chain change - Organisational changes insight |
| 3.3 | Step Two – How will the workforce change - Occupational change insight |
| 3.4 | Step Three – How the current education provision meets the future need - Highlighted changes for future provision |

## 3.1 Methodology and findings

Summary information is provided with a narrative based on the underlying data which is also provided using bespoke visualisations to enable greater insight and access to detail. The report is aligned to the needs of those responsible for workforce planning – employers, educators, and skills providers.

### Step One – How will the supply chain change - Organisational changes

Exploration of organisational changes provides insights into how organisations will need to adapt their current capabilities to implement the solutions that respond to the challenge addressed by the foresighting project.

Typically, organisational changes will also require the adoption of new capabilities and a change in the distribution of these capabilities across supply chain partners. The change in capabilities within an organisation as well as their supply chain partners will determine the changes knowledge and skill changes required by the role levels within the workforce of each Supply Chain partner.

### Step Two – How will the workforce change - Occupational changes

A set of 'Future Occupational Profiles' (FOPs) is produced by the foresight process that demonstrates how current occupations may need to change in the future. FOPs are generated using a combination of attributes from the underlying capability classification and from data collected in the workshops. The FOP generation algorithm works to group capabilities into logical sets reflecting role levels, function, proficiency and capability similarity. As part of the foresight process the generated FOPs are reviewed, revised, and distilled by the Employer group. The agreed set of FOPs are then compared with selected current education provision; the default reference is the set of Institute for Apprenticeships and Technical Education (IfATE) apprenticeship standards; to assess which current training and education provision could be used in the future. Two bespoke metrics - match and surplus - are used to evaluate the alignment of current provision with the set of FOPs proposed. Summaries are presented of the key findings related to each Supply Chain partner.

Findings are aimed at both Employers, and Education and Training Providers, and identify matches and gaps in future training needs compared with current provision to guide further detailed investigation.

### Step Three – How the current education provision meets the future need - Highlighted changes to future provision

The report identifies suggested changes to education and training provision – principally apprenticeship standards that will deliver the knowledge, skills and behaviours required by future occupations. In some cases, this will include the development of short courses and continued professional development (CPD) to upskill the current workforce to meet future needs. Additionally, foresighting outputs can be used to develop programmes, qualifications, and apprenticeship standards for new entrants to the workforce joining via apprenticeship, taught qualification, or other training programme.

The insight and data in this part of the report are primarily aimed at educators training providers, apprenticeship standards bodies and awarding organisations. Combined with insight arising from the Supply Chain capability changes, the provision insight offers an effective way for employers to identify training opportunities that align to their future needs.

## 3.2 Step One – How will the supply chain change - Organisational changes insight

### Organisation functions

The Workforce Foresighting process uses an information architecture built on five functional areas which are common to any business:

| | |
|---|---|
| **Design** | The function of an organisation that focuses on activities relating to product, service, or solution design. |
| **Implement** | The function of an organisation that focuses on activities relating to producing / making / providing its products or services. |
| **Logistics** | The function of an organisation that focuses on activities relating to procurement, delivery, materials, or services necessary for operations – service / manufacturing, etc. |
| **Support** | The function of an organisation that focuses on activities relating to users, in-service support, repair / maintenance, recycling, end of life disposal. |
| **Enterprise** | Core functions of an organisation - e.g., strategic planning, leadership and management, human resources, digital backbone and data systems, integration of relevant statutory / regulatory requirements and compliance. |

The functional structure is developed to levels of detail that enable the foresight process to reference external data sets including ONET (US) Occupational Information Network [[1]], ESCO – European Skills, Competences, Qualifications and Occupations[[2]], IfATE (UK) Institute for Apprenticeships and Technical Education[[3]] .

The five root functions comprise around 40 domains which are broken down to around 140 functional areas. The architecture is used to position ~ 25,000 capability statements which are the building blocks used in the workforce foresight process. Each capability statement has several attributes - some are static and reflect the position of the capability statement in the architecture, whilst others are dynamic and are assigned values through a cycle and set of workshops.

The data architecture is implemented in a bespoke 'data-cube' which underpins the foresight process, workshops, and enables extensive use of LLM and AI tools. Additionally, a key feature of the data-cube is that the data from each foresight topic cycle is added into the data set and can then be used, where relevant, in future cycles. This ensures that the capabilities of the system are dynamic and up to date.

[1] ONET - Occupational Information Network - https://www.onetcenter.org/
[2] ESCO - European Skills, Competences, Qualifications and Occupations - https://esco.ec.europa.eu/en
[3] IfATE – Institute for Apprenticeships and Technical Education - https://www.instituteforapprenticeships.org/

## Identifying the Future Supply Chain Capabilities

The following charts and graphs summarise the changes in the set of capabilities that will be required by the supply chain (Supply Chain involved in production) in the future. The pie-charts reflect the distribution of capabilities across the five functions of the capability classification. The future state data is captured in three technology focused workshops. The current state data is derived from information collected on apprenticeship standards used across current supply chain partners. sector. This latter information is not as detailed as that produced by the workshops but is indicative and used to provide a point of comparison.

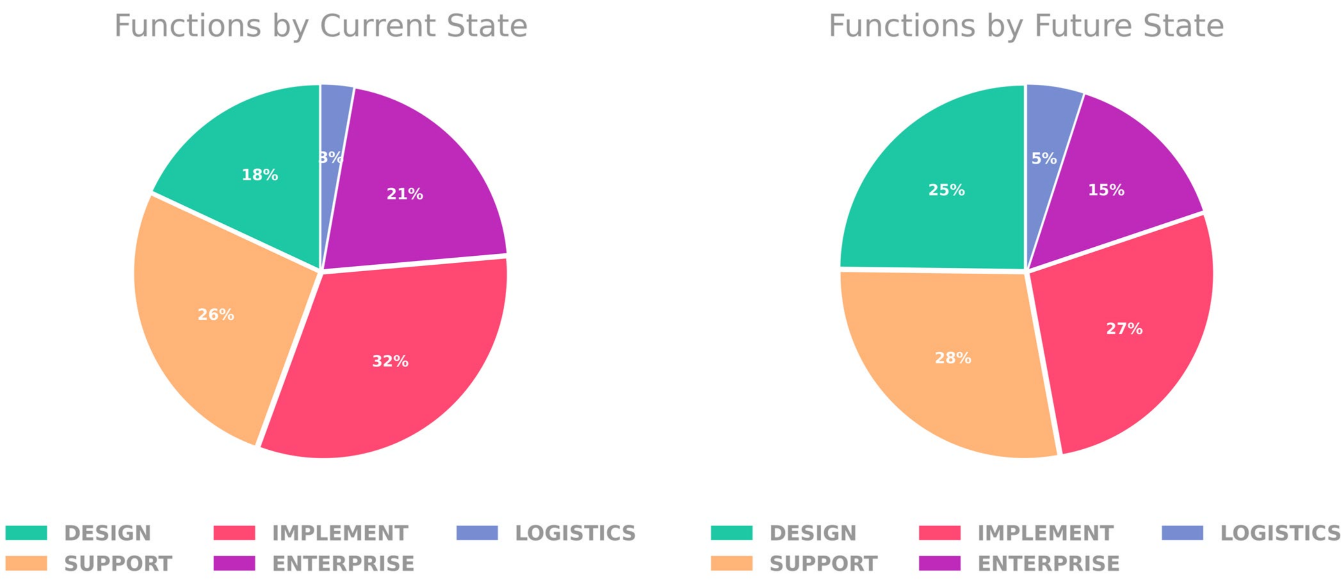



*Figure 3: Current and Future – Whole Supply Chain - Capability Function Distribution %*

These initial pie charts summarise the changes that will be required by the whole supply chain, across the five functions. What is evident is that the proportion of capabilities across the functions is not predicted to change significantly. However, the nature of the capabilities within those functions will change and this is shown below.

Whilst the information on current and future Supply Chain capabilities is useful to indicate relative changes, factors such as volume of activity will also determine which functions may have greater future significance.

The graphs below show the distribution of capabilities assigned at domain level within the five main functions for this cycle. These graphs provide insight into the relative importance of each domain for battery module and pack assembly in the future.

## Design Domains

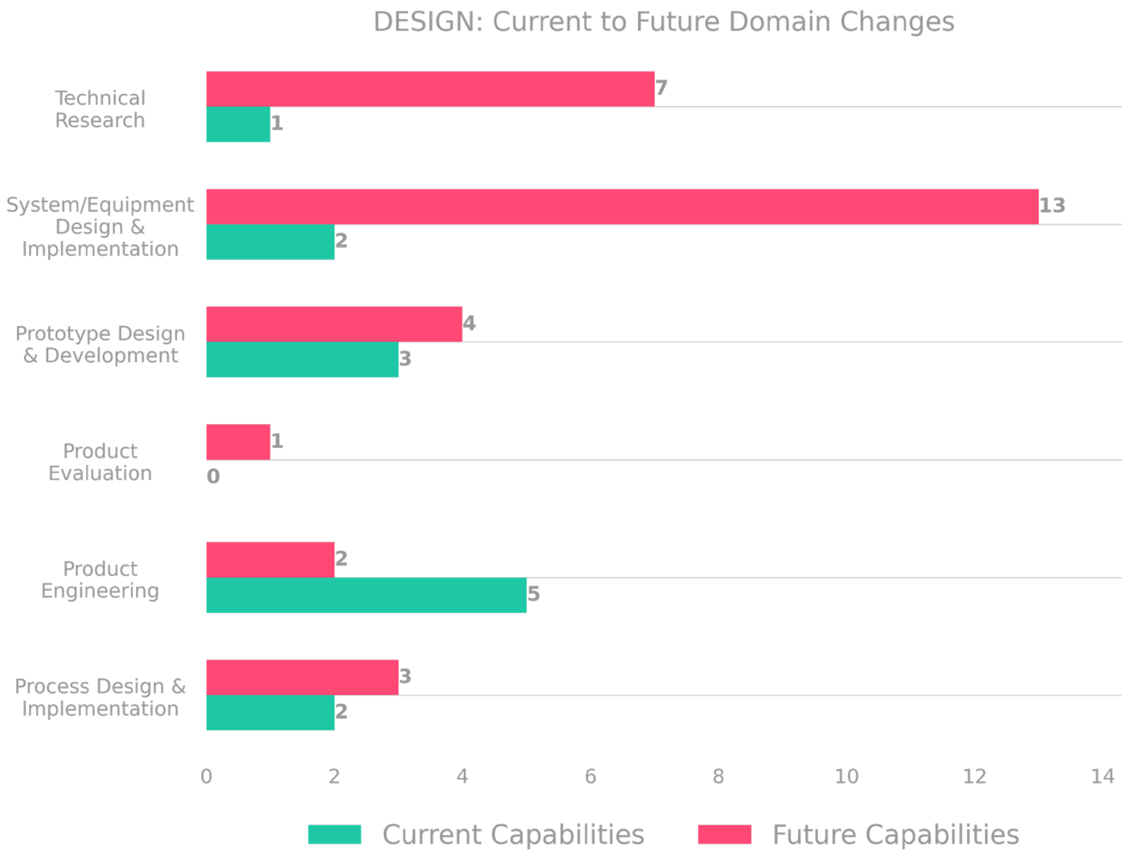



*Figure 4: Design Future Domain Spread of Capabilities*

The change to future domains demonstrates an increase in the activity around technical research and systems design and implementation. This reflects the needs for organisations to be at the forefront of module and pack design and the processes needed to manufacture these effectively. Product evaluation is included for the first time reflecting a drive towards internal and in line quality assurance.

## Enterprise Domains:

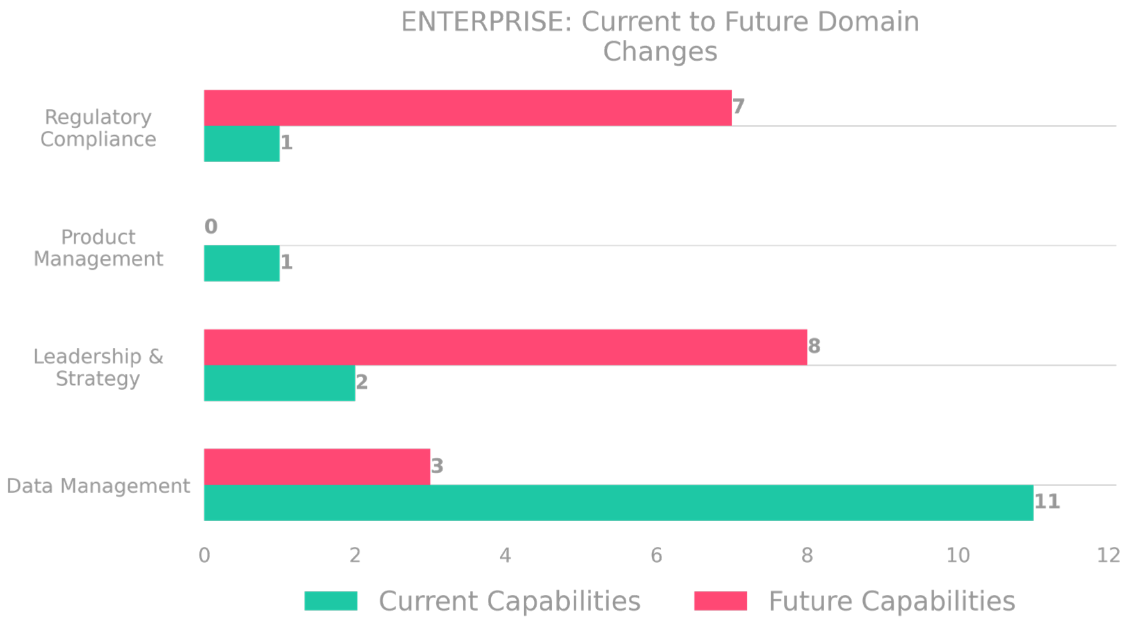



*Figure 5: Enterprise Future Domain Spread of Capabilities*

Regulatory compliance is a focus throughout the three battery manufacturing cycles being undertaken. It is recognised that identifying competencies within the organisation that enable it to better engage with external compliance will better enable the sector as it grows. It is highly likely that the role and activities of external compliance will also change over time and so having identified competencies within the organisation will ensure that manufacturers are able to adapt. Leadership and strategy have also grown in importance as the Foresighting work has sought to structure future occupation profiles and ensure that cross functional leadership is a key focus. Within the enterprise function the role of data management has decreased but this due to it becoming more of an embedded operational feature.

## Implementation Domains

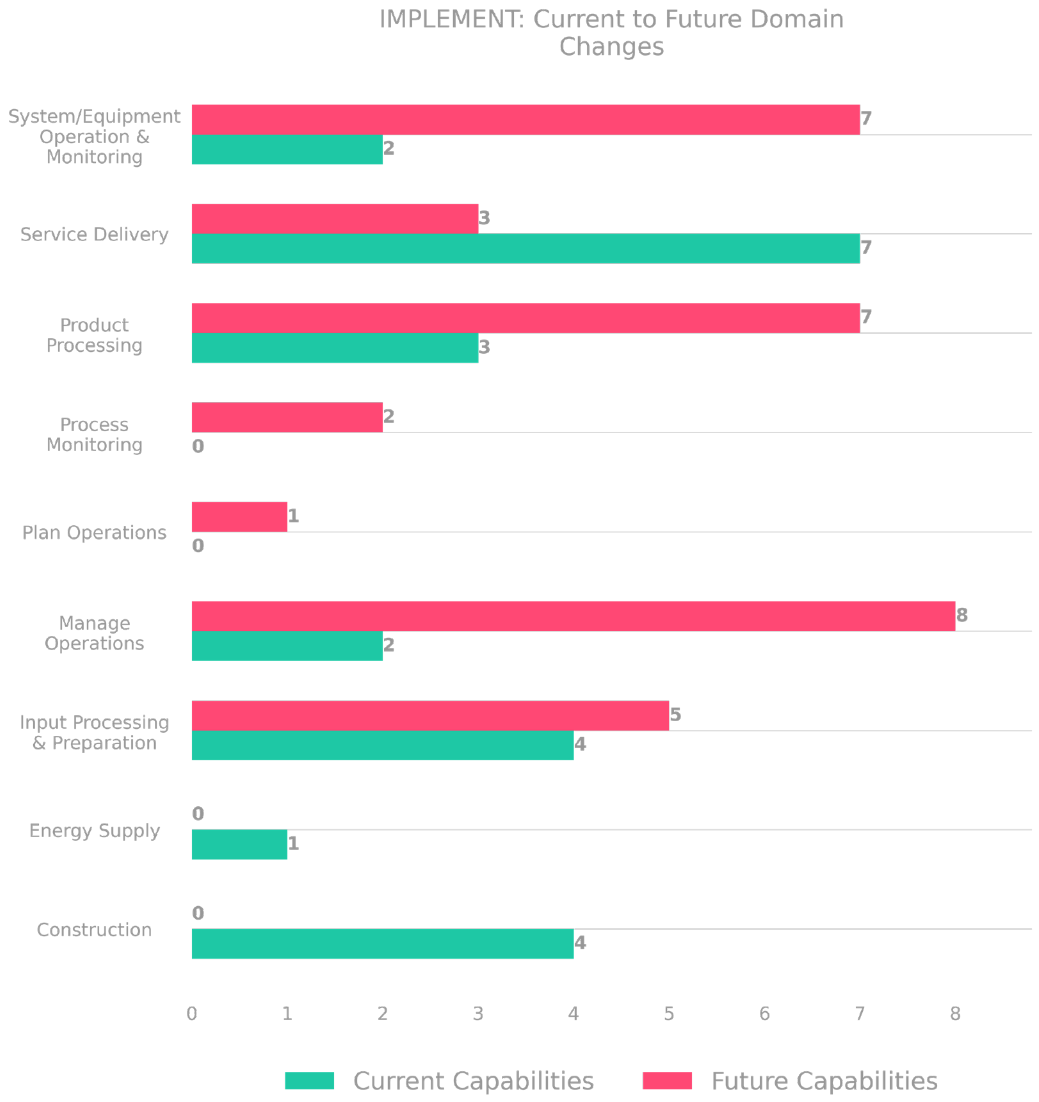



*Figure 6: Implementation Future Domains Spread of Capabilities*

The changes across the implementation domains represents the capabilities requires to transition from manual to automated processes. The importance of operating systems and equipment will grow significantly as will product processing and process monitoring. As a result the need to effectively manage operations has been identified as a set of critical competencies for future manufacturing.

## Logistics Domains

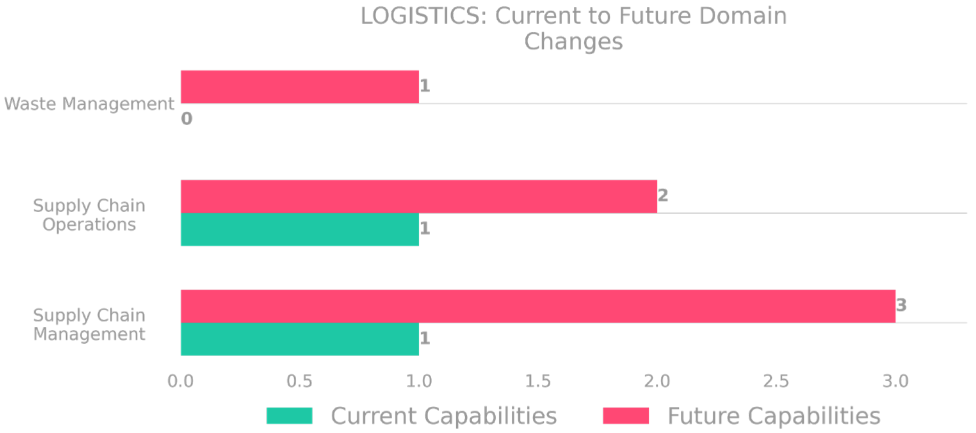



*Figure 7: Logistics Future Domains- Future Spread of Capabilities*

Across all the battery manufacturing cycles the importance of logistics has been deliberately emphasised. This has included appropriate waste management to support recycling activities. The nature of logistics within the manufacturing facility is changing with much greater automation playing a role in inventory management and movement.

## Support Domains

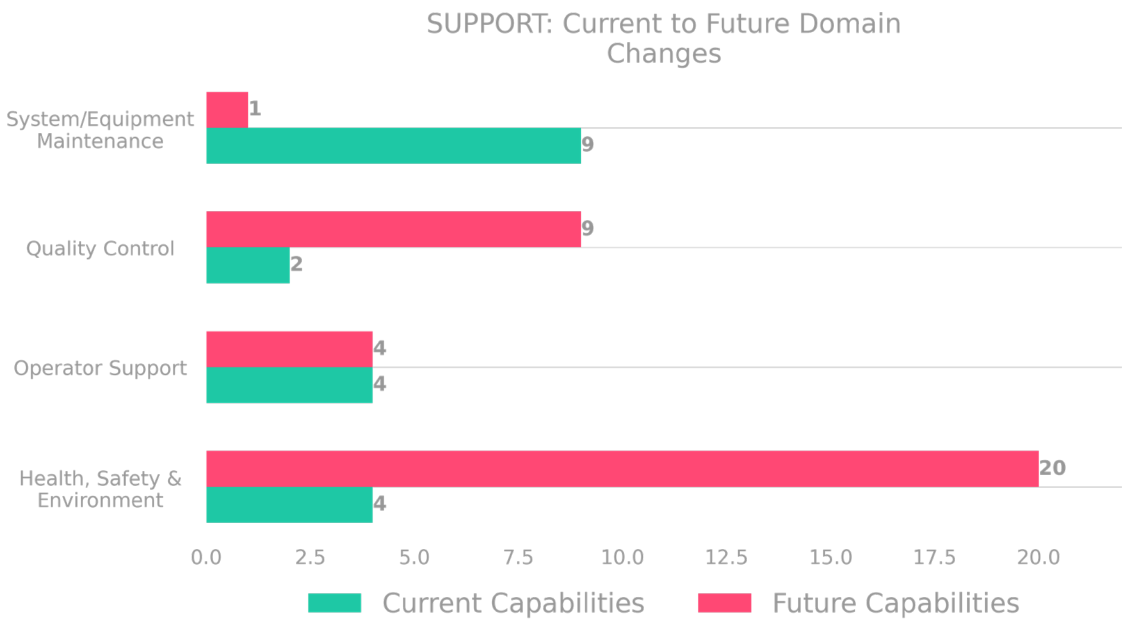



*Figure 8: Support Future Domains - Future Spread of Capabilities*

In terms of the support domains the cycle deliberately excluded maintenance and repair of manufacturing equipment from the scope of the work, hence the drop in capabilities in this space. A greater focus was placed on quality control and the importance of ensuring both the health and safety as well as the environmental considerations within organisations.

## Visualisation Instructions

| Visualisation Data Link | What is it and what can it be used for? |
|---|---|
| *Organisational Capabilities* | *The page provides details of the capabilities required by each supply chain partner and the supply chain as whole. The information is presented using the Capability Classification Framework, Design / Implement / Logistics / Support / Enterprise and can be interrogated and then exported to suit specific user requirements and interest.*<br><br>*The information provided also identifies capabilities supported by existing provision, and where there may be gaps that require new development to support to equip the future workforce.* |

## 3.3 Step Two – How will the workforce change - Occupational change insight

Insight into occupational change uses the understanding of how capabilities will change across business functions (section 3.2) to inform proposals for how occupations and their associated skills sets for each supply chain partner may need be revised to reflect change for each role level within that partner.

### Supply Chain partner organisation types

The workforce foresighting process recognises that different partners in a Supply Chain will require appropriate capabilities, and these are determined and agreed in the initial workshops.

In this cycle, the following Supply Chain partners were identified and then used during participant workshops and data analysis to determine the organisational needs:

1. Logistics (internal)
2. Quality Assurance
3. Module Production and Pack Production & In-line Quality Assurance
4. Module / Battery Systems Integration

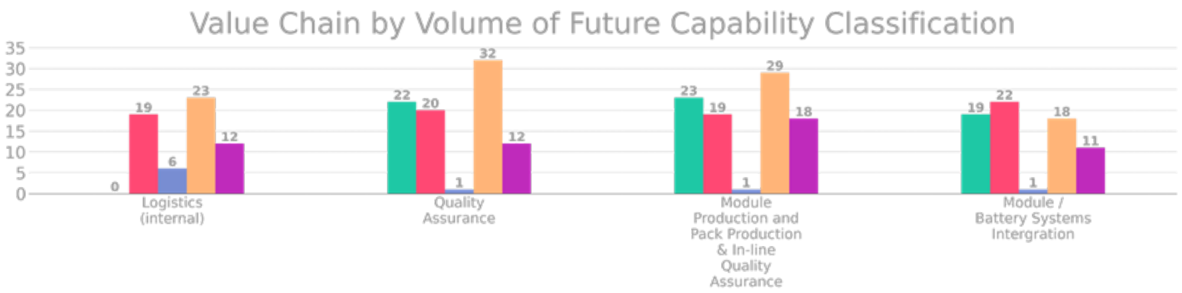



*Figure 9: Distribution of Functions across each Supply Chain Partner*

The graph illustrates the distribution of capabilities by function across the Supply Chain Partners. These capability sets are used to form the set of Future Occupational Profiles within each role level.

### Visualisation Instructions

Detailed instructions can be found in the appendix.

| Visualisation Data Link | What is it and what can it be used for? |
|---|---|
| *Supply Chain Capabilities* | This page provides an overview of the identified capabilities at a Supply Chain Partner level.<br><br>By selecting/deselecting each Supply Chain Partner you can review the capabilities identified as required in that area of the Supply Chain.<br><br>This can be used to generate organisational capability profiles for each area of the Supply Chain to help prioritise and focus the acquisition of new capabilities that will be required in the future.<br><br>It can also be used to generate combined organisational profiles, where an organisation may be involved in more than one area of the Supply Chain. |

## Role Levels

The foresighting process uses the concept of Role Levels to represent future occupations. Utilising this approach acknowledges that the workforce is not homogeneous, there will be varying levels of proficiency required across a workforce and qualifications and training may be aligned/require diverse types of vocational or academic qualifications. Additionally, the role level approach seeks to avoid presuming that the future workforce will be operating at a different level to the current state.

**Role Levels determined through workshops:**

1. Technicians
2. Supervisors / First Line Managers
3. Graduate Engineer
4. Senior Engineer

## Proficiencies

Each of these role levels will require proficiency that reflects their role and the needs of each Supply Chain Partner. The foresight process uses a three-point scale to capture and differentiate the proficiencies required. This information is used both in the generation of the Future Occupational Profiles, and to assist the definition of training needs identified. Within the workforce foresight process proficiency is defined as:

**Awareness (A)** - Has a foundational knowledge of tools, technology, techniques relevant to sector, industry, or organisation. Sufficient comprehension to know where to seek further information/details as necessary for a particular issue.

**Practitioner (P)** - Has the ability to apply and use independently a tool, system, or process. Understands the implications, consequences, and impact for their role/function. A Practitioner knows what key actions are required and in what context.

**Expert (E)** - Has detailed knowledge of process, system, tool, or technology. Can support others and identify improvements required for a process, system, or tool. An Expert can implement improvements personally or direct and guide others.

During the workshops participants applied their insight to assign proficiency for each role level to each capability. Individual responses were aggregated by the system to arrive at a consensus.

A summary of the distribution of required proficiency for the role levels in this cycle are:

In keeping with expectations of competence, the number of awareness level capabilities reduces as the seniority of the roles increases. In addition, there is a much greater emphasis on expertise for senior engineers. This helps to enable career pathways to be realised. Surprisingly, the number of expert competencies at the technician level is not in keeping with this trend. This is evidence that the role of technicians continues to, and will increasingly, be critical in battery manufacture. There is already evidence of the value placed on these roles within the EVEra 2023 employment report[4]. It will be critical that the role of technicians is not under-played in the future workforce.

[4] https://www.everarecruitment.com/Skills-report-with-salary-guide

| | Technicians | Supervisors / First Line Managers | Graduate Engineer | Senior Engineer |
|---|---|---|---|---|
| Awareness | 5 | 3 | 1 | 3 |
| Practitioner | 27 | 33 | 11 | 26 |
| Expert | 54 | 32 | 13 | 62 |

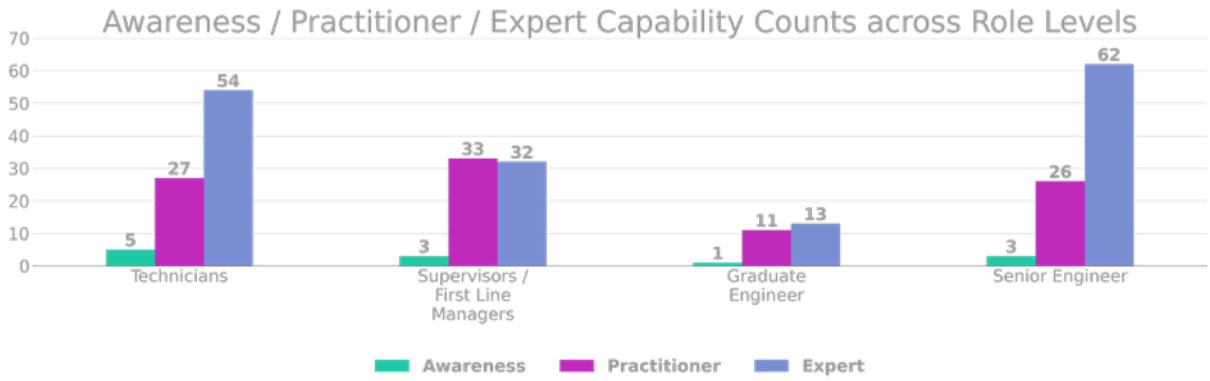



*Figure 10: Proficiency details by Role Level*

## Future Occupational Profiles

FOPs are used to describe and suggest occupations, or roles, that may be required in the future and provide a framework to indicate capabilities and related duties. They can be used to review the impact on current roles and the adaptation that may be required in the future.

**Educators** can review current apprenticeship standards against the requirements of the FOPs and interpret which need to be changed to fill the gaps between the current and future state.

**Employers** can consider existing apprenticeship standards and make a judgement on adapting an existing apprenticeship standard to upskill their workforce to meet the requirements of a particular FOP.

## FOPs and indicative skills need

Combining proficiency with the identified FOPs, the following graphs indicate the priority needs across the supply chain for each Role Level to deliver future capabilities.

## Technicians Role Level FOPs:

In this cycle the Technicians role level was defined as occupations and roles requiring education or training equivalent to Level 3 qualifications or apprenticeships.

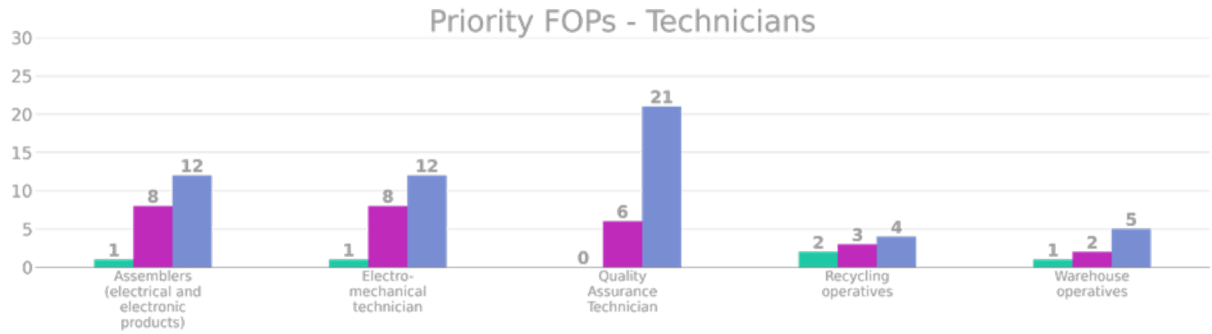



*Figure 11: Priority FOPs - Technicians Role Level*

## Supervisors / First Line Managers Role Level FOPs:

In this cycle the Supervisors / First Line Managers role level was defined as occupations and roles requiring education or training equivalent to Level 3/4 qualifications or apprenticeships.

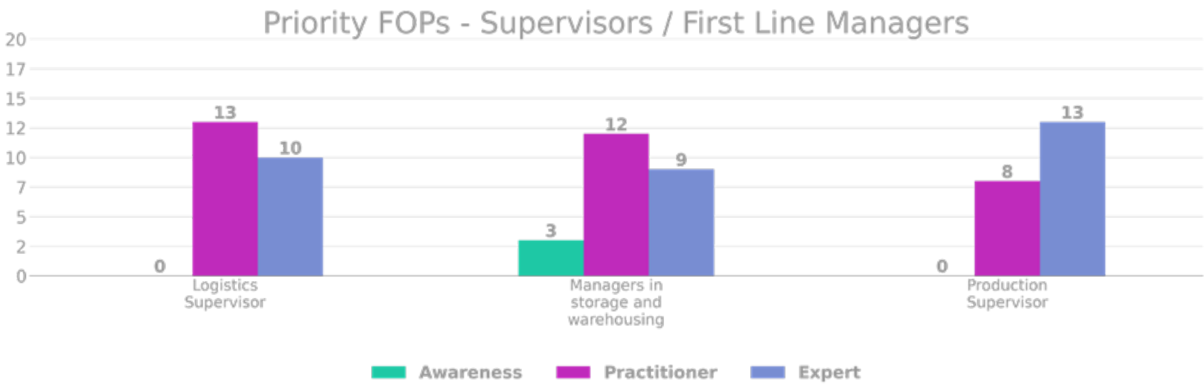



*Figure 12: Priority FOPs - Supervisors / First Line Managers Role Level*

## Graduate Engineer Role Level FOPs:

In this cycle the Graduate Engineer role level was defined as occupations and roles requiring education or training equivalent to Level 6 qualifications or apprenticeships.

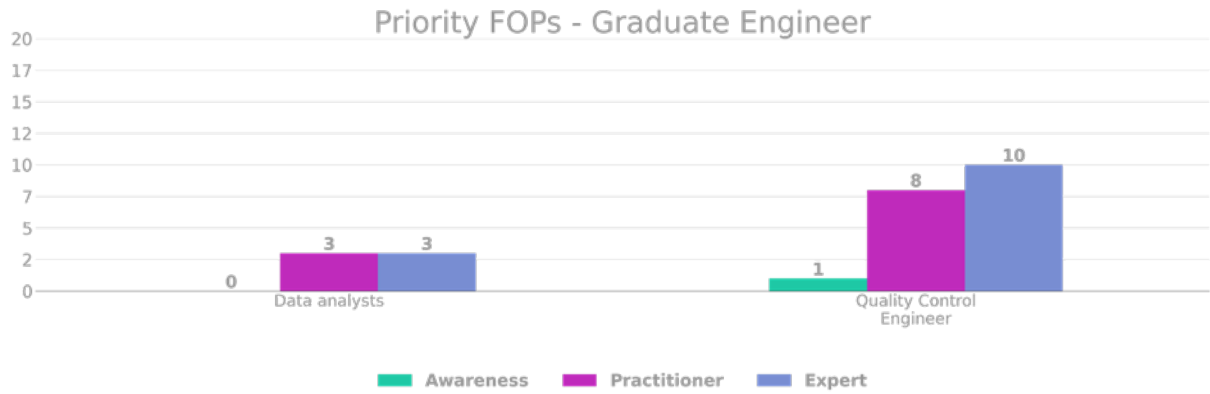



*Figure 13: Priority FOPs - Graduate Engineer Role Level*

## *Senior Engineer Role Level FOPs:*

In this cycle the Senior Engineer role level was defined as occupations and roles requiring education or training equivalent to Level 7 qualifications or apprenticeships.

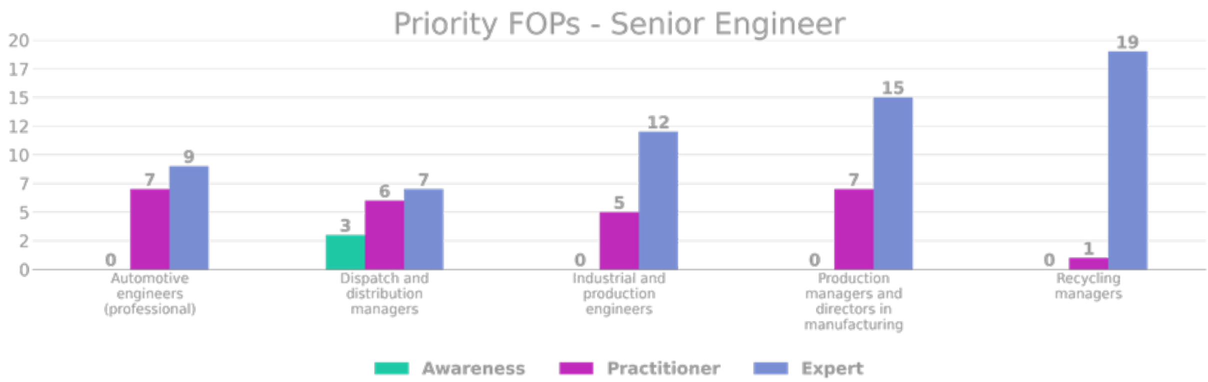



*Figure 14: Priority FOPs - Senior Engineer Role Level*

### Visualisation Instructions

Detailed instructions can be found in the appendix.

| Visualisation Data Link | What is it and what can it be used for? |
|---|---|
| *FOP Matrix* | This page provides a detailed breakdown of future occupational profiles that could be required in the future workforce. These were generated using a combination of attributes collected through the workshops and an algorithm. These suggested profiles were then reviewed and ratified by small groups of employers who were able to add/remove capabilities and uprate/downrate proficiency levels required.<br><br>You can view all the FOPs in a role level by selecting one (or more) of these from the drop down. This will then allow you to select the FOPs aligned to that role level.<br><br>The populated table allows you review and compare different FOPs within or across role levels. You can view the capabilities in each FOP and the assigned proficiency levels. |

## 3.4 Step Three – How the current education provision meets the future need - Highlighted changes for future provision

The Workforce Foresighting process has developed two metrics to quantify the alignment between a FOP and a current standard or qualification:

**Fit** – expressed as a %, it is a measure of the proportion of a FOP that is covered by an existing standard or qualification.

**Surplus** – expressed as a %, it is a measure of the not relevant material in an existing standard that is not required for a FOP.

An ideal existing qualification or standard would have a high fit and low surplus – this implies good coverage of the FOP but with little material that is not relevant to the FOP. Conversely a poor candidate would have a low fit and high surplus. Using these two metrics it is possible to quantitively evaluate, rank, and compare a range of existing provisions against a set of FOPs describing future needs.

Our interpretation is represented by a simple nine-box model to position the suitability of a given current occupational standard to a future occupational profile:

### Factor scores

| Fit Factor | Fit score | Surplus Factor | Surplus score |
|---|---|---|---|
| 0 - 32% | 1 | 81-100% | 1 |
| 33-65% | 2 | 51-80% | 2 |
| 66-100% | 3 | 0 - 50% | 3 |

*(Multiplying the Fit score by the Surplus score gives a Suitability Grid score of 1-9 as below)*

*Suitability Grid*

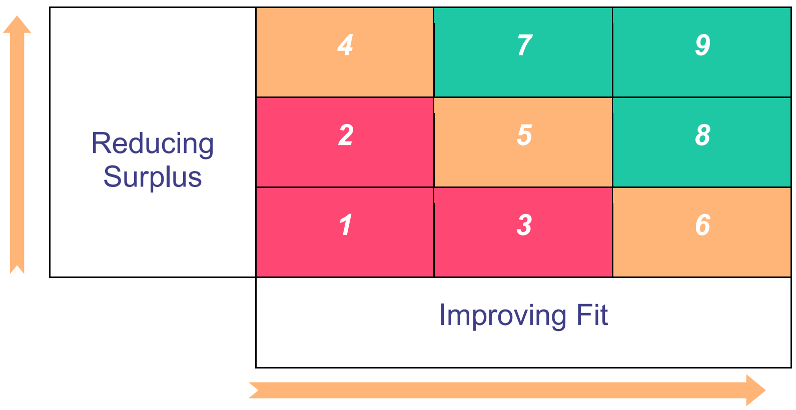



*Figure 15: Fit Factor scores and Suitability Grid*

**Using this score and indicated 'RAG status' the following interpretations can be made:**

**High Suitability – 7,8,9 – for standards that have good coverage of FOPs.**
Represents good candidates from current apprenticeship standards used as the basis of development to meet FOP requirements and inform elements of short course and CPD provision.

**Some Suitability– 4,5,6 – for standards that have only partial coverage of FOPs.**
These are likely to require extended work to meet FOP requirements, further review of the data may be necessary. They are likely to contain some useful information to inform elements of short course and CPD provision.

**Low Suitability – 1,2,3 – for standards that have poor coverage of FOPs.**
These are unlikely to be adaptable to meet future needs but may contain some useful information to inform elements of short course and CPD provision, which can be assessed using the data visualisation tools.

## FOP findings compared with current standards

Using the approach described above and applying the 'RAG' scores to each FOP indicating the suitability of current apprenticeship standards selected from the IfATE set, the following table begins to identify areas of action and concern for the provision of future skills for each Supply Chain Partner to respond to the challenge.

Across all the supply chain partners there is a concerning lack of parallels to existing standards that can be used to structure training. The areas of most concern are those in the senior engineer space which have been facilitated by L7 apprenticeships to this point. The removal of funding from those apprenticeships will impact on the ability of employers to transition existing engineers into new roles which has been effectively facilitated by these apprenticeships to this point. The lack of alignment with logistics standards matches that which was observed in the cell assembly cycle and highlights a key area for apprenticeship development. This persistent gap in logistics competencies highlights an ongoing challenge, as previous workforce development initiatives have often focused on core manufacturing roles, with insufficient attention given to internal logistics and supply chain functions, despite their growing strategic importance in both battery manufacturing and module and pack.

This analysis does not reflect other qualifications that may be in the market and could be used to base further training.

## Supply Chain Partner - Logistics (internal)

| Role Level | Selected Future Occupational Profiles | Current Suitability Summary |
|---|---|---|
| Technicians | Warehouse operatives | Some |
| Technicians | Recycling operatives | Low |
| Supervisors / First Line Managers | Managers in storage and warehousing | Low |
| Supervisors / First Line Managers | Logistics Supervisor | Low |
| Senior Engineer | Dispatch and distribution managers | Low |
| Senior Engineer | Recycling managers | Low |

### Detailed breakdown:

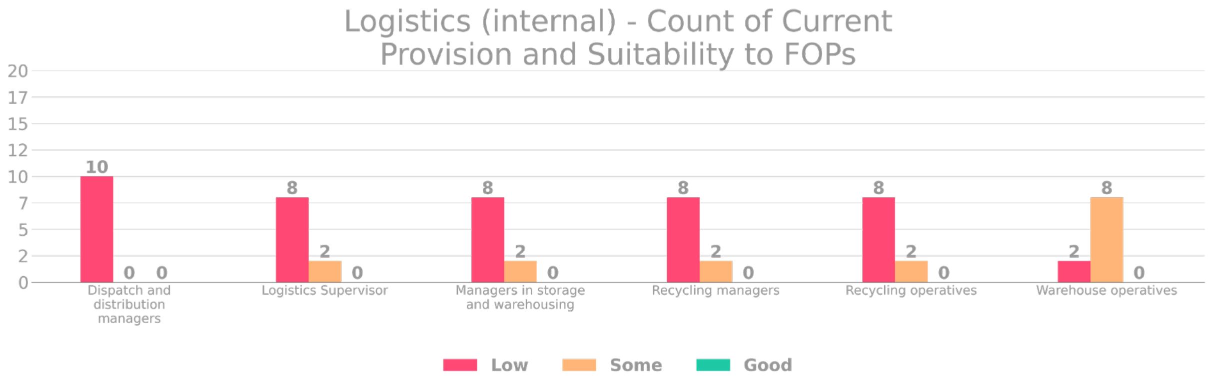



*Figure 16: Suitability Summary - Logistics (internal)*

## Supply Chain Partner - Quality Assurance

| Role Level | Selected Future Occupational Profiles | Current Suitability Summary |
|---|---|---|
| Technicians | Quality Assurance Technician | Some |
| Graduate Engineer | Quality Control Engineer | Low |
| | | |

| | | |
|---|---|---|
| Senior Engineer | Automotive engineers (professional) | Low |

## Detailed breakdown:

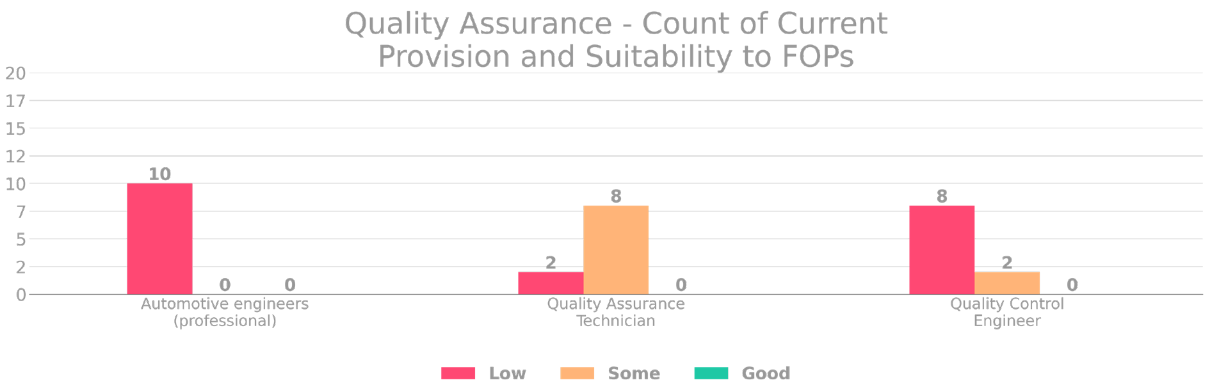



*Figure 17: Suitability Summary - Quality Assurance*

## Supply Chain Partner - Module Production and Pack Production & In-line Quality Assurance

| Role Level | Selected Future Occupational Profiles | Current Suitability Summary |
|---|---|---|
| Technicians | Assemblers (electrical and electronic products) | Some |
| Supervisors / First Line Managers | Production Supervisor | Some |
| Senior Engineer | Production managers and directors in manufacturing | Low |
| Senior Engineer | Industrial and production engineers | Low |

**Detailed breakdown:**

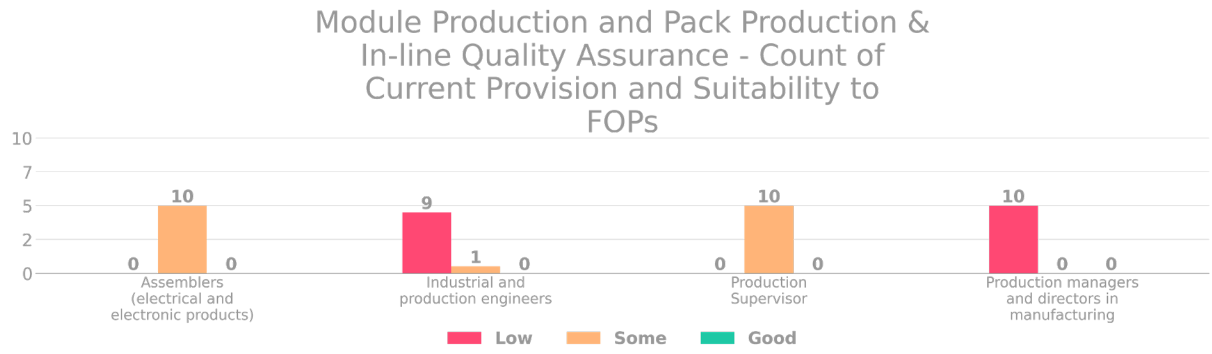



*Figure 18: Suitability Summary - Module Production and Pack Production & In-line Quality Assurance*

## Supply Chain Partner - Module / Battery Systems Integration

| Role Level | Selected Future Occupational Profiles | Current Suitability Summary |
|---|---|---|
| Technicians | Electro-mechanical technician | Some |
| Graduate Engineer | Data analysts | Low |

**Detailed breakdown:**

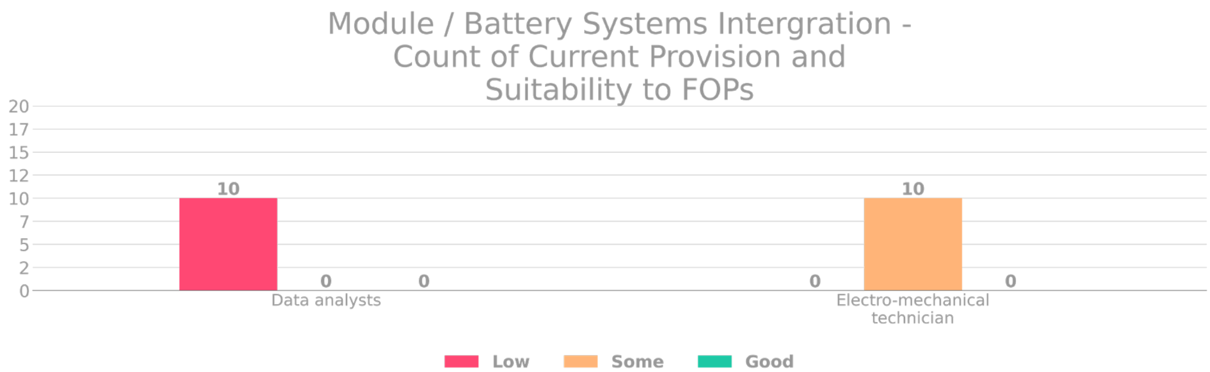



*Figure 19: Suitability Summary - Module / Battery Systems Integration*

## Link to full data set - Visualisation Instructions

| Visualisation Data Link | What is it and what can it be used for? |
|---|---|
| *FOP Detail* | This page allows you to review a specific Occupational Profile, including the capabilities contained within it and the Knowledge, Skills & Behaviour (KSB) tags associated with the capability.<br>You can select an individual Role Level and linked FOP in the two available dropdowns. The table in the lower section of the page will then be populated with all relevant capabilities. |

| | |
|---|---|
| | The search control above the table allows you to filter content of any of the columns of data. A key piece of functionality in this table is the presence of the KSB tags associated with the capabilities. |
| *Future KSBs Summary* | This page provides a view of the complete set of capabilities within the cycle along with all the associated KSB tags which are linked to them. It is the superset of all details displayed on the Fop detail page.<br>This is used to:<br>• To review the identified Knowledge, Skill and Behaviour tags for a given capability, to support development of future education and learning material.<br>• To review the requirements from a capability level, rather than a role level/occupational profile grouping. |
| *Capabilities Matched to Current Provision* | This page allows you to review and compare individual capabilities against 'Duty' statements in an Apprenticeship / Occupational Standard. You can select individual capabilities to review their specific matches. These matches are shown in the bottom panel, including the Standard, the Level, and the Duty Statement this is matched to.<br>You can filter in several ways to focus your review:<br>• By the Capability Classification Framework (left-hand panel).<br>• By capabilities that **are** served by the reference mapping framework the default is Institute for Apprenticeships and Technical Education (IfATE) provision.<br>• By capabilities that **are not** served by the reference mapping framework, e.g., IfATE provision – these are capabilities required in the future that may require new/bespoke training and CPD materials to be developed to upskill/re-skill the workforce.<br><br>This page can be used to identify where existing provision may exist across the broad spectrum of Apprenticeship standards, and not just within a narrow range of sector-specific Standards.<br>The data also allows you to identify where provision may already exist to support specific capabilities. |
| *Fit & Surplus Factors* | This page allows you to review the 'Fit' and 'Surplus' of Prototype Future Occupation Profiles (FOP) against existing training provision e.g. Institute for Apprenticeships and Technical Education (IfATE).<br><br>It is possible for the 'Fit' and 'Surplus' comparison to total over 100%, as they are two separate calculations based on a two-way comparison. |
| *Fit & Surplus Matrix* | This page is a visual representation of the 'Fit and Surplus Factor' insight. You can visually review 'Fit' and 'Surplus' of Prototype Future Occupation Profiles (FOP) against existing training provision e.g. Institute for Apprenticeships and Technical Education (IfATE).<br><br>This can help you identify which provision may align strongest, or which may require adaptation, to provide the suitable provision fit for each future role.<br>It will help you focus in on which provision to focus your attention for analysis. |
| *FOP Capability Matches* | This page allows you to view the matches between Capabilities and Institute for Apprenticeships and Technical Education (IfATE) Duty Statements. Clicking the arrow next to a number in the 'Matches' column will open a popup with more detail for each Capability.<br><br>Each capability also includes Knowledge, Skill, and Behaviour Tags, to support with scaffolding future education provision. |

| | |
|---|---|
| | You can review individual Prototype Future Occupational Profiles (FOPs) or review all FOPs under a Role Level, to give a more holistic view of Capabilities and Matches<br><br>Where a future capability has been matched to existing provision (currently, by default, IfATE apprenticeship standards) it is possible to interrogate the data and identify specific statements in standards that align to enable identification of existing training materials and activities that could be used or adapted to meet future requirements.<br><br>This can be used to review the capability requirements for Role Levels and FOPs, from Job / Occupation level through to Knowledge, Skill, and Behaviour level. |

# 4. Conclusion and Next Steps

# 4. Conclusion and Next Steps

| Section | Title |
|---|---|
| 4.1 | Summary of key insights |
| 4.2 | What this means for industry and the workforce |
| 4.3 | What this means for education |
| 4.4 | Recommended next steps |

*The UK's transition to battery electric vehicle (BEV) manufacturing represents one of the most significant industrial shifts in recent history, impacting not only automotive manufacturers but also supply chains, logistics, education, and workforce planning. This Workforce Foresighting cycle highlights that the challenge is not only technological but also fundamentally a skills and workforce issue. Without coordinated and urgent action, the UK risks falling behind global competitors, failing to meet its net-zero targets, and weakening its domestic manufacturing base.*

*This section outlines priority actions for government, industry, and education providers to address the workforce gaps identified in this report.*

## 4.1 Summary of key insights

This Workforce Foresighting cycle has identified critical skills gaps and challenges in the transition to BEV manufacturing, particularly in module and pack assembly, logistics, quality assurance, and battery recycling. The key insights from this study include:

- Urgent workforce transition required: Up to 40% of the UK's automotive manufacturing workforce will need to be reskilled to support BEV production by 2035.
- Gaps in training provision: There is insufficient alignment between existing apprenticeship standards and emerging workforce needs, particularly in logistics, recycling, and automation.
- Education system adaptation is essential: Current qualification frameworks need targeted revisions and new pathways to ensure industry relevance.
- Strategic coordination required: A more integrated approach between government, industry, professional bodies, and education providers is needed to align training efforts with market demands.

Failure to address these challenges in a timely and coordinated manner will hinder the UK's ability to secure investment in battery manufacturing and maintain a competitive advantage in the global market.

## Why these are important

- These findings are essential for addressing the anticipated **200 GWh demand by 2040**. Failure to act could result in the UK falling further behind global leaders like the EU and China.
- Closing skills gaps and aligning workforce capabilities with emerging technologies will be key to meeting production goals and ensuring a sustainable supply chain.
- Logistics Gaps - Workforce foresighting revealed that current standards for logistics and internal supply chain roles have low suitability, highlighting a significant blind spot in training initiatives.
- Imbalance in Technology Readiness - While immediate gains can be achieved through cell assembly automation, the longer-term deployment of solid-state batteries and modular manufacturing remains in early development stages.

**Impact on Next Steps or Considerations**

- **Accelerating Workforce Adaptation**: Targeted initiatives to reskill workers for roles in logistics and recycling should be prioritised to avoid bottlenecks in scaling production.
- **Fostering Collaboration**: Greater synergy among industry, academia, and government will be critical for addressing gaps in standards and curricula.
- **Balanced Investment Strategy**: While prioritising immediate technological solutions like automation, equal focus must be given to mid- and long-term innovations like modular systems and advanced chemistries.

By addressing these findings and surprises, the UK can chart a clear path toward achieving its battery manufacturing and sustainability goals.

The below table counts the number of IfATE standards by suitability score for each FOP. For the purpose of this report, we have utilised the suitability grid to highlight the top IfATE standards that support each FOP. The table identifies if they have low, some or high suitability and colour-coded their overall suitability.

| Role Level | Primary Supply Chain / Supply Chain Partner | Future Occupation Profile | Low Suitability | Some Suitability | High Suitability | Overall Suitability RAG |
|---|---|---|---|---|---|---|
| Technicians | Logistics (internal) | Recycling operatives | 8 | 2 | 0 | Low |
| Technicians | Logistics (internal) | Warehouse operatives | 2 | 8 | 0 | Low |
| Technicians | Quality Assurance | Quality Assurance Technician | 2 | 8 | 0 | Low |
| Technicians | Module Production and Pack Production In-line Quality Assurance | Assemblers (electrical and electronic products) | 0 | 10 | 0 | Some |
| Technicians | Module / Battery Systems Integration | Electro-mechanical technician | 0 | 10 | 0 | Some |
| Supervisors / First Line Managers | Logistics (internal) | Logistics Supervisor | 8 | 2 | 0 | Low |
| Supervisors / First Line Managers | Logistics (internal) | Managers in storage and warehousing | 8 | 2 | 0 | Low |
| Supervisors / First Line Managers | Module Production and Pack Production In-line Quality Assurance | Production Supervisor | 0 | 10 | 0 | Some |
| Graduate Engineer | Quality Assurance | Quality Control Engineer | 8 | 2 | 0 | Low |
| Graduate Engineer | Module / Battery Systems Integration | Data analysts | 10 | 0 | 0 | Low |
| Senior Engineer | Logistics (internal) | Dispatch and distribution managers | 10 | 0 | 0 | Low |
| Senior Engineer | Logistics (internal) | Recycling managers | 8 | 2 | 0 | Low |

| | | | | | | |
|---|---|---|---|---|---|---|
| Senior Engineer | Quality Assurance | Automotive engineers (professional) | 10 | 0 | 0 | Low |
| Senior Engineer | Module Production and Pack Production In-line Quality Assurance | Industrial and production engineers | 9 | 1 | 0 | Low |
| Senior Engineer | Module Production and Pack Production In-line Quality Assurance | Production managers and directors in manufacturing | 10 | 0 | 0 | Low |

### Top Fits

By reviewing the FOPs against the suitability grid, we can determine which of the groups of current apprenticeship standards are more applicable than others. These can be used as a basis for future training activities with adjustments and improvements to incorporate newly identified capabilities.

Many of the FOPs that have IfATE standards identified as 'some suitability' when compared with current IfATE standards and provision are:

| FOP Title | IfATE Apprenticeship Standard |
|---|---|
| Quality Control Engineer | Electro-mechanical engineer |
| Industrial and production engineers | Digital manufacturing engineering leader |
| Quality Assurance Technician | Electro-mechanical engineer |
| Assemblers (electrical and electronic products) | Lean manufacturing operative |
| Electro-mechanical technician | Installation and maintenance electrician |
| Electro-mechanical technician | Science industry maintenance technician |
| Electro-mechanical technician | Space engineering technician |
| Electro-mechanical technician | Power network craftsperson |

The use of the data visualisation tool is recommended to access the next layer of detail and review the specific standards that have been identified as having Good Suitability / Some Suitability or Low Suitability.

As a comparison we can also list the standards that score lowest against the required FOPs, suggesting that there are little suitable in the IfATE standards to support these Future Role Profiles. These occupational profiles will require additional effort to be placed in identifying whether suitable training exists in other qualifications and what additional learning opportunities need to be created to meet future needs. From the spread of FOPs, it is clear that challenges are not limited to any specific supply chain partner or level or role. However, there is a slight bias towards logistics profiles.

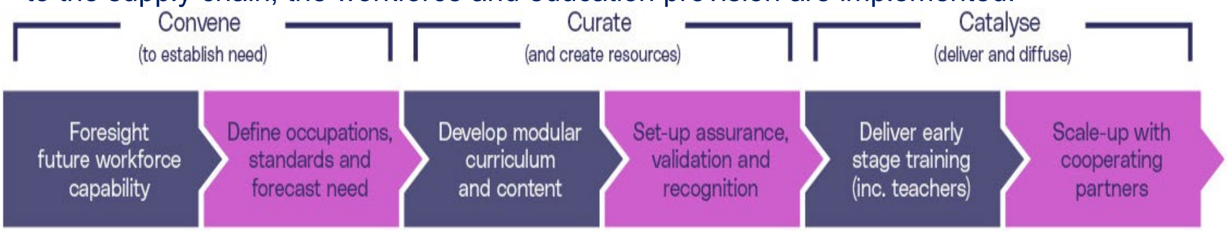
**FOPs with the lowest scores are:**

1. Recycling operatives
2. Warehouse operatives
3. Quality Assurance Technician
4. Logistics Supervisor
5. Managers in storage and warehousing
6. Quality Control Engineer
7. Data analysts
8. Dispatch and distribution managers
9. Recycling managers
10. Automotive engineers (professional)
11. Industrial and production engineers
12. Production managers and directors in manufacturing

## 4.2 What this means for Industry and the Workforce

### Collective Action

Foresighting has been developed to provide insight and the detailed information required to enable action by relevant stakeholders but is the first step of the Skills Value Chain. Collective action will be required by all stakeholders to ensure that the changes identified by foresighting – to the supply chain, the workforce and education provision are implemented.




This section summarises the actions required because of this foresight cycle.

### Industry Action Plan

Employers in BEV manufacturing, battery production, and supply chain management must proactively invest in skills development and workforce planning. Immediate actions include:

- Internal workforce assessments: Manufacturers must identify at-risk roles in internal combustion engine (ICE) production and develop transition plans for affected workers.
- Investment in automation training: The shift to BEV assembly will require greater use of automation; workforce training programs must reflect this need.
- Cross-sector upskilling programs: Collaboration between automotive, aerospace, and energy sectors will allow for shared workforce development efforts, particularly in electrification skills.
- Support for logistics workforce development: The industry must work with training providers to expand professional pathways in battery supply chain management.

The Electrification Skills Network (ESN) will play a critical role in coordinating these efforts. Rather than establishing a new working group, this forum should be expanded to align industry, education, professional bodies, and policy stakeholders in developing a unified skills agenda.

## 4.3 What this means for Education

**Curriculum and Training Development**
The findings from this foresighting cycle indicate that modifications to existing apprenticeship standards, technical courses, and degree programs will be required to meet future workforce needs.

- Expansion of BEV manufacturing apprenticeships: The existing L3 Battery Manufacturing Technician apprenticeship provides a solid foundation but requires expansion to include module and pack assembly competencies.
- New training pathways for logistics and recycling: There is an urgent need for new L3-L5 qualifications in battery logistics, warehousing, and recycling.
- Short-course and modular training: Education providers should develop flexible, modular learning options to enable rapid upskilling of workers transitioning from ICE manufacturing.
- Integration of automation and AI competencies: Training programs must incorporate automation, robotics, and digital twin technologies to support future BEV production methods.

Industry and education providers must work together to ensure that new qualification routes are developed with clear progression pathways, enabling workers to transition seamlessly into BEV-related roles.

## 4.4 Recommended next steps

The transition to a future-ready workforce for BEV manufacturing requires coordinated action across government, industry, and education. This report outlines a three-phase action plan to ensure the UK develops the skills necessary for the transition.

**Phase 1 – Immediate Priorities (0–2 Years)**

- Validate Future Occupational Profiles (FOPs) with industry to ensure alignment with employer needs. Further engagement with employers is needed to ensure that FOPs align with roles within organisations. This is a challenge given the different environment in which module and pack assembly will take place, but an initial focus may be placed on automotive OEMs.
- Expand short-term reskilling programs for workers transitioning from ICE manufacturing to BEV module and pack assembly. Several successful short courses are available in this space but many focus on aftermarket activities. It is necessary to ensure that the work of previously initiatives, such as the Emerging Skills Project, are built upon to enable manufacturing.
- Work with education providers to revise apprenticeship standards to better reflect industry needs in logistics, recycling, and automation. Several apprenticeship standards have been revised to address the battery sector but those associated with logistics, recycling and automation currently do not contain appropriate capabilities. Rapid re-skill and up-skill programmes can be addressed simultaneously using the Institute of the Motor Industry's Techsafe recognition within the professional register to facilitate demonstrations of competencies and recognised qualifications.
- Leverage the Electrification Skills Network (ESN) as the central forum for aligning industry and education on workforce planning. As the mechanism for bringing together

initiatives for the electrification workforce ESN is the most appropriate route to disseminate the work already undertaken and to establish next steps.

- Establish targeted funding mechanisms to support employer-led workforce training initiatives. Current Government funding does not properly support the shorter interventions needed to address more immediate needs. There are also concerns over the removal of funding for certain L7 apprenticeships that are used to re-skill engineers currently. A concerted effort to address future funding plans is needed to influence government.

**Phase 2 – Mid-Term Actions (3–5 Years)**

- Develop new qualifications and apprenticeship routes for high-demand roles in BEV manufacturing, including battery logistics and supply chain management. The amendments started in phase 1 should yield programmes that can be used particularly for the new-skill area.
- Expand workforce development programs to ensure a pipeline of engineers, technicians, and automation specialists for BEV production. The bulk of the workforce in this sector will be re-skilling from other sectors and this will hit a peak in the mid-term as manufacturing scales up.
- Create an employer-led accreditation system to ensure workers transitioning into BEV manufacturing have recognised credentials. Currently there is a lack of regulation of qualifications in battery manufacturing which needs to be addressed.
- Launch a UK Battery Workforce Hub to coordinate skills development initiatives across industry, education, professional bodies, and government. This hub would best sit within the work remit of ESN.

**Phase 3 – Long-Term Strategy (5+ Years)**

- Secure long-term public-private investment in skills development, ensuring continued support for workforce transition. A peak production nears training needs will reach a maintenance level and so a balanced approach to funding will be required.
- Develop future-proof qualifications that can adapt to next-generation battery chemistries and manufacturing techniques. To address this the mechanism of creating and amending qualifications also needs to be addressed. The process of changing existing qualifications is too lengthy and demand led education systems means that preparing for future need is impossible.
- Strengthen UK-EU collaboration on workforce mobility programs, ensuring UK workers have globally competitive skills in BEV manufacturing.

By implementing these recommendations, the UK can position itself as a leader in BEV manufacturing and battery production, ensuring long-term competitiveness in a rapidly evolving global industry.

Failure to act decisively will compromise the UK’s ability to attract investment, retain manufacturing jobs, and meet its net-zero commitments. Urgent collaboration is needed across all stakeholders to build a future-ready workforce and secure the UK’s industrial leadership in electrification.

# 5.0 Appendix

# 5. Appendix

| Section | Title |
| --- | --- |
| 5.1 | List of participants |
| 5.2 | Cycle timeline |
| 5.3 | Access to output data - link and authorisation |
| 5.4 | Glossary - common language |
| 5.5 | Visualisation links and illustrations |

## 5.1 List of participants

- *Aston Martin*
- *Automotive Technology*
- *Batri*
- *City & Guilds*
- *Electrification Skills Network*
- *Ford*
- *Fortescue Zero*
- *HVM Catapult*
- *Illston Authoring*
- *Institute of the Motor Industry*
- *Newcastle College*
- *North Warwickshire and South Leicestershire College*
- *Pro Moto*
- *Recovolt*
- *SIAS*
- *SectorTech*
- *Telford College*
- *UKBIC*
- *VOLKLEC*
- *WMG, University of Warwick*

## 5.2 Cycle timeline

Workforce Foresighting cycle started the Carry Out phase in October 2024. The Carry Out phase concluded in January 2025. The Findings report was prepared following the data validation period and published in March 2025.

## 5.3 Access to output data - link and authorisation

*Data Capture Overview*

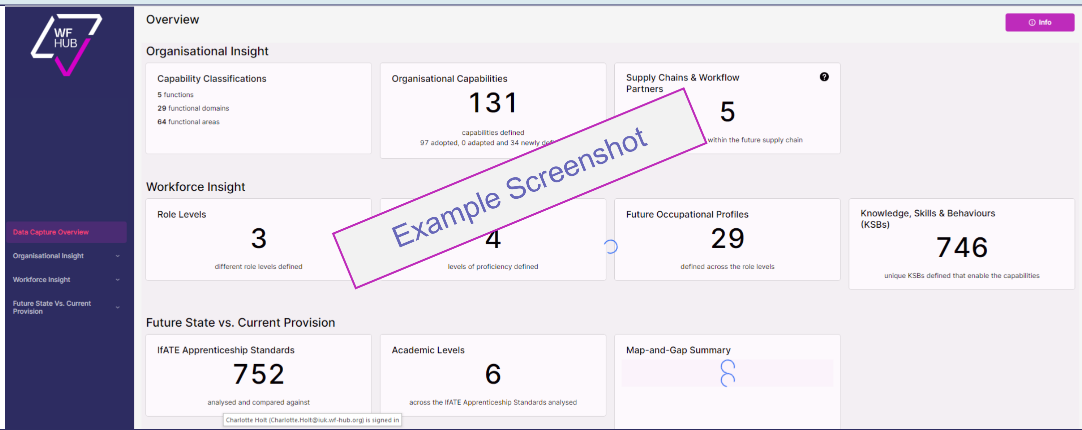
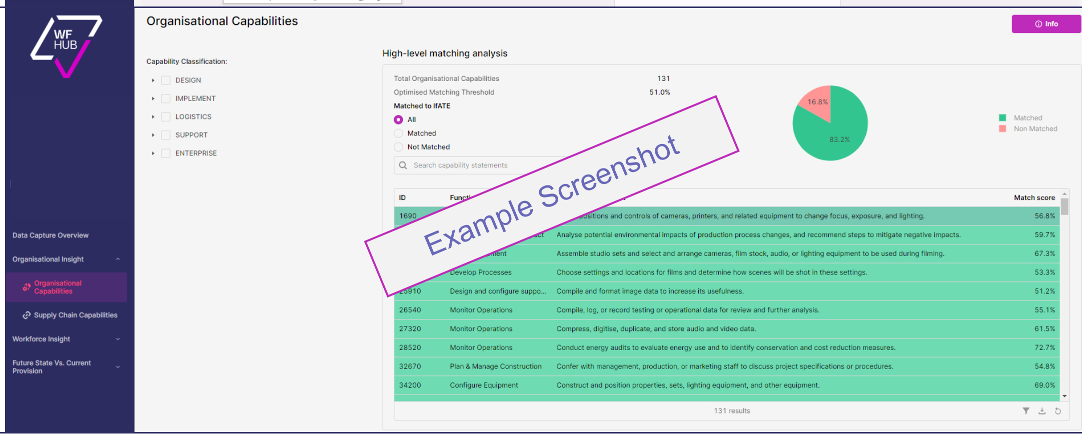
## 5.4 Glossary - common language

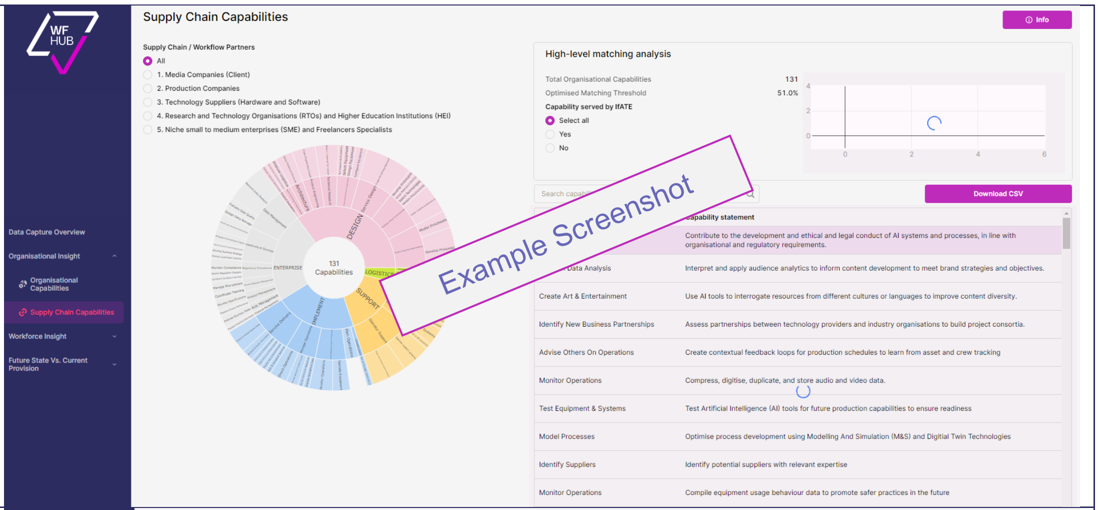
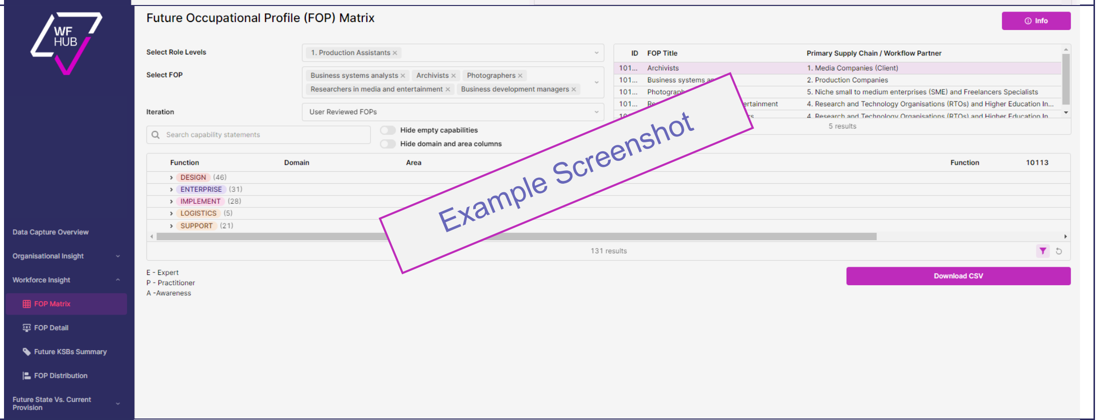
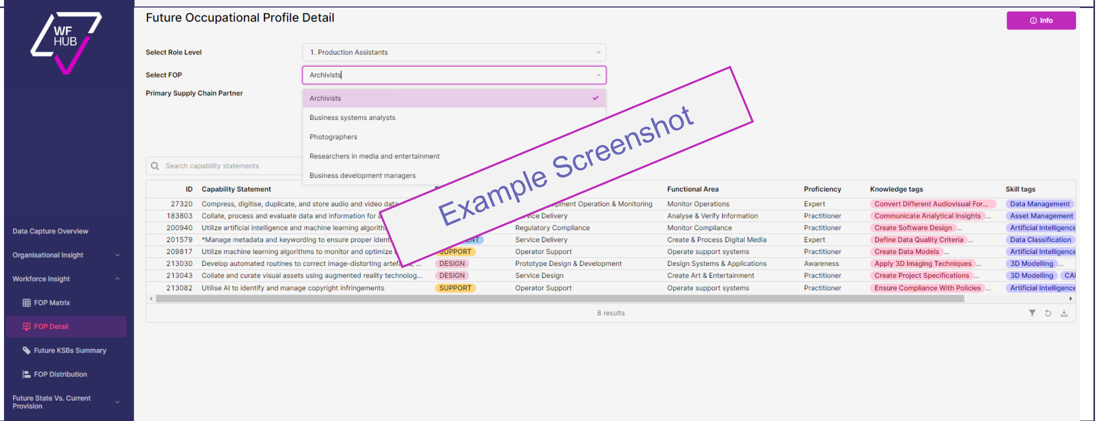
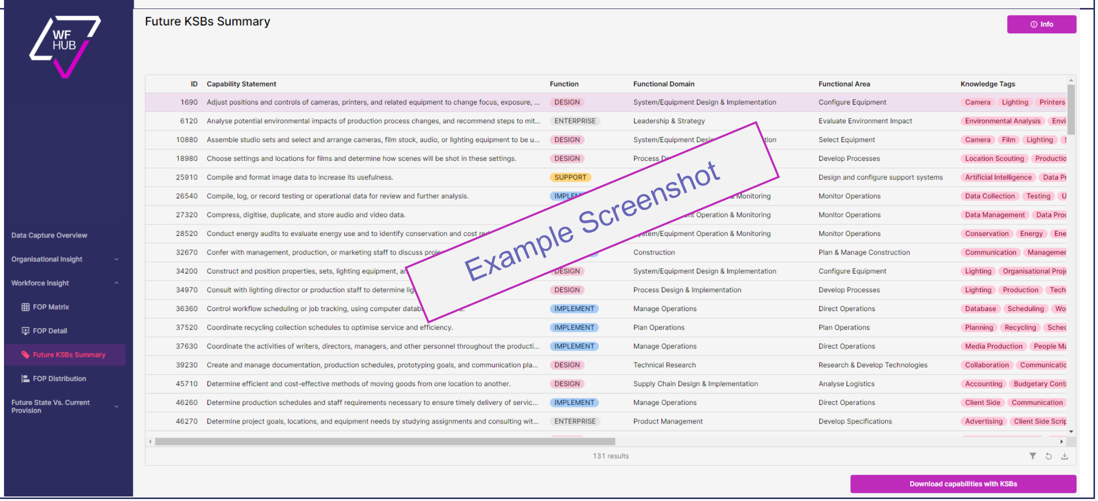
| Term | Definition |
|---|---|
| Impact Domains | Innovate UK domains used as Strategic Categories to assist setting and monitoring priorities |
| National Challenge (Industry / Sector / Region) | A recognised technological or socio-political threat or opportunity for which there is consensus that workforce action is necessary |
| Challenge Response | Specific intervention aimed at the challenge |
| Capability (Organisation) | The collective abilities, and expertise of an organisation to carry out a function, because provision and preparation have been made by the organisation |
| Capability Classification | Classification provides a common, structured vocabulary to define capability |
| Capability Statements | Description of the depth and nature of each capability within an organisation |
| Capability Syntax | Common language to describe each capability application within organisation type |
| Competencies (Workforce / Individual) | ‘Proficiency, aptitude, capacity, skill, technique, experience, expertise, facility, fitness related to capability |
| Competency definition 'KSBs' (Knowledge, Skills, and Behaviours) | Knowledge, Skills, and Behaviours are the elements used to express the required competencies for each Role Level |
| Competency Domain | Used during foresighting analysis to provide focus on existing and emerging competency needs |
| Delphi Process | Foresighting takes a Delphi approach which has come to represent consulting expert opinion. (Harking back to the Delphic Oracle of ancient Greece) |
| Foresight Cycle | Set of workshops, analysis and reporting that implements the Foresight Process for each subject |
| Foresight Process | A series of activities which are convened to understand future competence needs, the opportunities available and actions required to deliver the right skills at the right time and place |
| Foresighting Champion | An individual nominated within a new user organisation of foresighting to facilitate and lead the use of foresighting processes and tools with the support of the Project Team |
| Foresighting Subject | The application of specific technologies in the context of a given challenge and which are candidates for foresighting |
| Future Competency Set | The KBS output from the Educator workshop for each Role Level |
| Map and Gap Analysis | A combined expert and automated process that maps the Future Competency Set against a selected reference framework |
| Organisation Type | Simple description of nature of organisation for which capability is required |
| Proficiencies | Proficiencies differentiate the degree of competencies required from differing Role Levels to support capabilities |
| Project Sponsor | Typically, a stakeholder in the challenge being successfully met who requires information to under-write plans to act |
| Role Level | Role Levels are a collective of roles that exist in a typical manufacturing business / industrial sector |
| Syntax | The way in which a statement is phrased to ensure reliable, repeatable, and meaningful interpretation |

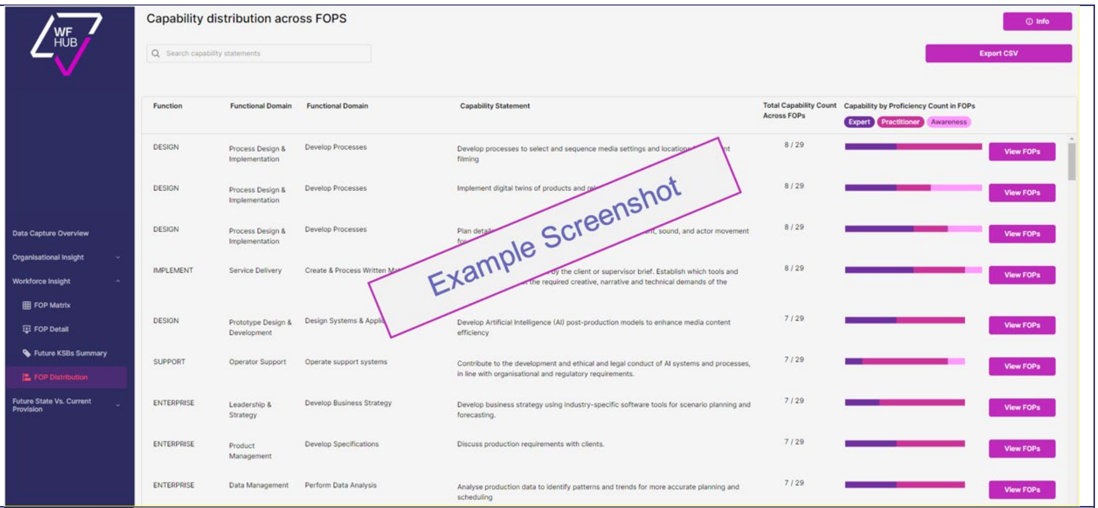
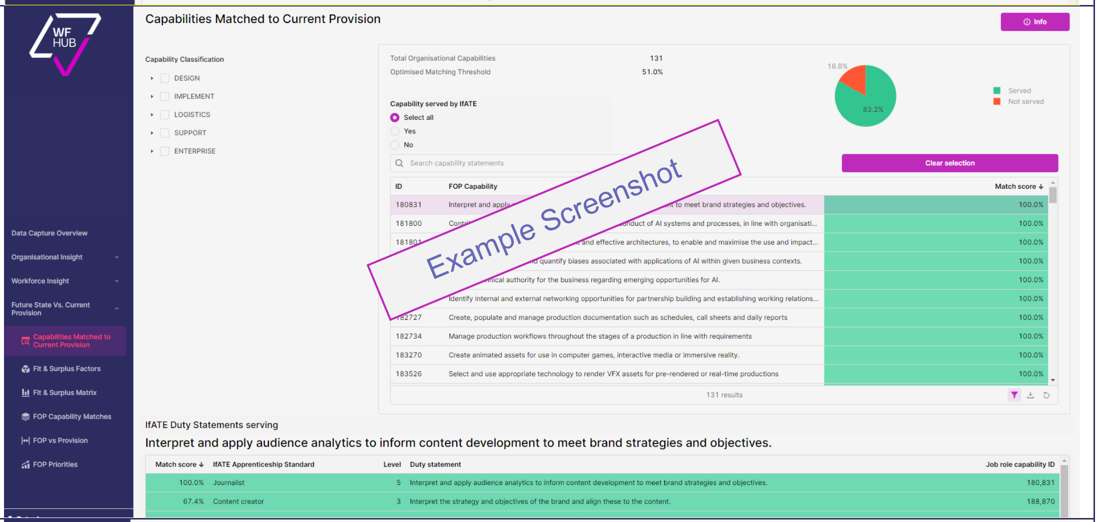
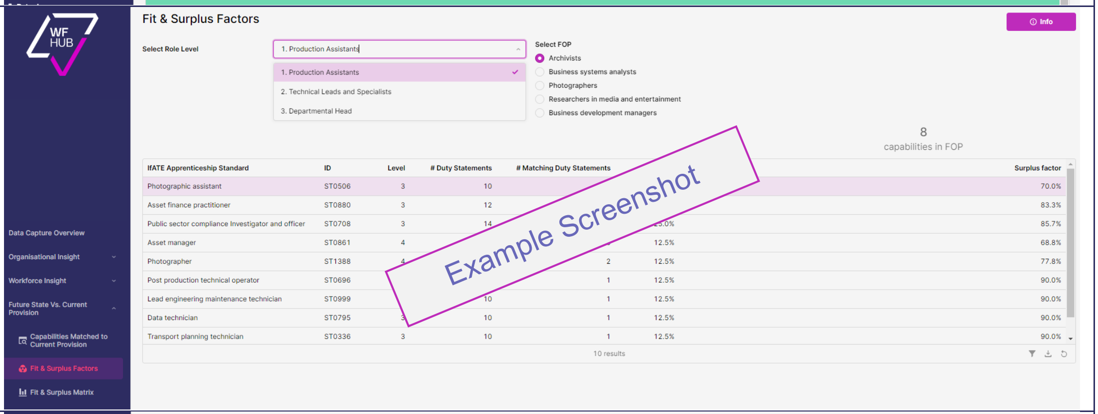
| | |
|---|---|
| Technologies | The technology that could be used to address the challenge |
| Working Scenario | To provide further context in relation to the subjects and used to position participants thinking during the detailed identification of future capabilities |
| Workshops | Online sessions used to undertake each step in the foresight process |
| Roadmaps | Sector, Industry, Regional view of emerging opportunities and their market entry |
| Participants | Technologists, Educators, Employers |

## 5.5 – Visualisation links and illustrations

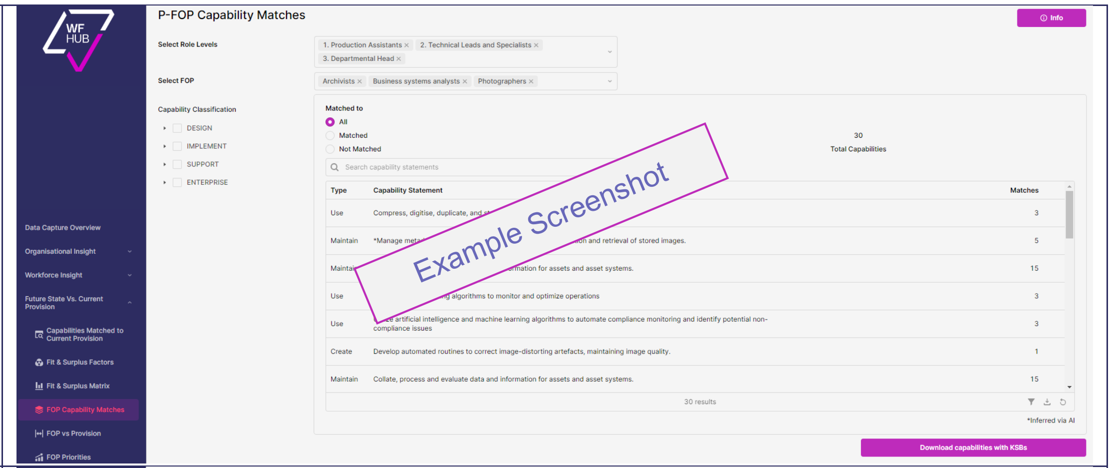
*Images are not cycle specific and just for guidance purposes*

| Link to Visualisation | View of data |
|---|---|
| *Data Capture Overview* |  |
| *Organisational Capabilities* |  |

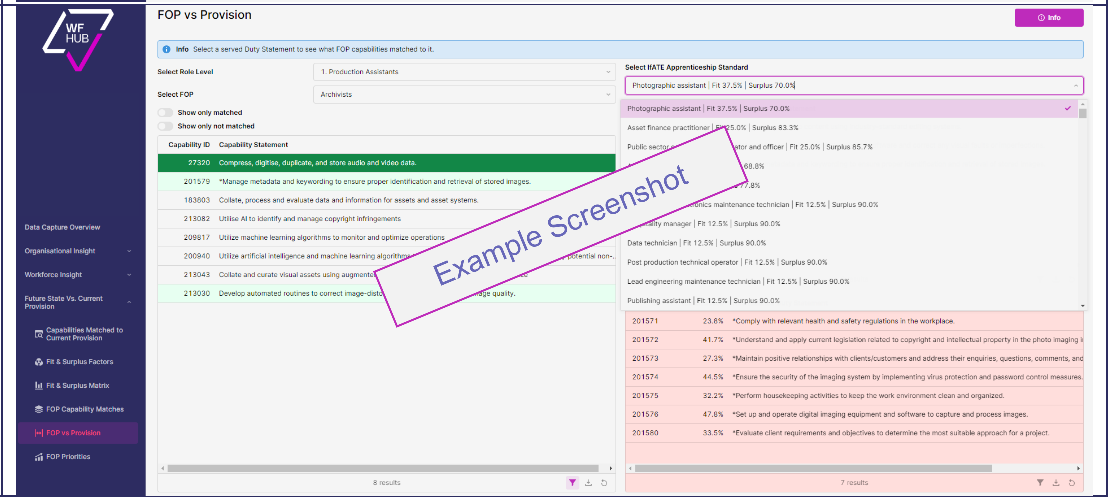
| | |
|---|---|
| Supply Chain Capabilities |  |
| FOP Matrix |  |
| |  |
| Future KSBs Summary |  |

| | |
|---|---|
| *FOP Distribution* |  |
| *Capabilities Matched to Current Provision* |  |
| *Fit  Surplus Factors* |  |
| *Fit  Surplus Matrix* |  |

## FOP Capability Matches




## FOP vs Provision




## FOP Priorities