

Manufacturing's green revolution



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Introduction:

UK manufacturing and the green transition

Britain championed the first industrial revolution. UK-designed technologies such as the power loom and the spinning jenny unleashed productivity gains that rocketed the national economy and reshaped global industry¹. More recently, the UK has shifted to a services-led economy (which now accounts for four-fifths of GDP) while China and the US have grown to dominate global manufacturing². Britain remains the eighth largest manufacturing economy and it continues to lead in 21st century products like advanced manufacturing, aerospace and defence, and offshore wind^{3,4}. The manufacturing sector accounts for half of UK exports and two-fifths of spending on research and development⁵. The sector employs 2.6m workers, at salaries 12% higher on average than those in the services industries⁶.

UK manufacturers are battling against economic headwinds. Increasing trade barriers following Britain's departure from the European Union and the elevated inflation environment are thinning the UK's industrial base⁷. Understanding what is at stake, the government has prioritised supporting regional manufacturers in its levelling up strategy, while also encouraging manufacturers to re-shore production amid supply chain volatility and geopolitical risk⁸⁻⁹. Supporting British manufacturers could deliver a double dividend, boosting lagging national productivity and narrowing regional inequality¹⁰.

Increasingly, UK policy makers are promoting the green transition of the manufacturing sector as a method to bolster the domestic industry while accelerating towards a net-zero economy. In the 2023 Autumn Statement the government announced a £4.5bn package to promote UK manufacturing across eight sectors over 2025-2030¹¹. £960m is ringfenced for the green industries growth accelerator, focusing on green manufacturing¹².

1 Industrial Revolution | Definition, History, Dates, Summary, & Facts | Britannica

2 Services: Key economic indicators 2023. The House of Commons Library

3 UK Manufacturing, The Facts: 2023 | Make UK

4 Net Zero Innovation Portfolio - GOV.UK (www.gov.uk)

5 UK Manufacturing, The Facts: 2023 | Make UK

6 ibid.

7 Decline of UK manufacturing accelerates as government 'abandons' sector | Economic growth (GDP) | The Guardian

8 Billions of investment for British manufacturing to boost economic growth | HM Treasury

9 UK manufacturers 'reshore' supply chains after pandemic and Brexit | Financial Times

10 Make UK, "Industrial Strategy: A Manufacturing Ambition Report", May 9, 2023

11 Billions of investment for British manufacturing to boost economic growth | HM Treasury

12 Huge boost for UK green industries with £960m government investment in and major reform of power network | Gov.UK



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Ms Brigitte Amoruso, Senior Climate Change, Energy and Environment Policy Specialist, Make UK

Prof Fiona Charnley, Professor of Circular Innovation, University of Exeter

Ms Lauren Hunter, Commercial Director, Loopcycle

Mr Gary Punter, Visiting Fellow, University of Cambridge

Mr Hugo Spowers, Managing Director, Founder and Chief Engineer, Riversimple

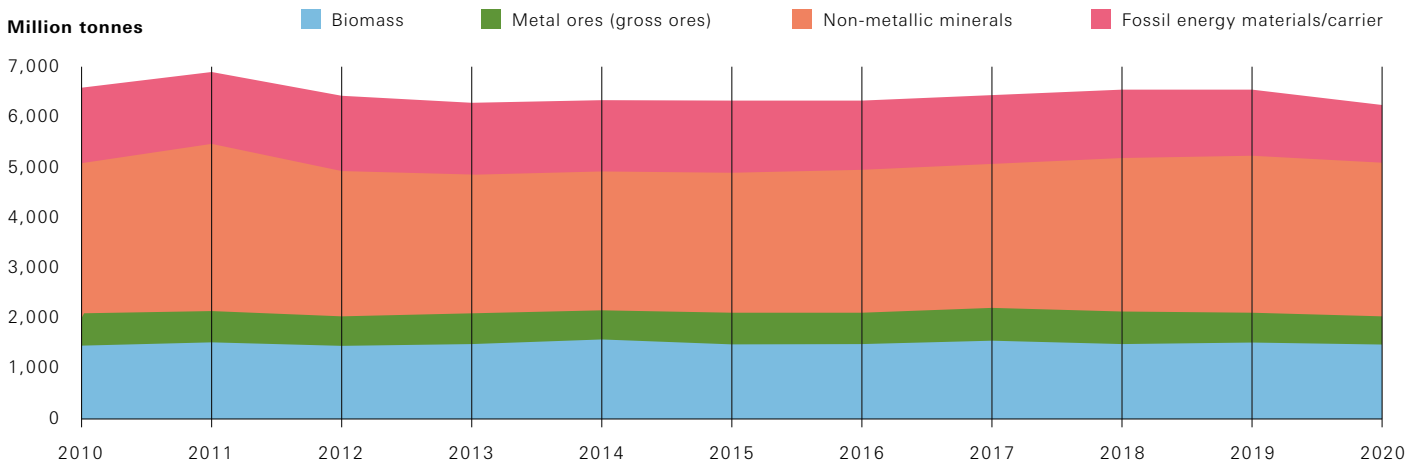


Fig. 1 Material Footprint of EU manufacturing, 2010-2020

Source: European Environment Agency¹³

There is also further investment in the 12 advanced manufacturing investment zones; the largest clusters in the Midlands and Manchester are focusing on critical industries (Greentech, Healthtech and underlying digital technologies) and these are expected to generate over £3bn of private investment and 65,000 jobs. The UK also published its first Battery Strategy in November 2023, outlining the government's plan to develop a globally competitive battery supply chain by 2030¹⁴.

The UK is also taking steps to protect domestic production and reduce 'carbon leakage' in the sector—which occurs when manufacturers import cheaper input materials produced in markets that have less or no carbon-taxing mechanisms. In late 2023 the government announced the UK Carbon Border Adjustment Mechanism (CBAM), which will apply a border tax to imported carbon-intensive materials — such as aluminium, cement, iron and steel¹⁵. The initiative, which is due to be implemented by 2027, will prevent international competitors producing cheaper goods in less carbon regulated markets from pricing out greener manufacturers in the UK. This is partially a reaction to the EU's CBAM, which will be fully effective in 2026, as well as increased demand for low-emission production¹⁶.

Despite recent progress, more must be done to ensure the UK can remain competitive with its US and EU counterparts. Brigitte Amoruso, Senior Climate Change, Energy and Environment Policy Specialist at Make UK, argues that the UK's long-term industrial strategy is less developed than leading economies like Germany, China and the US. The EU Green Deal Industrial Plan and the US Inflation Reduction Act (IRA) are hallmark long-term industrial plans that set a clear and comprehensive policy framework for the transition of their respective manufacturing industries¹⁷. A similar measure in the UK would contribute around £33bn to the economy, according to Ms Amoruso. The UK's green plan would

enable the shift towards greener manufacturing and position domestic players to benefit. This report will explore the specific benefits on offer for the UK's manufacturing sector.

Making manufacturing greener

Manufacturing accounted for one quarter of global emissions in 2021 (excluding indirect emissions caused by energy use)¹⁸. After a brief lull during the Covid-19 related lockdowns, manufacturing emissions have surged back to pre-pandemic levels. To stay on track with a net zero scenario, manufacturing emissions must decline by a quarter before 2030. Yet the sector is heavily reliant on fossil fuels, especially coal and gas, and the energy mix has barely budged since 2010. In 2021 fossil fuels were responsible for 68% of manufacturers' energy generation¹⁹. Between 2010 and 2020 emissions from the UK manufacturing sector fell by only 17%. Providing cheaper renewable sources of energy such as solar and wind electricity, or hydrogen has helped to instigate the shift, but more needs to be done to 'green' manufacturing operations in a UK context.

Raw material consumption is also stubbornly high. Across the European Union, 'materials intensity' has barely changed, discounting the pandemic-related slowdown in 2020.

The manufacturing sector is resource intensive, but there are fewer green alternatives to extraction. In fact, the net zero transition will depend upon ongoing intensive resource extraction to meet demand from low-carbon technologies for metals like nickel, cobalt, lithium, neodymium, and dysprosium. Hugo Spowers, Managing Director of sustainable car company Riversimple, believes "a renewable

¹³ European Environment Agency, "Europe's material footprint (8th EAP)", July 5, 2022

¹⁴ UK Battery Strategy | Department for Business and Trade

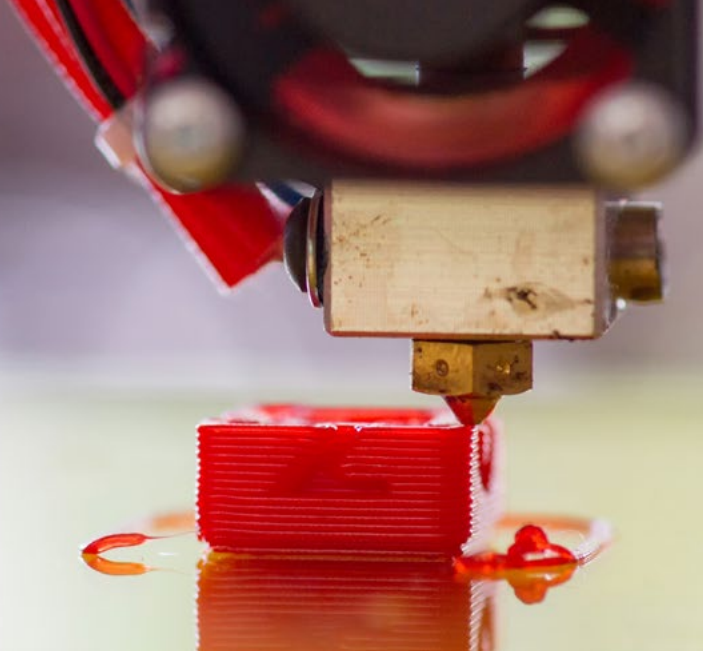
¹⁵ UK Carbon Border Adjustment Mechanism | Gov.UK

¹⁶ <https://gmk.center/en/news/uk-plans-to-introduce-a-tax-on-imports-of-carbon-steel-by-2027/>

¹⁷ US Inflation Reduction Act

¹⁸ David Hodgson et al., "Industry: Tracking Report", International Energy Agency, September, 2022

¹⁹ Ibid.



world is much more dependent on critical materials than the fossil fuel-based world.” Current methods to mine and process these critical minerals are environmentally harmful, and the end-products can be difficult to recycle. As with most industries, the manufacturing sector must also work on reducing its scope 3 emissions — the emissions a manufacturer is responsible for within its value chain — to make genuine progress in greening the industry²⁰.

Smart production, greener management

Digital innovations related to the Industrial Internet of Things (IIoT) like artificial intelligence, digital twins, sensors and big data have created opportunities to radically improve manufacturing efficiencies. According to one survey, 34% of British manufacturers said digital adoption boosted their energy efficiency, and a third said that process improvements helped reduce emissions²¹. The UK government is expanding its Made Smarter Adoption Plan, which helps small and medium-sized manufacturers utilise advanced technologies to reduce carbon emission and improve efficiencies²². The programme is rolling out in all English regions in 2025-26, before being expanded to the devolved nations.

Digital twins — a digital representation of real-world processes — can increase output quality and reduce waste²³.

A digital twin creates a virtual model of a manufacturing process, allowing manufacturers to run simulations and test process changes. It is estimated digital twins could drive a cumulative reduction in emissions of 7.5 Gt CO₂e (equivalent to a 14% decrease of current global emissions) by 2030²⁴. Virtual twins could slash emissions in the electrical and electronics manufacturing industry alone by 31 Mt CO₂e²⁵.

3D printing, which fabricates three-dimensional objects by sequentially adding layers or ‘slices’ of material, allows goods to be made without fixed production facilities, reducing transport and logistics costs by moving operations closer to customers^{26,27}. Artificial intelligence is aiding product design, material and energy optimisation, waste management, and smart or ‘predictive’ maintenance^{28,29}. “By leveraging digital technologies and minimising physical elements, the factory can be designed to be compact and efficient,” notes Gary Punter, Visiting Fellow at the University of Cambridge. “Digital modular approaches”, where parts of a process take place off-site, can be used to make smaller, more efficient factories.

However, manufacturers should not neglect more prosaic efficiencies. “When companies talk about sustainability, it tends to be the ‘clever’ stuff, and the shop floor is often left out. But it can be much simpler,” Punter argues. “We’ve seen one factory which turned its machines and lights off at lunchtime, and they saved enough electricity for the whole of their workforce to power their homes that evening.”

20 SBTi Scope 3 emissions

21 Make UK, “Decarbonising Manufacturing – Challenges and Opportunities”, July 11, 2022

22 Billions of investment for British manufacturing to boost economic growth | HM Treasury

23 Francisco Betti et al., “Lighthouses unlock sustainability through 4IR technologies”, McKinsey & Company, September 27, 2021

24 Simon Bentley and Tony Murdzhev, “Accelerating sustainability with virtual twins”, Accenture, January 26, 2021

25 Simon Bentley and Tony Murdzhev, “Accelerating sustainability with virtual twins”, Accenture, January 26, 2021

26 3D printing | Definition, Technology, History, & Applications | Britannica

27 Henrique Almeida et al., “Sustainability for 3D Printing”, Sustainability for 3D Printing (Book, Springer), September 1, 2021

28 Rohit Agrawal et al., “Integration of artificial intelligence in sustainable manufacturing: current status and future opportunities”, Operations Management Research, June 1, 2023

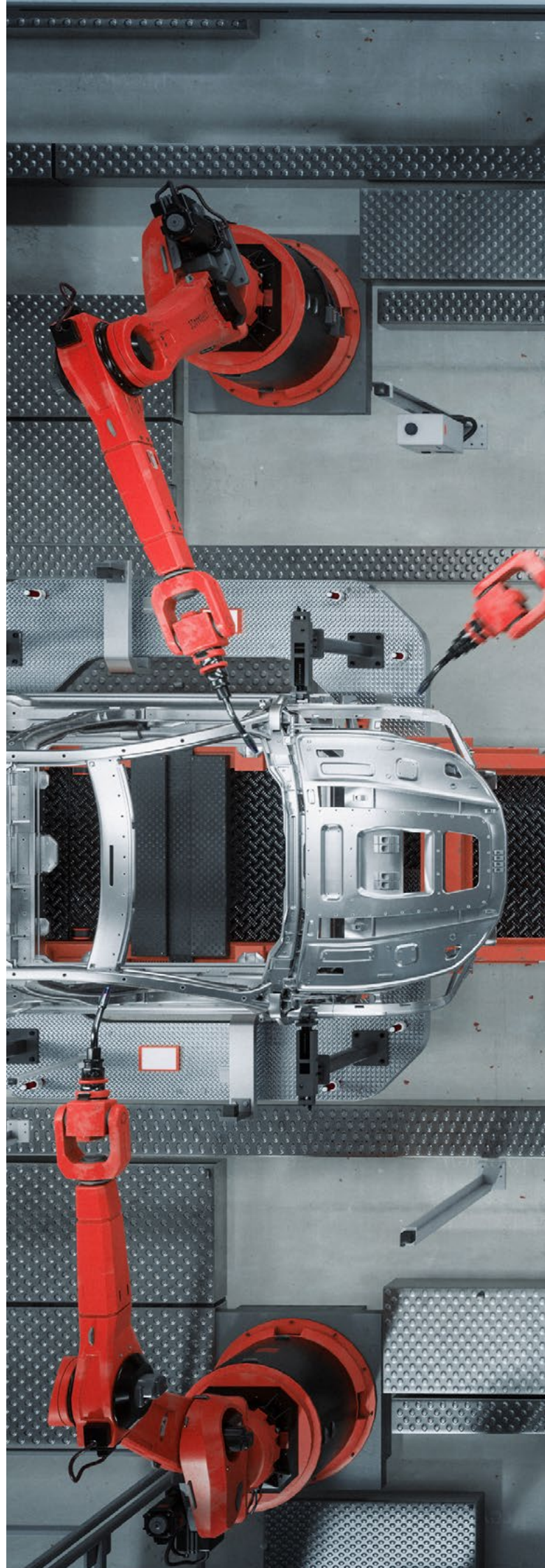
29 Ibid.

From sustainability to circularity

While smarter production can trim the sector's environmental impact, true change requires a circular economy approach to 'reuse, reduce and recycle' throughout the value chain. Resource extraction, usage and wastage can be reduced by ensuring fewer virgin products are in the cycle. Fiona Charnley, Professor of Circular Innovation at the University of Exeter, argues there is a danger that advanced technologies compound the environmental costs of manufacturing. Manufacturers can avoid falling into this trap by considering the whole lifecycle of a product.

For instance, Canon (a photography company) remanufactures and refurbishes many of its devices. When Canon collects used equipment, it reuses at least 80% of the materials, which helps to reduce greenhouse gas emissions associated with raw materials, parts and manufacturing by more than 80% compared to a newly manufactured product³⁰. Renault, meanwhile, is using circular economy principles for its end-of-life vehicle collection strategy, where it dismantles vehicle parts for re-use. Recycled content is being used in new Renault vehicles, equivalent to 32% of new vehicles by weight in the EU in 2016. With so many recycled plastics being circulated through the manufacturing chain, Renault can generate 10-15% in cost savings. Overall, estimates suggest that circular economy principles could help the EU manufacturing sector to realise net materials cost savings of up to US\$630bn each year³¹.

Circularity also requires producers to take greater responsibility for their products after they leave the factory — a concept known as extended producer responsibility (EPR). According to Fiona Charnley, manufacturers can remain responsible throughout the product lifecycle by introducing ways of "retaining the asset, upgrading it, refurbishing it, and potentially selling it again". Extended producer responsibility encourages producers to be more cognisant of their downstream value chain, and to maintain a more active relationship with demand partners.



³⁰ World Business Council for Sustainable Development, 8 Business Cases for the Circular Economy
³¹ Ibid.

CASE STUDY:

Extended producer responsibility

Extended producer responsibility (EPR) is an environmental policy tool that makes producers responsible for their products after they are sold, by requiring them to establish facilities through which their products can be returned, recycled or disposed of. This aims to help governments meet recycling targets and share the costs of waste management. The EU has been a leading advocate of EPR³², and efforts are underway to harmonise regulations across the bloc. By 2024, every member state must introduce an EPR system for packaging waste³³.

In the UK, EPR will replace the current Packaging Waste Regulations with a phased implementation from 2023. The packaging fees that companies have to pay have been deferred to 2025, but companies must still report their packaging data for 2023. The full EPR scheme is due to be introduced in the UK in 2024, following a public consultation conducted in late 2023³⁴. More recently, the EU unveiled plans to cut packaging waste completely by 2030 which may pose a challenge to UK Manufacturers exporting to the bloc in the shorter term as they struggle to adapt to changing regulations³⁵.

Whilst wide support was achieved from EU nations, at the global gathering in Nairobi in November, oil producing countries deployed blocking tactics to inhibit new legislation that would cut plastic packaging production, instead arguing for more efficient waste management solutions. Saudi Arabia, Russia and Iran were most vocal, supported by fossil fuel and chemical lobbyists. Graham Forbes, head of the Greenpeace delegation, described the effects of these talks as "disastrous"³⁶.



32 <https://www.europen-packaging.eu/wp-content/uploads/2021/03/EUROPEN-factsheet-on-EPR-for-used-packaging.pdf> - <https://www.resourcify.com/en/knowledge-centre/epr-extended-producer-responsibility-impact>

33 [https://www.europarl.europa.eu/RegData/etudes/BRIE/2023/745707/EPRS_BRI\(2023\)745707_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/BRIE/2023/745707/EPRS_BRI(2023)745707_EN.pdf)

34 Swiftpak, What is Extended Producer Responsibility UK?, August 2023

35 <https://www.ft.com/content/88d0142c-a603-4a34-a56f-fa719e710148>

36 <https://www.ft.com/content/8f10535d-25e3-4090-8ff7-cd51b51b5bfd>

There is a growing regulatory push, especially in the EU, for tools such as EPR and digital product passports to provide information about a product's components. Manufacturers also face rising pressure from stakeholders, who see transparency and performance as intertwined. Importantly, there is a commercial incentive for manufacturers to recover used materials. Wasted materials are losses in value, efforts to design more circular products are focused on retaining and recapturing this value.

Modern traceability systems make it possible for producers to follow their goods after they are sold. Loopcycle, a British company, uses QR codes to track and recover commercial equipment. Lauren Hunter, Loopcycle's Commercial Director, estimates that "80% of manufacturers don't know where their equipment goes". Traceability systems also enhance customer insights, offering commercial gains to manufacturing businesses. Producers can tailor customer experience based on where the product is likely to end up, and also streamline their warranty process.

CASE STUDY:

Digital product passports

The digital product passport (DPP) is an EU proposal to improve circularity and traceability. DPPs will provide information about a product's sustainability throughout its lifecycle — such as the components used to make it and its carbon footprint³⁷. This is designed to help consumers and businesses make informed choices, facilitate repairs and recycling, and improve transparency about a product's environmental footprint. The European Commission expects to implement DPPs for the first product groups, including batteries and consumer electronics, by 2026-27³⁸, meaning that British companies exporting products to the EU will require DPPs. "It adds responsibility to the manufacturer to show where their product is going, and gives every product a starting point," says Loopcycle's Hunter. "We can't drive a circular economy if manufacturers don't know where their product is going."

³⁷ <https://www.wbcsd.org/Pathways/Products-and-Materials/Resources/The-EU-Digital-Product-Passport>

³⁸ <https://www.wbcsd.org/contentwbc/download/15584/226479/1>



The emissions footprint of a product is spread across its value chain.

Stages of production by Greenhouse Gas (GHG) Protocol emissions scope

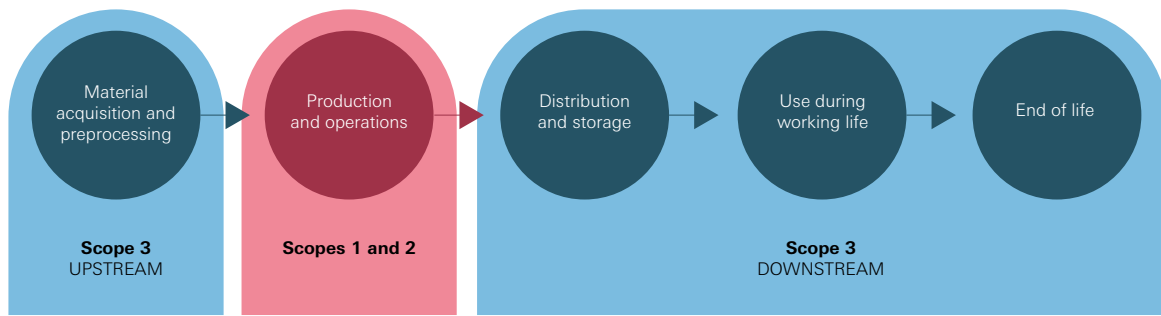


Fig. 2 Emission Footprints Across the Value Chain

Source: McKinsey & Company³⁹

The opportunity in circularity

The global circular economy is projected to be worth US\$4.5trn in the next 15 years, according to the European Union's Circular Economy Action Plan⁴⁰. Circular economy approaches have gained traction in high value areas like automotive and aerospace, where producers have significant incentives to preserve materials. Electronic device manufacturers have invested in recycling to reduce the materials intensity of their production. Dell has reportedly collected over 2.6bn pounds (lbs) of electronics for reuse or recycling since 2007⁴¹. In 2021, 59% of aluminium in Apple products came from recycled sources⁴².

Progress has been slower among manufacturers of fast moving consumer goods⁴³. Business models that rely on

goods being sold quickly and at low cost are less incentivised to invest in circularity innovations. Similarly, consumers buying lower cost items are less likely to seek to reuse and repurpose goods. Consumer-centric solutions could help to improve circularity. For example, take-back schemes or collecting used products or packaging for recycling in exchange for discounts would offer a direct benefit for consumers to be directly engaged in a circular economy.

Britain's advanced manufacturing sector is well positioned to do remanufacturing. The UK's Royal Mint, for example, has started to use technology to extract gold from recycled electronic products⁴⁴. Estimates suggest that as much as 7% of the world's gold may be contained in e-waste, with e-waste potentially containing up to 100 times more gold per tonne, than the same amount of gold ore. The Royal Mint is now hoping to recover a range of other useful metals, such as copper, nickel, silver, and tin, through a similar process⁴⁵.



39 Seunghyuk Choi et al., "Building sustainability into operations", McKinsey & Company, October 19, 2022

40 Elizabeth Lowe, "Manufacturing a Circular Economy", MakeUK, March 26, 2021

41 Dell Technologies, "Accelerating the circular economy to reduce waste and protect the planet", n.d.

42 Apple, "Apple expands the use of recycled materials across its products", April 19, 2022

43 Identifying the impact of the circular economy, European Economic and Social Committee

44 <https://www.royalmint.com/aboutus/press-centre/the-royal-mint-to-build-world-first-plant-to-turn-uks-electronic-waste-into-gold/>

45 BBC Newsround, Royal Mint: New technology recycling gold from electronic waste, March 2022

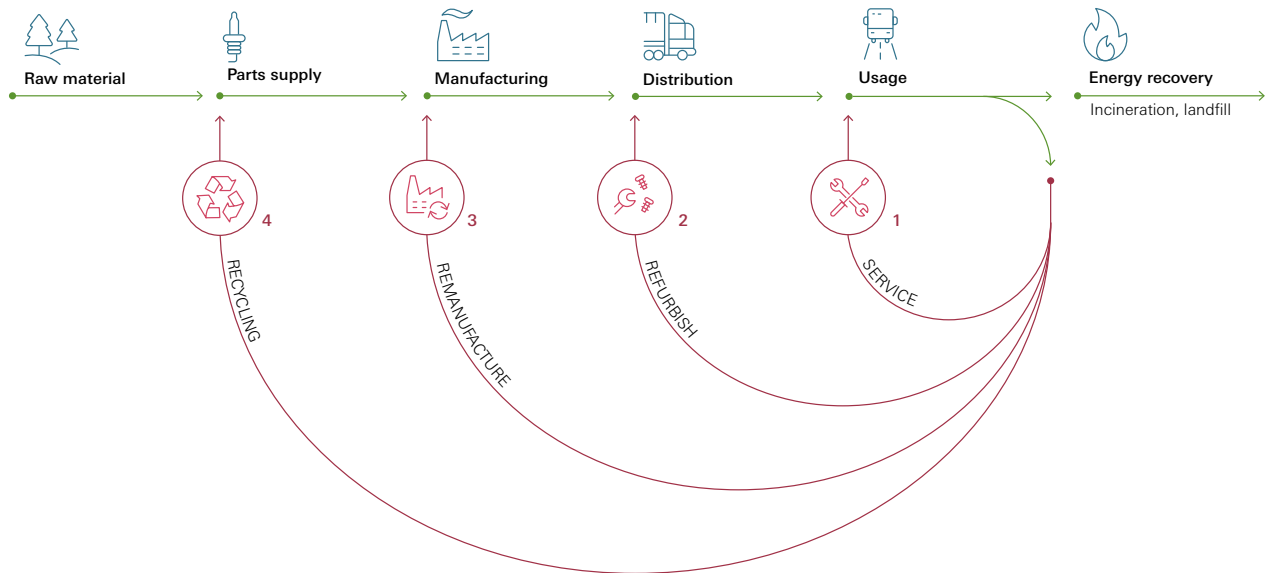


Fig. 3 Circular Economy in the Manufacturing Industry

Source: World Economic Forum⁴⁶

Policies and strategies for sustainability

A robust policy framework is needed to support a manufacturing transition. Industrial policy is having a global resurgence as countries compete for clean energy investments and attempt to secure critical resources⁴⁷. “A country needs to have an anchor as to what it thinks it’s good at, and industrial policy plays a big part in fulfilling that need,” says Cambridge University’s Punter.

The UK government is making progress in developing its manufacturing transition policy framework. The Autumn Statement reinforced these efforts, outlining several initiatives designed to support the greening of the domestic industry by investing in critical sectors like advanced manufacturing to support output, efficiency and employment growth⁴⁸. However, without a dedicated and comprehensive plan — like the US Inflation Reduction Act or the EU Green Deal — policies are vulnerable to changes with each government⁴⁹. The scrapping in 2021 of the May government’s 2017 Industrial Strategy, for example, highlighted the lack of coherence in the government’s long-term industrial policy⁵⁰. Further policy instability could delay the country’s progress in meeting its net zero goals⁵¹.

Net zero initiatives in manufacturing

Successive governments have produced strategies on sustainability and emissions reduction in manufacturing. On biodiversity, a “25 Year Environmental Plan”, put in place in 2018, promised to deliver cleaner air and water, and to protect ecosystems⁵². In 2020, a “Ten Point Plan for a Green Industrial Revolution” promised to scale up offshore wind, hydrogen and nuclear power, and to build a “world-leading” EV supply chain⁵³.

In 2021, the UK launched its “Industrial Decarbonisation Strategy”⁵⁴, which the government claimed as the first blueprint on how industry can cut emissions in line with net zero goals produced by a major economy⁵⁵. A “Net Zero Strategy: Build Back Greener” roadmap, also published in 2021, outlined proposals to decarbonise all sectors of the economy, including industry⁵⁶. Furthermore, a 2021 “UK Innovation Strategy” outlined plans to make the UK an innovation hub by 2035⁵⁷. It promised support for R&D, including through a £1bn Net Zero Innovation Portfolio, which funds low-carbon technologies.

The 2023 Infrastructure and levelling up measures highlighted the funding packages for the Green Industries Growth Accelerator to support clean energy and more significantly the clusters of advanced manufacturing Investment Zones in the UK. The UK battery strategy seeks to build supply chain resilience to enable a battery manufacturing ecosystem. This paves the way for highly anticipated longer-term investment strategies⁵⁸.

46 Martin Lundstedt, “From remanufacturing to recycling: how manufacturing can raise the bar on global climate goals”, World Economic Forum, Jun 14, 2021

47 <https://www.economist.com/special-report/2022/01/10/many-countries-are-seeing-a-revival-of-industrial-policy>

48 Advanced Manufacturing Plan 2023, Department for Business & Trade

49 https://ec.europa.eu/commission/presscorner/detail/en/ip_23_510

50 <https://committees.parliament.uk/publications/6452/documents/70401/default/>

51 <https://www.ippr.org/news-and-media/press-releases/revealed-uk-is-lagging-behind-in-the-race-for-green-growth-due-to-lack-of-industrial-strategy>

52 HM Government, “A Green Future: Our 25 Year Plan to Improve the Environment”, January, 2018

53 HM Government, “The Ten Point Plan for a Green Industrial Revolution: Building back better, supporting green jobs, and accelerating our path to net zero”, November, 2020

54 <https://www.icevirtuallibrary.com/doi/abs/10.1680/jener.21.00056?journalCode=jener>

55 HM Government, “Policy paper: Industrial decarbonisation strategy”, March 17, 2021

56 HM Government, “Net Zero Strategy: Build Back Greener”, October, 2021

57 HM Government, “UK Innovation Strategy: leading the future by creating it”, July, 2021

58 Chancellor backs business and rewards workers to get Britain growing, GovUK

The UK could also bolster its policies incentivising circularity in manufacturing. The EU is setting requirements for durability and recyclability in products, through proposed Ecodesign regulations, and requiring producers to take more responsibility for their goods via EPR⁵⁹. Although British policy “is still very much aimed at managing the risks associated with waste, and increasing rates of recycling”, the April 2022 Plastic Packaging Tax, could prompt changes to upstream operating models over time⁶⁰. The tax is payable by manufacturers and importers of plastic packaging containing less than 30% recycled plastic, encouraging players to focus on upstream improvements.

Obstacles to transition for consideration

Nearly two thirds (65%) of Britain’s manufacturers have taken action on delivering their net-zero target, according to a Make UK survey⁶¹. Despite the clear appetite, sustainability plans have been hindered by the rising costs associated with Brexit, the pandemic and Russia’s invasion of Ukraine. Disruptions to supply chains, increasing barriers to trade, rising energy costs, and growing uncertainty, make long-term investment decisions more difficult. Make UK’s Amoruso believes it is important for the government “to allay those concerns by creating a more stable long-term investment environment.”

Skills shortages are another potential constraint. Make UK estimates Britain has around 70,000 vacancies in the manufacturing sector, due partly to insufficient training. Its research suggests that only 62% of manufacturers have a workforce equipped with the skills they need to operate in a more sustainable way⁶². Brigitte Amoruso estimates that more than half have been unable to recruit the necessary labour over recent months, due to either a lack of technical skills, or a lack of applications. “The industry needs a blend of technical and soft cognitive skills, as well as management and leadership skills,” she argues. There is demand for everything from carbon accountants to energy auditors and sustainability managers. Although the points-based immigration system introduced in 2021 allowed for a strong inflow of highly-skilled workers from around the world, many skills gaps remain unaddressed⁶³.

The manufacturing sector will need to draw young, tech-savvy workers away from other industries. “It is primarily the tech startups that attract graduates, rather than large-scale manufacturers,” notes Exeter University’s Charnley. “There

is more we could do to promote manufacturing and address that misconception that it is an old industry all about the factory-floor.” A cleaner manufacturing industry could be a more attractive proposition for candidates with the necessary skills. There is “an opportunity to attract new talent and workers to green, innovative and sustainable industries such as hydrogen”, Amoruso argues. “Among the younger generation, there is a strong desire to work for employers with a focus on green credentials and sustainability.”

Policymakers and industry representatives should also work with universities to develop vocational skills development programmes focused on rendering the skills that will be demanded by a greener manufacturing industry. Targeted initiatives led by industry-education partnerships would help to maximise the supply of relevant skills.

Improving automation and upgrading capital assets could help mitigate imbalances in the supply and demand for green skills in the manufacturing sector. The UK ranks 24th in the IFR global robotics and automation index, suggesting room for improvement that could help reduce demand for green manufacturing skills⁶⁴⁻⁶⁵. However, manufacturers also face barriers in the cost of upgrading capital equipment. Industry players are delaying and avoiding major investment amid the current economic uncertainty. In response, Make UK called for the government to bolster targeted long-term incentives on the basis that manufacturing investment cycles are long, and many businesses would miss out on support if they would not be able to replace their equipment imminently. In response, in April 2023, the government replaced super-deduction with a “full-expensing” incentive to encourage investment in plant and machinery⁶⁶. Although this scheme was originally due to expire in 2026, the government made this permanent in the Autumn Statement. The full expensing incentive is predicted to render £14bn in additional investment by 2029, and £20bn by 2034⁶⁷.

Additionally, the Autumn Statement included an amendment to R&D-related tax reliefs for loss making businesses that allocate a large portion of their expenditure to R&D⁶⁸. Starting from April 2024, the government will implement a single research and development expenditure credit (RDEC) scheme, merging two previously existing schemes that were more stringent. The tax relief will now be available to a wider range of businesses by reducing requirements on size of business and lowering the threshold for R&D expenditure (from 40% to 30% of total expenditure)⁶⁹.

59 https://commission.europa.eu/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/sustainable-products/ecodesign-sustainable-products_en

60 Carbon Brief, “Can the UK Plastic Tax help decarbonise the packaging industry?”, April 2022

61 Majority of UK manufacturers increasing net-zero efforts, survey reveals | E&T Magazine (theiet.org)

62 Make UK, “Green Skills Guiding Principles”, Sept 3, 2021

63 <https://www.cipd.org/globalassets/media/knowledge/knowledge-hub/reports/2023-pdfs/2023-migrant-workers-skills-shortages-uk-report.pdf>

64 <https://ifr.org/ifr-press-releases/news/world-robotics-2023-report-asia-ahead-of-europe-and-the-americas>

65 <https://engineering-update.co.uk/2023/02/02/global-robot-report-highlights-uks-urgent-need-to-increase-automation-engineering-global-robotreport/>

66 <https://www.govgrant.co.uk/research-and-development-capital-allowances/>

67 <https://obr.uk/box/the-impact-of-corporation-tax-changes-on-business-investment/>

68 <https://gateleyplc.com/insight/article/autumn-statement-2023-research-and-development-tax-relief-changes/#:~:text=Changes%20for%20R%26D%20claims&text=The%20originally%20proposed%20threshold%20for,would%20be%20eligible%20to%20claim.>

69 https://kpmg.com/uk/en/home/insights/2023/11/tmd-autumn-statement-move-to-merged-r-and-d-tax-relief-regime-confirmed.html?gclid=Cj0KCQiAqsitBhDIARIsAGMR1Rjfi4KbwKhMLTLX8a6AIdTIG7Fuj59Crp-2Lx9V63DBCRGG0wXTUDMaAhWmEALw_wcB



Conclusions

- **The global manufacturing industry is still behind on net zero reforms.** It is responsible for around a quarter of global emissions and industrial decarbonisation is slow. British manufacturers have been buffeted by rising costs and supply chain problems caused by Brexit, the pandemic, regulatory uncertainty, and Russia's invasion of Ukraine, making their sustainability agendas more difficult to deliver. The industry's material intensity may increase in the years ahead, thanks to rising demand for resources needed in the net zero transition. Renewable energy and EV batteries, for instance, rely on a host of critical minerals which are hard to extract and difficult to save from landfill.
 - **Digital innovations are helping cut energy use and emissions.** Advanced technologies from 3D printing to digital twins, falling under the banner of the Industrial Internet of Things (IIoT), are helping factories to boost efficiency and reduce waste. A third of British manufacturers report that digital adoption is helping them cut energy use and emissions⁷⁰. These technologies also have a significant potential to address some of the productivity challenges in the sector. However, companies should continue to implement simple strategies to reduce their environmental footprint, such as turning off lights and machines when they are not being used. The 'shop floor' remains an important part of the solution and is often overlooked.
 - **Circularity in manufacturing is an opportunity not a cost.** Manufacturers are facing growing pressure to adopt more circular models, by being more thoughtful about sourcing materials, and taking life-long responsibility for products after they leave the factory. In particular, upstream solutions are becoming more popular in which sustainability principles are embedded in the initial design of manufacturing products. Regulations supporting circular economies are coming into force in the EU, and investors increasingly demand transparency from manufacturers. With European counterparts having to adhere to circularity regulation, British manufacturers will have no choice but to alter their operations to better compete with their rivals.
- Those that view the business model innovation as an opportunity will be able to use a circular approach to their advantage — garnering cost and emissions savings, together with the benefits of a more efficient and productive operating process.
- **A clearer policy framework is needed in the UK to support greener manufacturing.** Policymakers are taking positive steps in supporting sustainability in UK manufacturing and across the broader economy, most recently with the detailed and extensive provisions outlined in the Autumn Statement. This progress should be followed up with a far-reaching headline strategy, such as those boasted by the US and EU countries. The announcement and adoption of an industrial transition plan will prevent an incoherence in the long-term direction of Britain's manufacturing sector.
 - **Skills development will be needed to support the transition.** Industry research suggests manufacturers are struggling to recruit people with the skills needed to help them decarbonise and create more sustainable business models. A mix of technical and soft skills are needed, with rising demand for carbon accountants, energy auditors and sustainability managers, among other roles. That points to the need for vocational education both in school and through life-long learning. However, manufacturers will also have to compete to attract skilled and environmentally-minded young graduates from attractive industries such as tech. From a demand reduction perspective, manufacturers should try to automate and digitise wherever possible.
 - **Greening manufacturing offers significant opportunities for the British industry and economy.** Manufacturing plays a key role in the UK economy, its export base, research and innovation spending, and employment. Despite significant progress, it remains one of the biggest sources of global greenhouse gas emissions. Shifting to cleaner and more circular production processes will accelerate the necessary transition towards net zero, boost national productivity and tackle regional inequality.