Insight report

UK Zero Emission Vehicle Manufacturing:

Competitiveness and strategic priorities for the sector



ADVANCED PROPULSION CENTRE UK

Department for
Business, Innovation,
Science and Trade

The Advanced Propulsion Centre UK (APC) operational costs are funded by the UK Government's Department for Business, Innovation, Science and Trade (BIST) and industry contributions. BIST is the ministerial department for economic growth, supporting businesses to invest, grow, and export, creating jobs and opportunities across the country. Our combined mission is to accelerate the development of advanced propulsion technologies to reduce greenhouse gas emissions, minimise embedded carbon, and improve air quality.

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Foreword

The UK automotive industry remains a cornerstone of UK manufacturing, but its competitive position is under increasing pressure. Production volumes have declined since 2019, while global investment, rising labour and energy costs, structural change across Europe and growing competition from China are reshaping the economics of automotive manufacturing. Against this backdrop, strengthening manufacturing competitiveness is now a strategic requirement for the sector.

The transition to zero-emission vehicles is therefore both a challenge and a defining opportunity. The ambition to increase annual vehicle production to 1.3 million by 2035, supported by programmes such as DRIVE35, provides an opportunity to strengthen the UK's position as a globally competitive manufacturing base. Achieving this ambition will depend not simply on production volumes, but on improving productivity, reducing costs, strengthening resilience and developing new technological capabilities.

This report examines the ZEV value chain to identify where cost, labour intensity, automation potential and supply-chain risk converge, and where the UK can capture the greatest value. The opportunity is significant. Batteries, electric drive units and power electronics account for around two-fifths of the value of a mass-market EV, creating a clear opportunity for future investment and domestic capability. There is also substantial scope to improve productivity in labour-intensive areas such as seats, interiors and wiring harnesses, while building on established UK strengths in steering, braking and chassis systems.

A central theme of the report is that many of the technologies needed to improve competitiveness already exist. Manufacturing execution systems, digital twins, automation, robotics and AI-enabled process optimisation are increasingly mature, with case studies demonstrating measurable productivity and efficiency gains. The greater challenge is adoption: developing the data foundations, skills, processes and digital change management required to deploy these technologies effectively, particularly across smaller suppliers.

The UK has significant strengths, including established automotive clusters, world-class engineering capability, a strong research and innovation base and an extensive supplier ecosystem. Competitiveness will not be secured through any single intervention, but through the alignment of capital investment, innovation, supply-chain resilience, skills and closer collaboration between OEMs and suppliers.

DRIVE35 provides an important platform for this ambition. This report offers a practical evidence base for industry, investors and policymakers as the UK seeks to translate ambition into globally competitive, technology-enabled manufacturing at scale.



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Executive Summary

The transition to zero-emission vehicles (ZEVs) represents a major industrial opportunity for the UK automotive sector. Backed by the Government's DRIVE35 programme and ambitions to increase annual vehicle production to 1.3 million units by 2035, the shift to electrification creates the potential to capture higher-value manufacturing activities, expand domestic supply chains and strengthen the UK's position as a globally competitive automotive manufacturing hub.

At the same time, the industry is operating in an increasingly competitive environment. Global investment in EV manufacturing is accelerating, with China continuing to expand its scale and capabilities while European producers are restructuring operations and improving productivity to remain competitive. In this context, the UK auto manufacturing sector faces a range of competitiveness challenges, including energy costs, labour shortages, and the transition to EV platforms. At the same time, these pressures create an imperative and opportunity to boost productivity and competitiveness through innovation, automation, and advanced manufacturing technologiess.

This insight report assesses the competitiveness of the UK ZEV manufacturing value chain and identifies the areas with the greatest potential to increase productivity, strengthen supply chains and drive economic growth.

The analysis highlights four key findings:

1. High-value electrification technologies offer the greatest growth opportunity. Batteries, electric drive units and power electronics account for a significant share of vehicle value in electric vehicles, creating substantial opportunities for domestic manufacturing and supply chain development. The shift towards software-defined vehicles also increases the importance of electronic hardware, including system-on-chips, electronic control units and related components.

2. Productivity improvements are critical in labour-intensive manufacturing segments. Activities such as interiors, seating systems and wiring harness production remain relatively labour-intensive and present significant opportunities for automation and process optimisation. The UK can build on its established strengths in chassis systems, steering, braking and vehicle assembly to improve competitiveness and secure future investment.

3. Many of the technologies needed to improve competitiveness are already available. Proven solutions including manufacturing execution systems, digital twins, machine vision, predictive maintenance, advanced robotics and AI-enabled process optimisation are delivering measurable benefits across global automotive manufacturing. The challenge for the UK is less about technology availability and more about accelerating adoption, developing capabilities and ensuring a workforce equipped to deploy these technologies at scale.

4. Electrification creates opportunities to simplify and modernise manufacturing. Dedicated battery-electric vehicle platforms and redesigned vehicle architectures can reduce manufacturing complexity, improve production efficiency and support greater levels of automation across assembly operations.

The UK enters this transition with significant advantages, including world-leading engineering expertise, established automotive manufacturing clusters, a strong research and innovation base, and close collaboration between industry, government and academia. These capabilities provide a strong foundation for attracting investment and capturing a greater share of value from the growing ZEV market.

To maximise this opportunity, targeted action is required to strengthen high-value ZEV supply chains, accelerate automation and digitalisation, improve supply chain resilience, develop advanced manufacturing technology cluster and support closer collaboration across the automotive ecosystem.

By combining these actions with continued support for innovation, scale-up and capital investment, the UK can increase productivity, grow domestic value creation and establish itself as a leading location for the manufacturing of zero-emission vehicles and next-generation automotive technologies.



1. Introduction

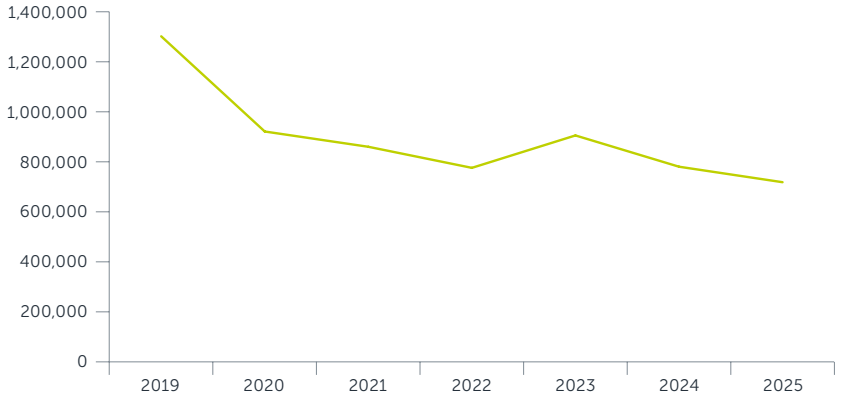
The UK is known as an automotive manufacturing powerhouse; it contributes £92[1] billion in turnover as of 2024 and employs around 800,000 people in the sector. In 2025, nearly 720,000 cars were built in the country. However, like all traditional automotive nations in Europe, South Korea and Japan, the UK is facing challenges due to declining production volume, as shown in Figure 1.

Challenges that cut across industries

Various factors are contributing to the decline in vehicle production volume in the UK. However, productivity and competitiveness challenges cut across different manufacturing sectors. Some of the factors that influence UK competitiveness are:

1. Expanding manufacturing investment in China and India
2. Increasing global competitive environment on labour and energy costs
3. Post-COVID EU automotive production challenges
4. Increasing export factor from Chinese EV production

Figure 1: SMMT UK passenger car and LCV volume figures



[1]SMMT motor industry facts 2026

Expanding manufacturing investment in China and India
Global manufacturing competitiveness is increasingly influenced by investment in advanced production facilities and next-generation industrial infrastructure. Over the past two decades, countries such as China and India have significantly expanded manufacturing capacity through sustained capital investment, strengthening their position in global value-added manufacturing, as shown in Figure 2, a proxy for manufacturing investment.

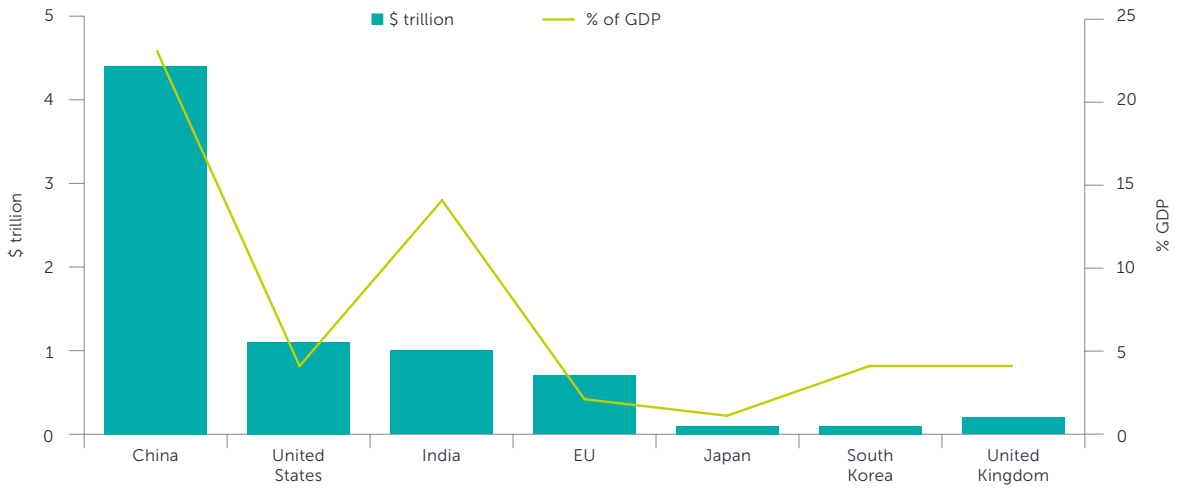
Global competitive environment for energy and labour costs
The UK automotive sector operates in a highly competitive global manufacturing environment, where energy costs, labour availability, and operating costs increasingly influence global OEMs' investment and production decisions.

These factors are incentivising the adoption of advanced manufacturing technologies, automation and digital processes to improve productivity and competitiveness.

As shown in Figures 3 and 4 on the following page, the UK has relatively high labour and industrial energy costs compared with many international peers, creating a strong business case and motivation for innovation, efficiency improvements and technology deployment across the automotive value chain.

To help address high industrial energy costs, the UK Government has introduced the British Industrial Competitiveness Scheme (BICS), which will come into effect in 2027. Under the scheme, eligible manufacturing businesses will be exempt from paying the indirect costs associated with renewable obligation schemes, the capacity market, and feed-in tariffs. As a result, participating businesses could see their energy bills reduced by up to 25%.

Figure 2: Net productive investment as a measure of GDP across the world[2]



China and India have significantly expanded manufacturing capability and capacity through sustained capital investment over the past two decades

"The UK automotive sector operates in a highly competitive global manufacturing environment creating a strong business case for innovation and technology deployment"

[2]Catalyzing competitiveness where investment happens and why
Net productive investment is a proxy for calculating the new manufacturing productive capacity added to a country.

Figure 3: Labour wages across OECD nations[3]

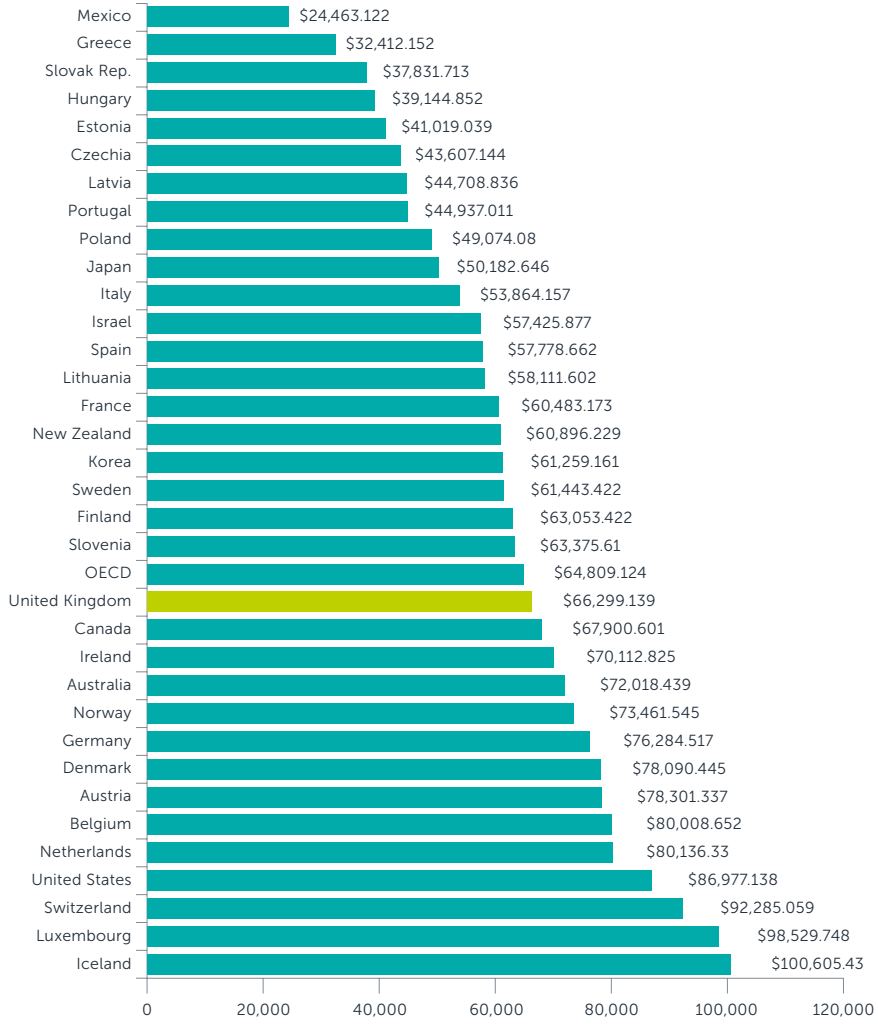
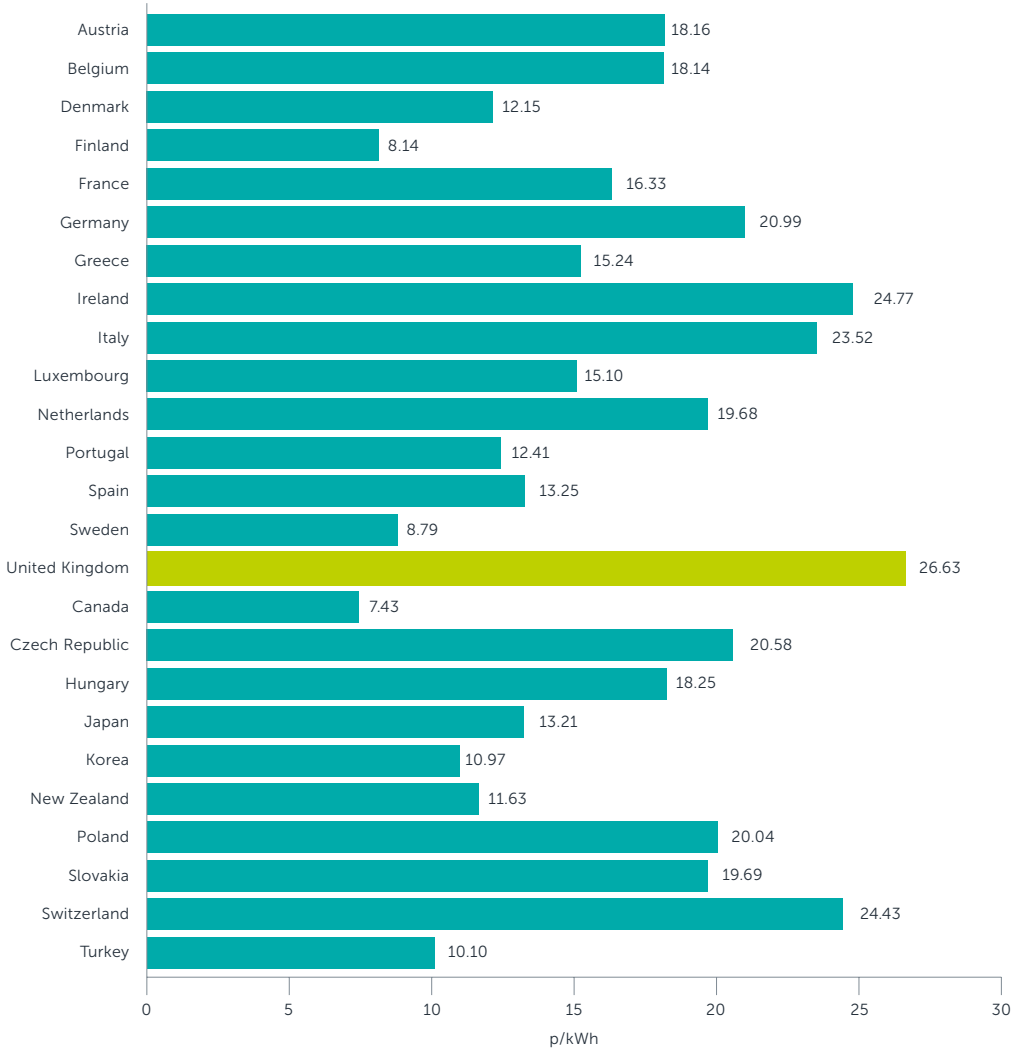


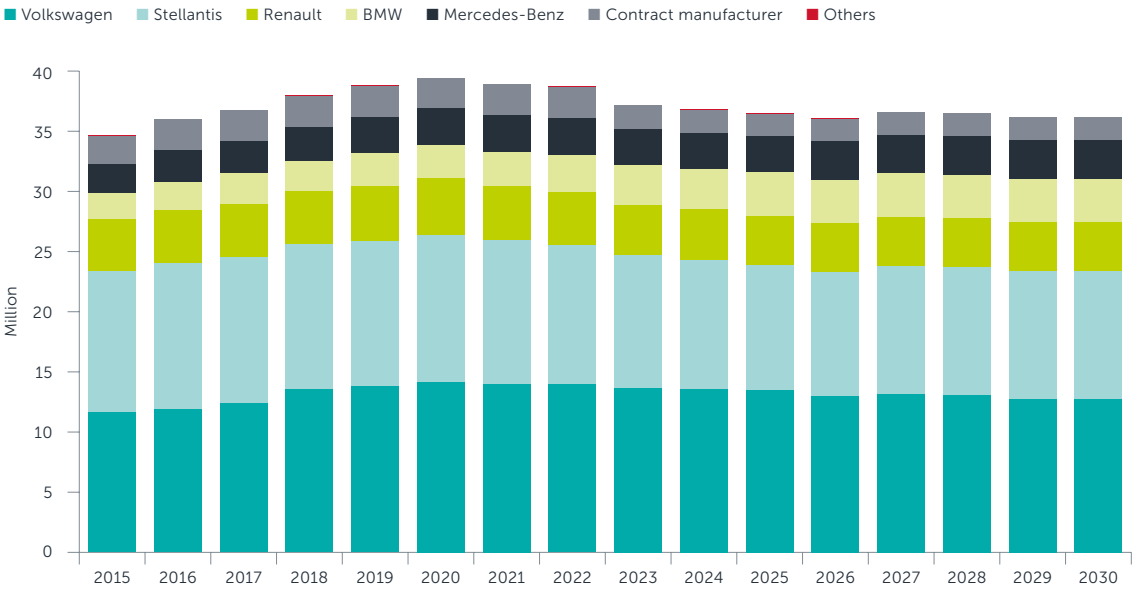
Figure 4: Industrial energy costs[4]



[3]OECD annual wages data 2025
[4]Gov.UK IEA database

Global Automotive production and market challenges
European automotive OEMs are navigating a period of significant transformation as the industry transitions towards electrification, digitalisation and new mobility services. Manufacturers are responding to diverse powertrain choices, evolving supply chains, and intensifying global competition by reassessing their production footprints and improving operational efficiency. As shown in Figure 5, European OEMs production capacity has adjusted from around 40 million vehicles in 2020 to 36.4 million vehicles in 2025. This changing landscape has created opportunities for manufacturers to improve capacity utilisation, adopt advanced manufacturing technologies and invest in higher-value, more competitive production systems.

Figure 5: BNEF EU automakers production capacity[5]



European OEMs and their supply chain are navigating through a significant transformation as electrification and new mobility paradigm become the mainstream.

[5]Does not include Nissan and JLR as they are Japanese and Indian owned conglomerates respectively



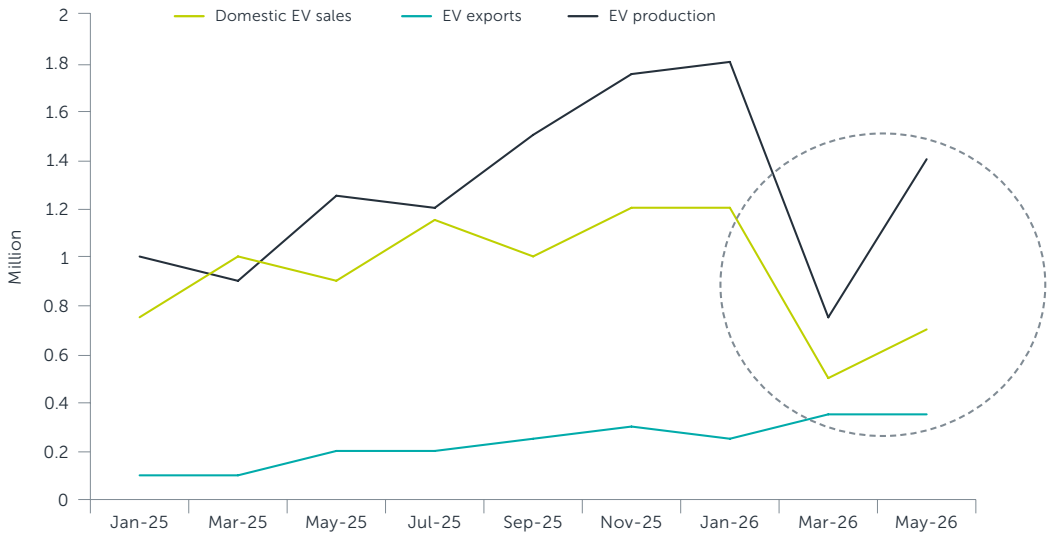
China EV export competition

One major driver for European OEMs' competitiveness is Chinese competition, particularly in EV exports. Two-thirds of China's car market consists of electric vehicles (that is, plug-in and full electric)[6]. China accounted for nearly 75% of global production of electric vehicles in 2025. [7]. Sustained EV production from Chinese OEMs has continued in 2025 despite slowing sales in China, with output now exported to the rest of the world, as shown in the figure opposite.

The rapid growth of Chinese EV exports is intensifying competition across global automotive markets and accelerating the pace of transformation among European OEMs. In response, manufacturers are investing in productivity improvements, new vehicle platforms and technologically advanced production systems to enhance competitiveness and meet evolving customer demands. The UK Government's DRIVE35 programme aims to position the UK as a global leader in zero-emission manufacturing and supply chains. One of the major factors in the business case for the £4 billion investment is to scale up automotive production in the UK to 1.3 million vehicles (cars and commercial vehicles) by 2035, as set out in the Industrial Strategy[10]. The challenges above indicate some of the headwinds the programme might face in achieving its ambition by 2035. To scale the automotive volume production to its pre-COVID times, the UK needs a healthy and resilient supply chain that can support the OEMs with its future model programmes and vehicle productions. A healthy supplier landscape is vital for retaining strategic capabilities and sustaining long-term competitiveness.

Regulatory factors, such as intercontinental tariffs, incoming rules of origin regulations on batteries, and the proposed draft legislation on the Made in Europe Industrial Accelerator Act[9] will play an important role in shaping the future of automotive production in the UK and Europe.

Figure 6: China EV local production and export data[8]



[6]EVs capture two thirds of china's car market in record breaking week
[7]Trends in the electric car industry
[8]Benchmark intelligence
[9]Industrial accelerator act
[10]Drive35 summary business case

1.1 Insight report objectives and scope

This insight report provides an overview of opportunities for manufacturing competitiveness in the automotive supply chain from the Advanced Propulsion Centre's (APC) perspective. The report focuses on two pillars:

1. **ZEV manufacturing value chain:**
   Providing a manufacturing operational assessment of the key steps in making a zero-emission vehicle in the UK. This includes highlighting areas that have potential to improve sub-component production in the region.

2. **Manufacturing Innovation analysis:**
   Providing an overview of the key technology options that exist to improve the overall productivity and efficiency of the automotive manufacturing operations. This includes mapping manufacturing key performance indicators (KPIs) against emerging technologies that could improve the production of sub-components listed in the value chain.

This report scope covers:

- ➔ Light passenger cars. Commercial and heavy-duty vehicles will be included in the analysis in future phases of work.
- ➔ Finished sub-components of the zero-emission vehicle segments listed in the next section. It does not cover the supply chain for semi-finished products; however, the importance of the supply chain for components is considered.

"The DRIVE35 programme designed by the UK Government, aims to position the UK as a global leader in zero-emission manufacturing and supply chains."

2. ZEV manufacturing value chain and major constraints in the value chain

The automotive value chain is a complex operation in this modern era. There are various players, from refining critical minerals to producing sub-components needed for vehicle assembly to OEMs who assemble vehicles. There are production and legislative challenges as products are transformed and value is added between the different stages. According to an OECD report from 2024[11], automotive investment globally has struggled post-COVID, resulting in a severe supply chain shock. This has affected tier-2 and tier-3 suppliers in the automotive industry more than OEMs. However, some parts of Europe have started to recover.

To understand the overall impact of the supply chain, APC mapped the end-to-end steps of ZEV manufacturing from upstream critical-mineral sourcing to vehicle manufacturing, as shown in figure 7 on the following page. This report primarily focuses on the midstream and final assembly of passenger EVs and does not include the upstream or the assembly of commercial and special-purpose vehicles.

Other steps vital to vehicle manufacturing, such as R&D and engineering, are outside the scope of this report.

One of the major differences between the ZEV value chain and conventional car manufacturing is that battery-powered vehicles have a simpler vehicle architecture and have around 80% fewer moving parts than an ICE vehicle[12]. This has implications for the labour costs and the type of assembly skills needed between an ICE and a BEV vehicle.

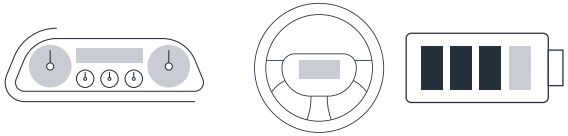
[11]The future of the automotive value chain
[12]How does increased EV production affect employment

Figure 7: ZEV value chain map from raw materials to vehicle manufacturing[13]



Upstream

- Critical mineral resources
- Battery materials
- Steel
- Aluminium
- Copper
- Magnets
- Silicon



Midstream

Core components	Battery system	EDUs	Chassis and interiors	Vehicle body and accessories	Automotive electronics
	Battery Cells	Inverters/OBC	Car windows	Body-in-white	ECUs
	Pack	E-motors	Steering wheel	Wheels	Wiring harnesses
			Seats	Brake pads	
			Rear-view mirror	Wheel hub	
			Dashboard	Drive shaft	
			Headlights	Exterior trims	
			HVAC		
			Suspension		



Vehicle Manufacturing

- Passenger EVs
- Commercial EVs
- Special-purpose vehicle

Denotes out of scope for this report's analysis

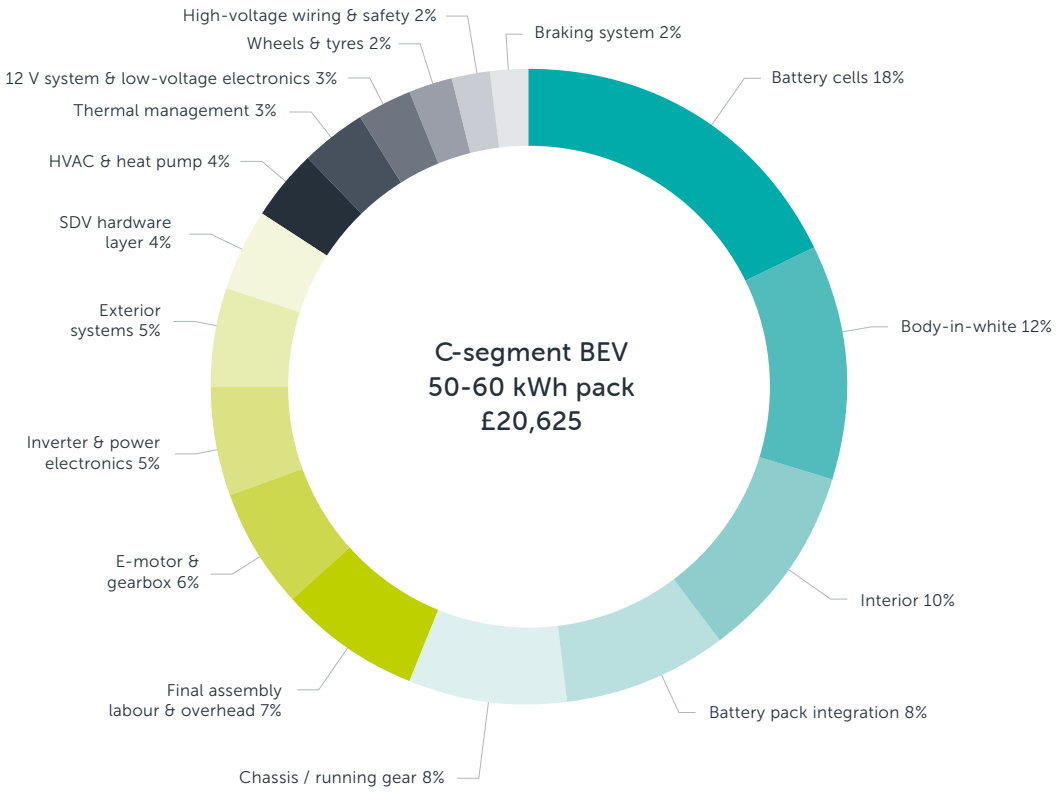
[13]Adapted from JRTO report on Automotive value chain

To understand the complexities of the value chain, APC has assessed the potential value-share stack of the sub-components used in the assembly line, providing a rough bill of materials (BOM) for a mass-affordable EV to be built in the UK. The analysis is based on an average mainstream C-segment BEV with a 50-60 kWh pack and a factory-gate price of £20,625. The breakdown of the Share of vehicle cost, along with the details of sub-components, is shown below.

The analysis indicates that batteries, EDUs, and power electronics account for around two-fifths of the overall value share, highlighting the importance of the electrified powertrain to overall zero-emission automotive manufacturing.

The body-in-white, interior, chassis, and final assembly rank second in value share of zero-emission manufacturing, playing an anchor role for the automotive supply chain in the UK. While software-defined vehicle (SDV)-related components such as System-on-Chips (SoCs), memory, and data cables are currently low, they have significant potential to rise in value share due to increased use of ADAS and other self-driving assistance features that demand high computing chips and zonal architectures[15].

Figure 8: ZEV Bill of materials value share[14]



"Batteries, EDUs, and power electronics account for around two-fifths of the overall value share and will determine future automotive competitiveness for the UK supply chain."

[14]APC analysis from Munro teardowns, McKinsey insights and research papers
[15]Software defined vehicles



3. Supply chain operational assessment

To support the supply chain effectively by improving resilience and expanding capability, APC has developed an operational assessment framework that identifies potential hotspots for supply chain improvement within the BOM sub-components listed in the section above. The selected dimensions address either the competitive environment outlined in the sections above or the criticality of a sub-component to the strategic importance of the domestic automotive value chain.

The framework analysed the following five dimensions:

1. **Energy consumption:** The intensity of energy consumption needed to produce the sub-component.
2. **Weight of the sub-component:** Understanding the bulkiness of the sub-component for logistics and just-in-time sequencing of moving parts.
3. **Labour intensity:** The labour intensity that is required within the sub-component production.
4. **Automation potential:** The level of automation currently deployed to produce the sub-component.
5. **Supply chain criticality to the UK:** The availability of capability and capacity in the UK to produce the sub-component locally.

All the above dimensions were assessed using a 1-5 scoring system, where 5 represents the highest criticality or the magnitude of the challenge and 1 is not significant to the cause.

Improvement index: To provide a measurable reference for the dimensions above and a framework for competitiveness, a supply chain improvement index was developed. The index quantifies the significance of logistical factors, labour intensity, and current automation levels needed to produce a sub-component.

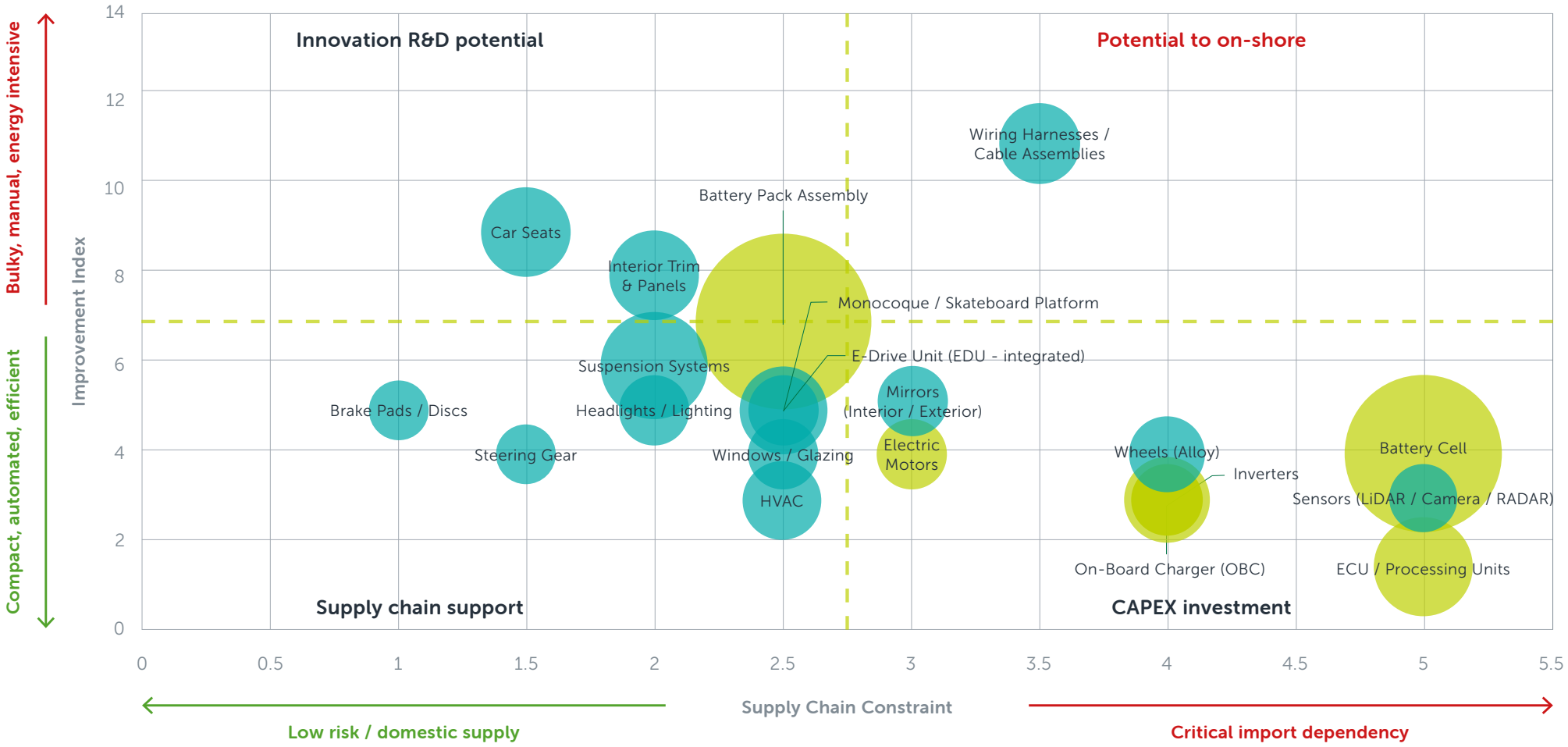
Supply chain improvement index = Weight+((labour-automation) *1.5) +energy consumption

Labour and automation are weighted more heavily in the analysis to recognise the innovation and technology potential for automation, rather than logistics or energy consumption, during the production of a sub-component.

The framework was applied to identify where the UK can capture the greatest value from future ZEV production. Sub-components were evaluated against their market potential with a 1.3 million-vehicle production scenario and their importance in building a competitive and resilient domestic supply chain, as shown in Figure 9.

APC has developed an operational assessment framework that identifies potential hotspots for supply chain improvement within the BOM sub-components

Figure 9: Supply chain improvement index[16]



Potentially affected by the EU rules of origin and IAA Act

[16]APC analysis. Bubble size represents the relative market size of the sub-components to be made in the UK for 1.3 million vehicles. The quadrants shown are a qualitative visual guidance tool. The sub-components listed are non-exhaustive.

Opportunities for investment in battery powertrain products:
The framework highlights a significant opportunity to expand UK capability in high-value BEV powertrain technologies that account for a substantial share of vehicle value. Battery cells, sensors and ECU processing units, which are critical enablers of electrified and software-defined vehicles, are currently produced predominantly in highly automated facilities outside the UK. As demand for these technologies continues to grow, there is a clear opportunity to attract capital investment, establish domestic manufacturing capability and strengthen the UK's position within future ZEV supply chains. This opportunity is further reinforced by emerging regulatory frameworks such as rules of origin requirements and the proposed Made in Europe Industrial Accelerator Act (IAA).

Through ATF interventions, there are efforts being made to localise EDU production[17] and critical power electronic components[18] in the UK. However, the long-term sourcing outlook for these components remains highly dependent on OEM strategies, particularly decisions around supplier sourcing, and the degree of in-house development and manufacturing of powertrain technologies.

Innovation R&D potential for interiors and wiring harnesses:

The analysis highlights significant opportunities to improve the competitiveness of labour-intensive vehicle components already produced in the UK, particularly interiors and seating systems.

Critical sub-components like seats and interior trims involve complex manufacturing processes and offer strong potential for productivity gains through the deployment of automation, digital manufacturing tools and advanced production technologies outlined in Section 4. Wiring harnesses represent a further opportunity for supply chain growth. While cabling production is currently concentrated outside the UK due to the labour-intensive nature of the process, emerging automation and manufacturing innovations could improve economic viability and incentivise future onshoring opportunities.

Supply chain support for bulky non-powertrain components:
The analysis also illustrates that the UK has strong capabilities in chassis and vehicle body accessory components, such as steering gear and brake pads, which are currently produced using advanced manufacturing methods and technologies. These sectors provide a strong anchoring platform for future growth, with opportunities to strengthen domestic supply chains, increase manufacturing resilience and support the scaling of UK vehicle production in line with the ambitions of DRIVE35.

A major trend affecting automotive competitiveness is the growing bifurcation between battery powertrain suppliers and traditional non-BEV component manufacturers. The latter continue to face persistent pressure on profit margins as value shifts across the supply chain, alongside the significant investment requirements associated with retooling, technology upgrades, and capital reallocation to support the electrification transition[19]. These challenges have contributed to a fragmented and, in some commodity areas, oversupplied supplier landscape. However, opportunities exist for consolidation, the adoption of process efficiency and automation measures, and strategic portfolio realignment to enhance the resilience and competitiveness of UK-based production.

Opportunities around BEV skateboards or platforms:
Developing new skateboards or platforms for BEV vehicles could be a strong opportunity to develop future models in the UK. Fully dedicated platforms can reduce overall vehicle development costs and improve the profitability of BEV vehicles. BMW's Neue Klasse platforms have helped to push down BMW's manufacturing costs by 10%[20]. These new technology platforms can help scale automotive production volumes and achieve the target of 1.3 million vehicles.

Assembly and processing of key sub-components:
Assembly, stamping, moulding and pressing processes are fundamental building blocks of the ZEV manufacturing value chain. While not included within the supply chain innovation index, they account for around 8% of vehicle costs and represent attractive opportunities for investment in advanced manufacturing technologies, helping to improve productivity, reduce costs and strengthen UK manufacturing capability

As an example, plastic injection moulding can be very energy intensive, and material circularity mechanisms like recycling can reduce energy demand and boost sustainability over virgin materials[21].

[17]Ford UK: Halewood Transmission Factory Transformation [18]Hundreds of millions of pounds to turbocharge manufacturing sector in Wales
[19]2026 Global Automotive Supplier Study [20]2026 BMW ix3 [21]APC Effect of Energy Efficiencies on Embodied Emissions

4. Manufacturing innovation landscape

Technology and automation-related improvements can enhance competitiveness in energy consumption, labour, and quality. Technology improvements in manufacturing are highly dependent on the key performance indicators (KPIs) measured. There are three different types of KPIs used within the manufacturing space:

1. Productivity and efficiency-related KPIs
2. Quality-based KPIs
3. Cost-related KPIs

The detailed list and the description of KPIs are provided in the appendix.

To achieve the productivity objectives listed in the KPIs above, the technology products could be categorised into three themes.

1. **Low-cost automation:** Using lower-cost, readily deployable technologies that improve the manufacturing productivity on a shop floor.
2. **Process-improvement tools:** Technology or tools that improve the operational process flows and enable seamless movement of materials and products between different parts of the value chain.
3. **Emerging technologies:** Cutting-edge innovative technologies that seek to bring transformative changes to the manufacturing operations on the shop floor.

A non-exhaustive list of the above technologies is provided in Table 1:

Table 1: Technologies driving manufacturing competitiveness across automotive production

Category	Technologies	Primary Contribution area
Low-cost automation	• Collaborative robots (Cobots) • Autonomous mobile robots (AMRs) & automated guided vehicles (AGVs) • Karakuri systems (Physics-based) • Digital Work Instructions • Predictive Maintenance	Safety, quality, people, cost.
Process improvement tools	• Manufacturing Execution Systems (MES) & Enterprise Resource Planning (ERP) Software • Digital Twins & Simulation • In-line Metrology & Statistical Process Control (SPC) • AI-Driven Process Optimisation	Quality, cost, delivery.
Emerging technologies	• Humanoid Robotics • AI/Machine vision systems • Advanced Material Joining • Additive Manufacturing • AR/VR for training & maintenance, repair, & overhaul (MRO) • Precision Laser Processing	Cost, delivery, quality.

Technology improvements in manufacturing are highly dependent on the key performance indicators (KPIs) measured.

Manufacturing Technology Assessment: ROI vs. Manufacturing Impact

APC has analysed the technologies listed in Table 1 based on their potential to improve manufacturing KPIs, their return on investment (ROI), and key benefits and barriers to their adoption. The analysis is presented as a technology priority matrix in figure 10. The table 2 below lists the axes description.

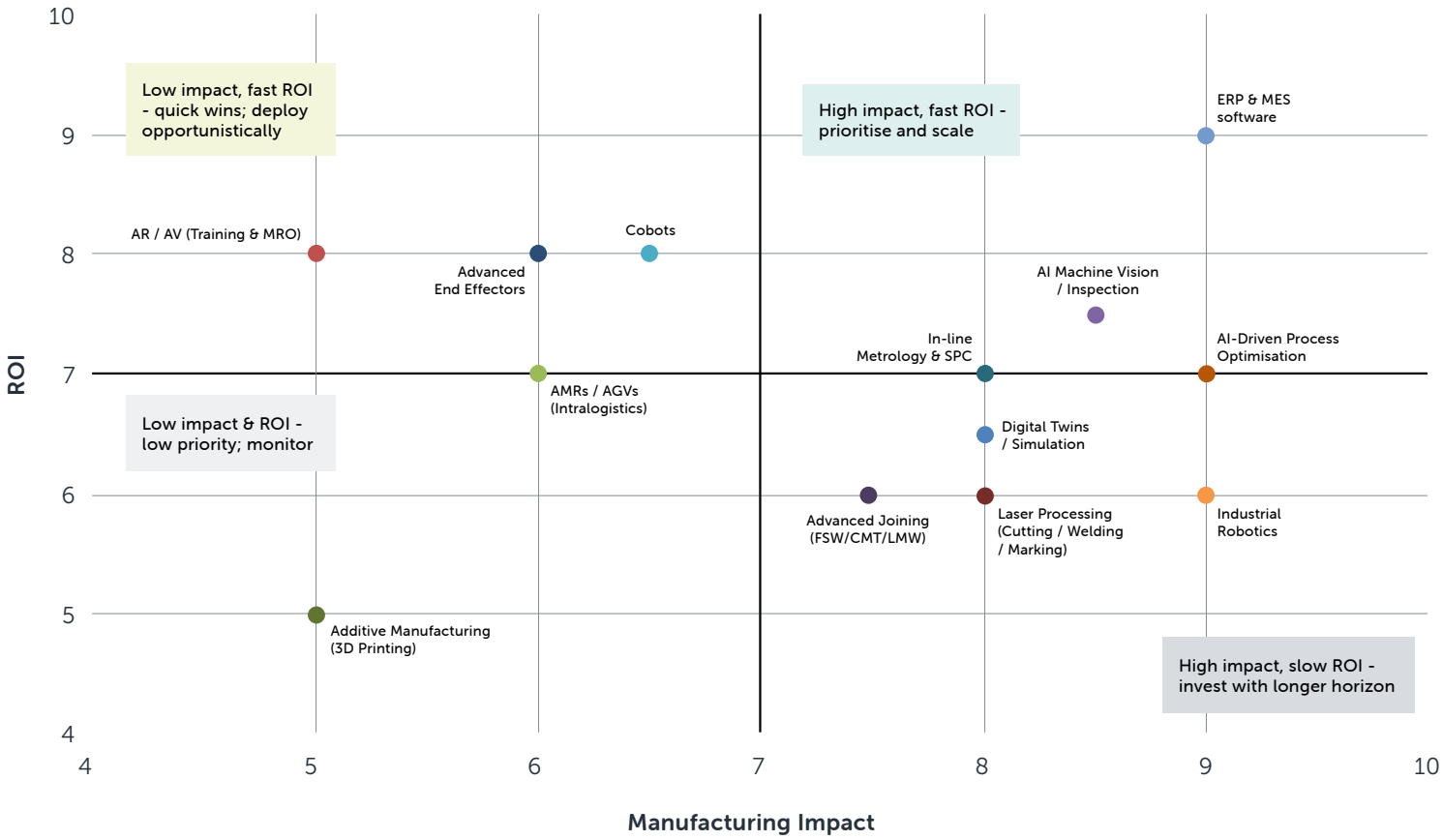
Table 2: What the axes measure

Dimension	Axis	Definition	Scoring Scale	High Score (9–10)	Mid/Lower Score (5–6 or Below)	Key Assessment Criteria
Manufacturing Impact	X-axis	Measures how significantly a technology improves core BEV manufacturing KPIs, including throughput, yield, Overall Equipment Effectiveness (OEE), scrap rate, and takt time, when deployed across manufacturing operations. It evaluates tangible manufacturing performance improvements rather than technological novelty or sophistication.	1–10	Technologies that deliver transformational improvements across multiple manufacturing processes and subcomponents simultaneously.	Technologies whose impact is narrower, indirect, or limited to a single application or process area.	• Improvement in throughput • Improvement in yield • Improvement in OEE • Reduction in scrap rate • Improvement in takt time • Breadth of impact across manufacturing operations
ROI	Y-axis	Measures how quickly and effectively a technology generates a return on investment. The score combines deployment cost, payback period, and breadth of applicability across the BEV bill of materials.	1–10	Technologies with documented automotive payback periods of less than 12 months and broad applicability across multiple processes.	Technologies that are capital-intensive, require lengthy integration, or deliver returns in only a limited set of applications.	• Capital expenditure required (lower capex scores higher) • Typical payback period (shorter scores higher) • Breadth of application across BEV manufacturing processes • Ability to amortise investment across multiple use cases

The chart below is divided into four quadrants by threshold lines at 7 on each axis. Technologies in the upper-right quadrant deliver both high manufacturing impact and strong ROI. Technologies in the upper-left are Quick Wins: lower manufacturing impact but fast, accessible payback. Technologies in the lower-right are Strategic Bets: transformative manufacturing impact but requiring committed, longer-horizon capital investment.

The lower-left quadrant contains low priority technologies where neither the impact nor the near-term ROI case is yet compelling at BEV manufacturing scale.

Figure 10: Manufacturing technology priority matrix



Source: APC analysis and technologies listed are non-exhaustive

Key findings

ERP and MES delivers highest impact
ERP and MES Software, AI-Driven Process Optimisation, and Industrial Robotics all score 9 on manufacturing impact, making them the highest-priority technologies in the analysis. ERP and MES are the standout: they score 9 on both axes, the only technologies to do so, and act as the foundational layer that every other technology depends on.

ERP and MES software extend their impact beyond the factory floor, integrating procurement, supply chain, inventory, and finance into a single operational system, meaning their return on investment is realised across the entire business, not just in production.

Capex-light AI technologies
The top right quadrant (high impact, strong ROI) is anchored by AI Machine Vision, In-line Metrology, and AI Process Optimisation.

These technologies share short payback periods, broad applicability across the BEV bill of materials, and a growing evidence base from live deployments.

At battery cell prices of €80 to €120 per unit, the financial case is immediate and unambiguous.

Capital-intensive technologies:
Industrial Robotics, Laser Processing, Digital Twins, and Advanced Joining are in the bottom-right quadrant. They are structurally necessary for competitive BEV manufacturing, but they require programme-level capital commitment tied to new model launches or greenfield line design, not opportunistic deployment. Industrial Robotics scores a moderate ROI despite its high impact rating because its highest-value applications in BIW welding and paint applications are saturated; the remaining deployment opportunities are in more complex, lower-volume tasks where integration costs are higher and payback periods extend to two to four years.

Industrial automation robotics deployments:
Cobots, AMRs, and Advanced End Effectors are the most underexploited opportunity in the analysis. All three carry ROI scores of 7-8, with cobot payback averaging 12 months across automotive Tier 1 deployments, according to Universal Robots' published case studies.

Cobots, AMRs and advanced end effectors are directly applicable to the highest-labour-content bottlenecks in BEV assembly, such as harness fitting, interior trim installation, and seat loading. They can be deployed immediately at low capex alongside larger strategic investments.

Additive Manufacturing is the relatively low-priority technology. The business case today is limited to tooling and fixtures, and series production competitiveness remains three to seven years away. Targeted investment in fixture applications is warranted; broad programme commitment is not.

Technology deployment and adoption
Most of the technologies considered in this report are highly mature. They are readily available and can be integrated within the manufacturing environment. Emerging frontier technologies in AI, humanoid robots, and large language models offer significant opportunities to increase productivity and transform automotive shop floors.

The barrier to deployment is in implementation, such as lacking the right data, skilled people, and effective digital processes to fully leverage the potential of the above-listed technologies. APC analysis also finds that most automotive-relevant technologies are already commercially mature, but deployment difficulty rises sharply when integration, data quality, cyber security, and skills needs are considered.

The adoption constraint in the UK is usually not whether the technology exists, but whether firms can absorb it operationally.

Barclays research on manufacturing, has highlighted that the biggest issue for digital transformation in manufacturing is the inability to track key KPIs and the lack of workforce skills needed to transform processes. It also notes that up to 15%[22] of the survey respondents do not measure or track their key productivity KPIs. Future competitiveness will depend heavily on integrating technologies into a unified digital manufacturing ecosystem rather than deploying standalone solutions.

[22] Manufacturing productivity report

UK's strengths in industrial clusters

To strengthen competitiveness and improve productivity, one pathway for success is through automotive industrial clusters that keep suppliers closer to vehicle production facilities. As highlighted in the IEA report, 40% of Europe's car production is in 10 clusters with an area of 120km by 220km[23]. The report highlights that the cluster in Northeast England is one of the ten largest European auto manufacturing areas. The UK has a strong automotive manufacturing industrial and supplier base, as highlighted in the recent UK Government's industrial cluster[24].

The manufacturing clusters in the UK are creating massive economic impact on the UK. These automotive clusters added £18 billion in value to the UK economy and exported products worth £38.6 billion, accounting for 10% of the UK's total export goods[25].

Similar clusters would initiate the next technology revolutions for automotive applications. As highlighted in the Manufacturing Technology Centre (MTC)'s report[26] on robotics, robotics and autonomous systems (RAS) clusters could help improve the overall competitiveness of emerging technology adoption in the automotive industry. The report also highlights the need to address the skills gap to unlock the potential of these technologies for industrial use cases.

The UK has a strong presence and a robust network for coordinating innovation activities in manufacturing. Various initiatives collaborate with the government, academia, and innovation networks. There are unique opportunities to collaborate and foster innovation networks to improve adoption of the emerging technologies on the automotive shop floor.

"The manufacturing clusters in the UK are creating massive economic impact on the UK. These automotive clusters added £18 billion in value to the UK economy."

[23] What next for the global car industry
[24] www.innovationclusters.dsit.gov.uk/
[25] SMMT motor industry facts 2026
[26] Gobal robotics clusters study



5. Case studies for industrial adoption in Europe for technology development

5.1 Industrial case studies across different parts of the value chain

This section highlights six industrial case studies that document real-world technology deployments in BEV and automotive manufacturing. Each case presents the implementation context and the quantified improvements in manufacturing KPIs.

All KPI figures are sourced from published manufacturer case studies, industry whitepapers, trade show presentations, and OEM press releases. Where figures are estimated and derived from benchmark data, this is explicitly stated.





Case Study 1

TRUMPF / CATL — Laser Tab Welding in Battery Module Production

Technology:
Laser Processing

Component Area:
Battery Cell & Module

Organisation:
TRUMPF + CATL / Samsung SDI

Context & Challenge

CATL and Samsung SDI operate high-speed laser tab welding lines using TRUMPF TruDisk and TruFiber systems. Laser welding replaced ultrasonic welding for Al/Cu current collector tabs. Inline OCT (Optical Coherence Tomography) from Precitec provides 100% weld monitoring.

Manufacturing KPI Improvements

- **Throughput:** Up to 100 cells/min *on high-speed lines*
- **Weld Defect Rate:** <50 ppm *vs. ultrasonic welding*
- **Process Cpk:** >1.67 *for critical dimensions in production*
- **100% Weld Inspection:** Zero added cycle time *via inline OCT*

Sources & assumptions:
TRUMPF Laser Technology for Battery Manufacturing whitepaper (trumpf.com, 2022); Precitec OCT product documentation; Battery Show EU 2023. Some throughput figures representatives of published norms.

Case Study 2

KUKA / BMW — LBR iiwa Cobot for Drivetrain Assembly (Dingolfing)

Technology:
Collaborative Robotics (Cobots)

Component Area:
EDU / Electric Motor Assembly

Organisation:
KUKA + BMW Group, Dingolfing

Context & Challenge

BMW deployed KUKA's LBR iiwa sensitive cobot in powertrain assembly for gear insertion tasks requiring compliance and force-controlled fitting, previously manual ergonomic-risk operations. The cobot operates without safety fencing in a direct HRC zone. Extended to electric motor stator assembly.

Manufacturing KPI Improvements

- **Ergonomic Risk:** RULA 6–7 → Acceptable *eliminated high-risk rating*
- **Lost-Time Injuries:** Zero *at cobot stations post-deployment*
- **OEE Improvement:** +5–8% *vs. manual station (fatigue eliminated)*
- **Safety Fencing:** None required *ISO TS 15066 compliant HRC*

Sources & assumptions:
KUKA AG Case Study: BMW LBR iiwa Powertrain Assembly (kuka.com); BMW Group Sustainability Report referencing HRC applications. OEE delta is estimated.

Case Study 3

Fronius CMT — Aluminium BIW Welding for Audi e-tron Platform

Technology:
Advanced Joining (FSW, CMT, LMW)

Component Area:
BIW / Battery Housing

Organisation:
Fronius International + Audi AG

Context & Challenge

Audi's e-tron (Q8 e-tron) platform uses an extensive aluminium spaceframe requiring low-heat-input joining of thin-wall extrusions and castings. Fronius Cold Metal Transfer (CMT) was qualified as the production joining method, enabling joining of 0.8 mm Al sheet without burn-through.

Manufacturing KPI Improvements

- **Spatter Rate:** <2% *vs. 15–20% for conventional MIG*
- **Weld Travel Speed:** Up to 2 m/min *robot-integrated*
- **Thermal Distortion:** –40% *vs. conventional MIG on Al*
- **Rework Rate at BIW Station:** <1% *post-CMT implementation*

Sources & assumptions:
Fronius CMT application documentation (fronius.com); Audi lightweight body construction press materials (2018–2022). Distortion and rework figures are indicative/estimated.

Case Study 4

Hexagon / Renault — Inline Metrology & SPC for BIW Quality Control

Technology:
In-line Metrology & SPC

Component Area:
BIW

Organisation:
Hexagon Manufacturing Intelligence + Renault Group

Context & Challenge

Renault implemented Hexagon inline scanning cells at Douai and Maubeuge plants, replacing end-of-line CMM sampling (5–10% of production) with 100% in-station optical gauging. SPC feedback loops connect directly to jig and fixture adjustment systems.

Manufacturing KPI Improvements

- **Defect Detection Latency:** Hours → Seconds *real-time process feedback*
- **Inspection Coverage:** 5–10% → 100% *all vehicles inline*
- **BIW Dimensional PPM:** –40–50% *reduction*
- **Scrap Rate at BIW:** –20–30% *estimated reduction*

Sources & assumptions:
Hexagon Manufacturing Intelligence Automotive Case Studies (hexagon.com); Renault Group manufacturing press releases. Scrap reduction figures are estimated.

Case Study 5

Bosch DeepField AI — Weld Quality Prediction in Serial Production

Technology:
AI-Driven Process Optimisation

Component Area:
BIW / Battery Module Welding

Organisation:
Bosch Connected Industry + OEM (undisclosed)

Context & Challenge

Bosch Connected Industry's DeepField Connectware AI was applied to resistance spot welding lines. The system ingests real-time welding signals (current, force, displacement) and uses a neural network to predict weld nugget quality without destructive testing, flagging out-of-spec welds and initiating parameter corrections.

Manufacturing KPI Improvements

- **Destructive Test Frequency:** –70% *reduction*
- **Weld Rework Rate:** –25% *reduction*
- **OEE at Weld Stations:** +3–6% *improvement*
- **Annualised Scrap Saving:** €0.5–1.5M *at pilot plant (estimated)*

Sources & assumptions:
Bosch Connected Industry DeepField product documentation and published case material (bosch-connected-industry.com, 2021–2023). Financial savings are estimated.

Case Study 6

Pailton Engineering / Fairino — Cobot for pick & place operations

Technology:
Cobots

Component Area:
Steering Systems

Organisation:
Pailton Engineering + Fairino

Context & Challenge

Pailton make steering systems, based in Coventry, UK and founded in 1969. They supply automotive OEMs with steering components and used a Fairino Cobot for its induction hardening pick & place operation that was earlier manually executed.

Manufacturing KPI Improvements

→ **Parts per hour:** 60 *(reduced labour cost & time)*

Sources & assumptions:
Pailton Engineering presentation at Robotics & Automation Summit, MTC



6. Conclusions and Recommendations

The transition to zero-emission vehicles is an industrial transformation that brings about a major opportunity for the automotive industry. By combining its manufacturing heritage, innovation capability, and targeted investment through programmes such as DRIVE35, the UK automotive industry has the potential to capture a greater share of future automotive value chains and become a global leader in advanced, sustainable vehicle production.

The insight report highlighted some readily available technology products that can be integrated into automotive manufacturing shopfloors. Focus must be given to digital change management, the right people and skills, and the processes needed to deploy the technologies. This will also allow the suppliers to be efficient in their product allocation and resource footprint.

A few of the opportunities highlighted in the report can be addressed directly through funding from the DRIVE35 programme. Through its R&D competitions, and the Supply Chain Transformation programme supports manufacturers in enhancing competitiveness and accelerating EV readiness. This includes funding for automation, retooling, and productivity improvements, as well as capital investment to support the production of EV-specific components through the Automotive Transformation Fund (ATF).

To leverage the above opportunities and maximise the potential, the report recommends the following priority items in Table 3:

Table 3: Strategic recommendations from the report

Opportunity	Recommendation	Impact
Innovation	To support and strengthen innovation in bulky and critical sub-component production, such as seats and wiring harnesses, to improve productivity through automation.	• Increased onshoring opportunities for commodities that are currently inefficient to be made in the UK
CAPEX support	Continue to support investment in battery and electrical powertrain-related supply chain to anchor high-value components in the UK.	• Protecting the UK automotive industry from regulations like rules of origin and made in Europe. • Developing high-value share components within the UK • Cross-sector opportunity for demand aggregation on critical battery technologies. E.g, defense and AI data centres.
Supply chain support	Renewed drive on supply chain resilience support for non-BEV components that are anchor commodities for the UK's supply chain	• Anchoring the UK supply chain on critical commodities needed for the manufacture of vehicles in the UK and improving longer-term competitiveness.
Technology and R&D clusters for frontier technologies	Creating skills, investment and technology R&D environment for the frontier technologies that can boost the overall productivity and adoption of technologies to the automotive industry. This is through investment in advanced automation technology clusters.	• UK will be the 'go-to place for next-generation productive technologies to boost vehicle production and hence increase gross value added and manufacturing volumes.
Fostering networks and collaboration	Promote early collaboration between designers, suppliers, and OEMs through greater involvement in RFQ and procurement activities during the design phase	• Less wastage and efficient unit economics for the cars to be produced in the UK

"By combining its manufacturing heritage, innovation capability, and targeted investment through programmes such as DRIVE35, the UK has the potential to capture a greater share of future automotive value chains."

7. Appendix

Some of the KPIs within this classification are listed below,

1. **Productivity and efficiency-related:**
   - **Overall Equipment Effectiveness (OEE):** The gold-standard metric for asset utilisation, calculated as Availability × Performance × Quality. World-class automotive plants target OEE scores of at least 85%.
   - **Throughput:** The volume of units produced over a specific period (e.g., units per hour or cells per minute).
   - **Cycle Time:** The total time taken to complete one specific process or a full production cycle for a component.
   - **Takt Time:** The pace of production required to meet customer demand.
   - **Capacity Utilization:** The percentage of a plant's potential nameplate production capacity that is being utilised.
2. **Quality-based KPIs:**
   - **First-Pass Yield (FPY) / First Time-Right:** The percentage of products that are manufactured correctly the first time without requiring any rework, scrap, or repair.
   - **Parts Per Million (PPM):** A measure of the defect rate, indicating the number of defective parts found for every million parts delivered or produced.
   - **Scrap Rate:** The percentage of raw materials or produced units that are discarded as waste.
   - **Process Capability (Cpk/Ppk):** Statistical indices that measure how consistently a process can produce parts within specified engineering tolerances.
3. **Cost-based KPIs**
   - **Unit Cost:** The total expenditure (including materials, labor, and overhead) incurred to produce one finished vehicle or component.
   - **BOM (Bill of Materials) Cost:** The total cost of all physical parts and raw materials required for one vehicle.
   - **Energy Consumption:** The amount of electricity or gas used during production, often measured per unit produced (e.g., kWh per battery cell)
   - **Labour Productivity:** Measured as value-added per employee or units produced per full-time equivalent (FTE) worker.

8. Glossary

Abbreviation	Meaning
ADAS	Advanced Driver Assistance Systems
AGV	Automated Guided Vehicle
AMR	Autonomous Mobile Robot
APC	Advanced Propulsion Centre UK
ATF	Automotive Transformation Fund
BEV	Battery Electric Vehicle
BIW	Body-in-White
BMS	Battery Management System
Cpk	Process Capability Index
DRIVE35	UK industrial programme supporting zero-emission vehicle manufacturing and supply-chain growth
EDU	Electric Drive Unit
ERP	Enterprise Resource Planning
FPY	First Pass Yield
HVAC	Heating, Ventilation and Air Conditioning
MES	Manufacturing Execution System
OECD	Organisation for Economic Co-operation and Development
OEE	Overall Equipment Effectiveness
OEM	Original Equipment Manufacturer
PPM	Parts Per Million
SDV	Software Defined Vehicle
ZEV	Zero-Emission Vehicle

Definitions

Automation Potential
Ability to substitute or augment manual work with technology.

Cobot
Collaborative robot designed to work safely near people.

Digital Twin
Virtual representation of a factory, process or product.

Industrial Cluster
Concentration of manufacturers, suppliers, talent and research organisations.

Machine Vision
Camera-based inspection systems often enhanced by AI.

Manufacturing Competitiveness
Ability to produce efficiently on cost, quality, speed, innovation and scale.

Onshoring
Bringing manufacturing activities into the domestic market.

Predictive Maintenance
Monitoring equipment data to prevent failures before they occur.

Rules of Origin
Trade regulations defining local content requirements.

Supply Chain Resilience
Capability to maintain supply through disruptions.

Value Chain
Sequence of activities from raw materials to vehicle assembly.

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Further information

If you have any questions or would like more detail on any of the graphs or data email **info@apcuk.co.uk**

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