

What are the circular economy best practices beyond the UK?

Examples from the automotive and construction industries

Shyamain Wickramasingha

October 2026

UKRI Engineering and Physical Sciences Research Council
University of Leeds
Manchester 1824 The University of Manchester
University of Sussex

About the centre

The Production and Consumption Transformations Centre (PACT) brings together researchers, policymakers, businesses and civil society to understand the wider economic, social and political systems that drive emissions.

By developing practical, evidence-based solutions, the centre supports a transition that not only cuts emissions, but also protects jobs, shares costs and benefits fairly, and builds a more resilient, sustainable economy

About the report

The transition to a circular economy (CE) is a growing priority for the UK automotive and construction sectors. As the UK develops a national CE strategy and sector specific roadmaps through the Growth Plan, this report reviews successful CE strategies in Denmark, Finland, France, Germany, Italy, the Netherlands, Sweden, Norway, China and Japan – the emerging world leaders of CE in automotive and constructions industries.

The report identifies best practice, highlights gaps, and draws lessons to inform effective CE policy and implementation in the UK.

Acknowledgements

PACT would like to extend our gratitude and thanks to our partners and funders. This work was supported by the Engineering and Physical Sciences Research Council.

Grant number UKRI1500.

Suggested citation

Wickramasingha, S. (2026). *What are the circular economy best practices beyond the UK? Examples from the automotive and construction industries*

https://doi.org/10.48785/100/524

UKRI Engineering and Physical Sciences Research Council

University of Leeds

Manchester 1824 The University of Manchester

University of Sussex

Summary

The transition to a circular economy (CE) is a growing priority for the UK automotive and construction sectors due to their significant emissions. As the UK develops a national CE strategy and sector specific roadmaps through the Growth Plan, this report brings together successful CE strategies beyond the UK - in Denmark, Finland, France, Germany, Italy, the Netherlands, Sweden, Norway, China and Japan – the emerging world leaders of CE in automotive and constructions industries. The report highlights CE best practice, identifies notable gaps, and draws lessons to inform effective CE policy and implementation in the UK.

The review identifies six common features underpinning successful circular economy (CE) strategies across leading countries:

- **Dedicated national strategies** provide a coordinated, economy-wide framework and avoid fragmented interventions. This creates a unified approach and level playing field, supporting investment and innovation.
- **Legally binding approaches** strengthen governance legitimacy. This has helped to address systemic resistance and enforce consistent standards across sectors.
- **International policy alignment**, particularly with emerging EU regulations on CE and waste handling. Policy alignment has removed trade barriers by enabling seamless, cross-border trade and resource flows.
- **Design for Sustainability (DfS)** is a key driver of CE in these countries, integrating environmental considerations across the entire product lifecycle from the point of design to resource extraction and production to repair, reuse, remanufacturing, and recycling.
- **Industrial symbiosis** enables different industries to exchange waste, energy, and materials, turning by-products into valuable resources.
- **Collaborative stakeholder engagement**, particularly public-private partnerships and industry networks, have facilitated resource sharing, and knowledge exchange, enabling the alignment of stakeholder interests.





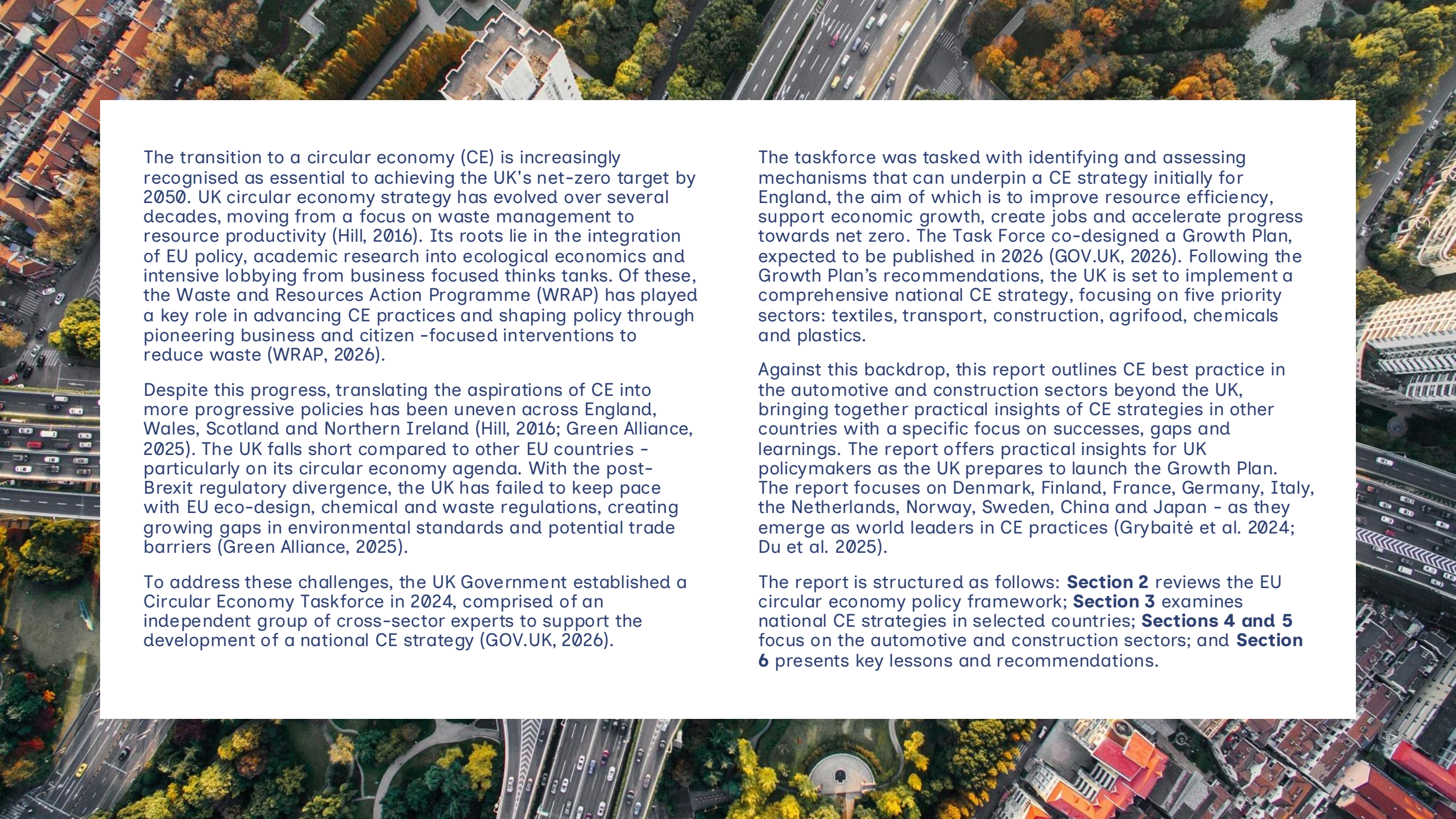
Despite significant progress, CE strategies remain at a relatively early stage of development. As this report shows, there are notable policy and implementation gaps within many of the interventions, including:

- **Regulatory and administrative complexity** arising from overlapping or inconsistent policies.
- **Absence of a holistic approach**, with interventions often focused on specific stages of the value chain rather than the full product lifecycle.
- **Barriers to reuse**, including a lack of suitable methods for re-use, concerns over long-term performance, and difficulties obtaining insurance for recycled products.
- **Cost and resource gaps**, such as limited investment, insufficient scale, technological gaps, and a lack of expertise.
- **Cultural and organisational resistance**, including risk aversion, resistance to change traditional methods, and a perceived lack of value in recycled goods.
- **Waste exports**, with substantial volumes still shipped to developing countries in the South, raising concerns about ethics, power and waste colonialism.

Even with these challenges, establishing a CE strategy remains a critical first step in shifting from a wasteful, linear "take-make-dispose" model to a more sustainable and regenerative model. In particular, the role of European Union (EU) policy in driving CE strategies is critical. As the world's largest single market, EU measures have the potential to transform product lifecycles, shape global standards, and drive industrial decarbonisation. As companies worldwide must meet EU requirements to access its markets, these policies have impacts far beyond Europe.

Against this backdrop, the report provides examples of best practice and practical recommendations for UK policymakers and industry stakeholders of scalable and feasible approaches to a CE, as the UK is set to launch its Growth Plan and circular economy agenda.

Introduction



The transition to a circular economy (CE) is increasingly recognised as essential to achieving the UK's net-zero target by 2050. UK circular economy strategy has evolved over several decades, moving from a focus on waste management to resource productivity (Hill, 2016). Its roots lie in the integration of EU policy, academic research into ecological economics and intensive lobbying from business focused thinks tanks. Of these, the Waste and Resources Action Programme (WRAP) has played a key role in advancing CE practices and shaping policy through pioneering business and citizen -focused interventions to reduce waste (WRAP, 2026).

Despite this progress, translating the aspirations of CE into more progressive policies has been uneven across England, Wales, Scotland and Northern Ireland (Hill, 2016; Green Alliance, 2025). The UK falls short compared to other EU countries - particularly on its circular economy agenda. With the post-Brexit regulatory divergence, the UK has failed to keep pace with EU eco-design, chemical and waste regulations, creating growing gaps in environmental standards and potential trade barriers (Green Alliance, 2025).

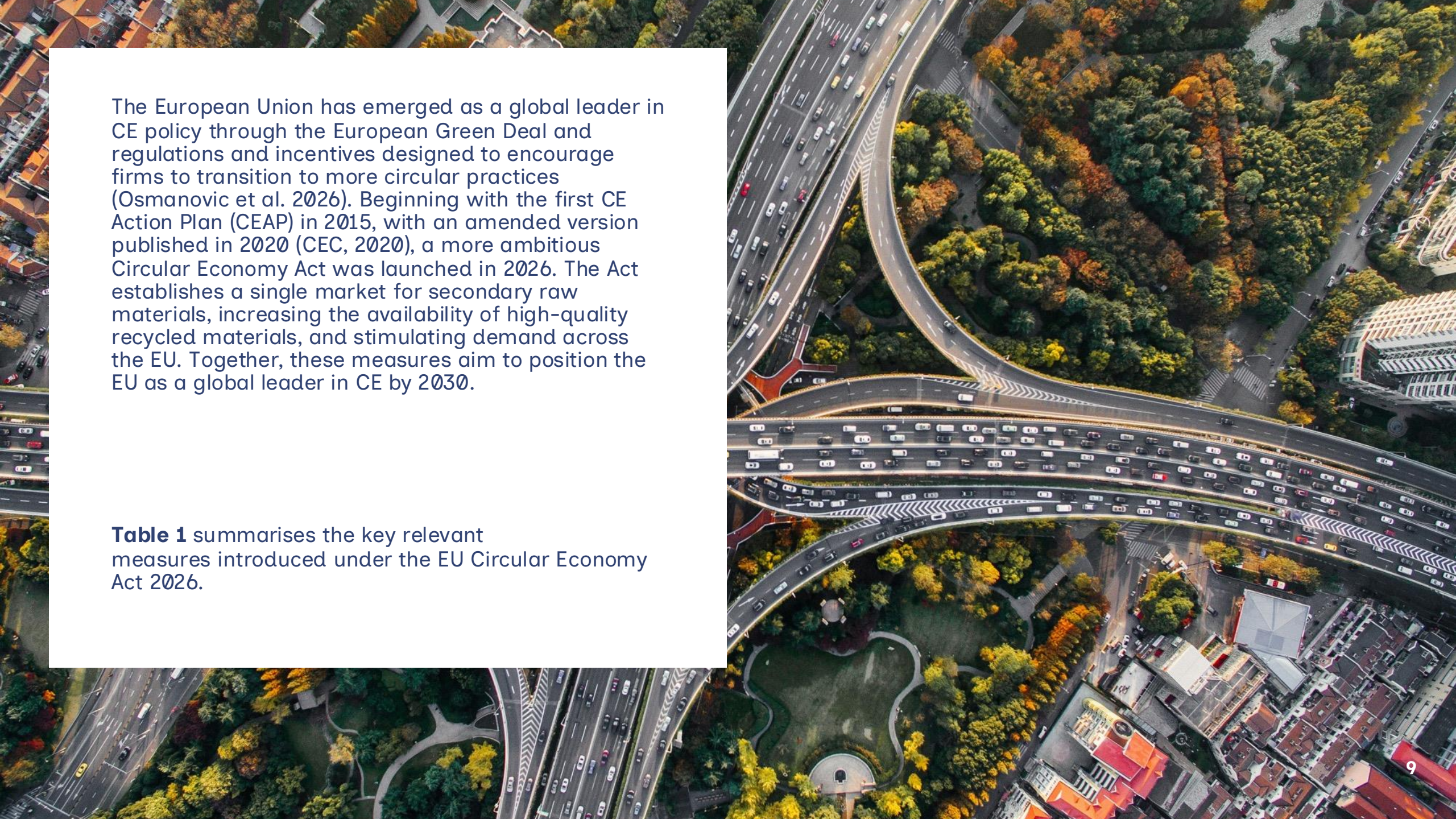
To address these challenges, the UK Government established a Circular Economy Taskforce in 2024, comprised of an independent group of cross-sector experts to support the development of a national CE strategy (GOV.UK, 2026).

The taskforce was tasked with identifying and assessing mechanisms that can underpin a CE strategy initially for England, the aim of which is to improve resource efficiency, support economic growth, create jobs and accelerate progress towards net zero. The Task Force co-designed a Growth Plan, expected to be published in 2026 (GOV.UK, 2026). Following the Growth Plan's recommendations, the UK is set to implement a comprehensive national CE strategy, focusing on five priority sectors: textiles, transport, construction, agrifood, chemicals and plastics.

Against this backdrop, this report outlines CE best practice in the automotive and construction sectors beyond the UK, bringing together practical insights of CE strategies in other countries with a specific focus on successes, gaps and learnings. The report offers practical insights for UK policymakers as the UK prepares to launch the Growth Plan. The report focuses on Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Sweden, China and Japan - as they emerge as world leaders in CE practices (Grybaitė et al. 2024; Du et al. 2025).

The report is structured as follows: **Section 2** reviews the EU circular economy policy framework; **Section 3** examines national CE strategies in selected countries; **Sections 4 and 5** focus on the automotive and construction sectors; and **Section 6** presents key lessons and recommendations.

2. EU interventions on circular economy



The European Union has emerged as a global leader in CE policy through the European Green Deal and regulations and incentives designed to encourage firms to transition to more circular practices (Osmanovic et al. 2026). Beginning with the first CE Action Plan (CEAP) in 2015, with an amended version published in 2020 (CEC, 2020), a more ambitious Circular Economy Act was launched in 2026. The Act establishes a single market for secondary raw materials, increasing the availability of high-quality recycled materials, and stimulating demand across the EU. Together, these measures aim to position the EU as a global leader in CE by 2030.

Table 1 summarises the key relevant measures introduced under the EU Circular Economy Act 2026.

Action	Purpose
ACTION 1: A SUSTAINABLE PRODUCT POLICY FRAMEWORK	
Ecodesign for Sustainable Products Regulation (ESPR), July 2024	Promotes a sustainable design approach for new products with the aim of making sustainable products the norm in the EU market.
Directive empowering consumers for the green transition, March 2024	Ensures that consumers are provided with information on the durability and reparability of goods and the legal guaranteed rights at the point of sale.
Directive on repair of goods, July 2024	Fosters sustainable consumption by making it easier and more cost-effective for consumers to repair products rather than replace them through its 'Right to Repair' mandate.
ACTION 2: KEY PRODUCT VALUE CHAINS	
Regulation on Packaging Waste (PPWR), February 2025	Harmonises national measures further – strengthening the internal market – for secondary raw materials, manufacturing, recycling and reuse.
Batteries Regulation, July 2023	Ensures that batteries placed on the EU market are sustainable and circular throughout their whole life cycle.
Regulation on End-of-Life Vehicles, proposed 2023	Mandates that cars be designed for easier dismantling, requires 25% recycled plastic content (with 20% from ELVs) by 2036, and enhances traceability to prevent masses of vehicles from disappearing.
ACTION 3: LESS WASTE, MORE VALUE	
Waste Framework Directive (WFD), October 2025	Prioritises waste prevention and enforces the 'polluter-pays' principle. It establishes a five-step waste hierarchy, in order: prevention, re-use, recycling, other recovery, and disposal. WFD sets binding targets for recycling and sustainable resource management.
Waste Shipment Regulation (WSR) May 2024	Imposes strict rules for transporting waste within, into, and out of the EU. It bans exporting plastic waste to non-OECD (Organisation for Economic Corporation and Development) countries, mandates strict auditing for exports, and introduces full digitalization to combat illegal trafficking.
Generalised Extended Producer Responsibility (EPR), January 2025. **Component of WFD*	Makes manufacturers, importers, and brands responsible for the entire life cycle of their products, particularly the post-consumer stage, with the primary goal of turning the tide on waste and promoting a circular economy.

Source: European Commission (2026)

These policies have been widely adopted within the EU and beyond - with Norway, China and Japan aligning their domestic CE policies with EU regulations. In what follows, this report highlights some of the best practices in these countries.

Funded by UKRI Engineering and Physical Sciences Research Council

3. National circular economy strategies in other countries

Countries with advanced circular economy (CE) programmes have established dedicated national strategies, with some of them including legally binding policies. These centralised frameworks embed circularity across industrial sectors, ensuring a coordinated and consistent approach rather than relying on voluntary action by individual businesses (Marino & Pariso, 2020; Škrinjarić 2020). **Table 2**: Summarises national circular economy strategies in other countries:

Policy	Key Elements
DENMARK	
Circular Economy Action Plan (CEAP) 2024 **Legal nature:** CEAP guides various legally binding Acts (e.g. Environment Protection Act)	CEAP has 129 initiatives aiming to reduce waste and increase recycling (European Union, 2026b). Key elements include: •Strengthening enterprises as drivers for transitioning •Promoting digitalisation for traceability and recycling •Eco-design of products for sustainability •Strengthening CE in the building sector •Increasing the value of biomass
FINLAND	
Strategic Programme to Promote a Circular Economy (SPPCE) 2021 **Legal nature:** Government-adopted resolution that acts as a coordinating policy framework for administrative branches.	Finland was the first to adopt a national CE strategy, with the launch of the Finnish Roadmap to a Circular Economy in 2016 (SDG 12 Hub, 2021; European Environment Agency, 2025). Key elements include: •Systemic changes in operation models (construction, manufacturing) •Strengthening green public procurement •Limiting consumption of primary raw materials •Hubs for municipalities and businesses to support a CE
FRANCE	
Anti-Waste and Circular Economy Law (AGEC Law) 2020 **Legal nature:** Legally binding	AGEC mandates a shift from linear to circular systems through 50 measures. Key elements include: •Combating waste and promoting reuse •Enhancing product sustainability and repairability •Transforming production and sorting practices •Public procurement •Consumer information

Policy	Key Elements
GERMANY	
German Recovery and Resilience Plan (GRRP) 2021 **Legal nature:** Legally binding	GRRP supports flagship investment and reform projects. For this, the National Circular Economy Strategy (NKWS /NCES) was adopted by the Federal Cabinet in 2024 (European Environment Agency, 2024a). Key elements include: •Digital transformation •Industrial resilience •Increasing the use of secondary raw materials •Design for recycling •Strengthening social inclusion •Future education and youth
ITALY	
National Strategy for Circular Economy (NSEC) 2022 **Legal nature:** Most of the components are legally binding (i.e. Eco-design and EPR)	Most of NSEC's components are legally binding to promote sustainability, eco-design, and EPR (OECD, 2024). Key elements include: •Using secondary raw material markets •Enhancing waste traceability •Reducing landfill use to be lower than 10% by 2035 •Promoting symbiosis •Fostering sustainable supply chains

Policy	Key Elements
SWEDEN	
National Strategy for Circular Economy (NSCE) 2020 **Legal nature:** NSCE works in conjunction with binding EU regulations and Swedish environmental legislation	NSCE aims transition to a CE and a fossil-free nation with net-zero emissions by 2045 (PACE, 2023). Key elements include: •Sustainable production and product design •Sustainable consumption •Non-toxic and circular material cycles •Innovation
NORWAY	
National Strategy for a Green Circular Economy (NSGCE) 2021 **Legal nature:** NSGCE includes a set of policies and sectoral measures that are legally binding	NSGCE is driven through the Action Plan for a Circular Economy, aiming to transition to a CE (Regjeringen, 2026). Key elements include: •Circularity as a driver for innovation and employment •Non-toxic material cycles •Sustainable product design •Sustainable consumption and usage
NETHERLANDS	
The National Programme for Circular Economy (NPCE) 2023-2030 **Legal nature:** NPCE relies on legally binding measures and EU Directives to enforce its goals.	NPCE aims for a 100% circularity by 2050 and a 50% reduction in raw material consumption by 2030 (Government of the Netherlands, 2023; European Environment Agency, 2024a). Key elements include: •Systemic transformation of production and consumption •Policy mix - i.e. standard setting, fiscal incentives, and regulations •Circular design and reparability •Public procurement •Stakeholder participation •International coordination

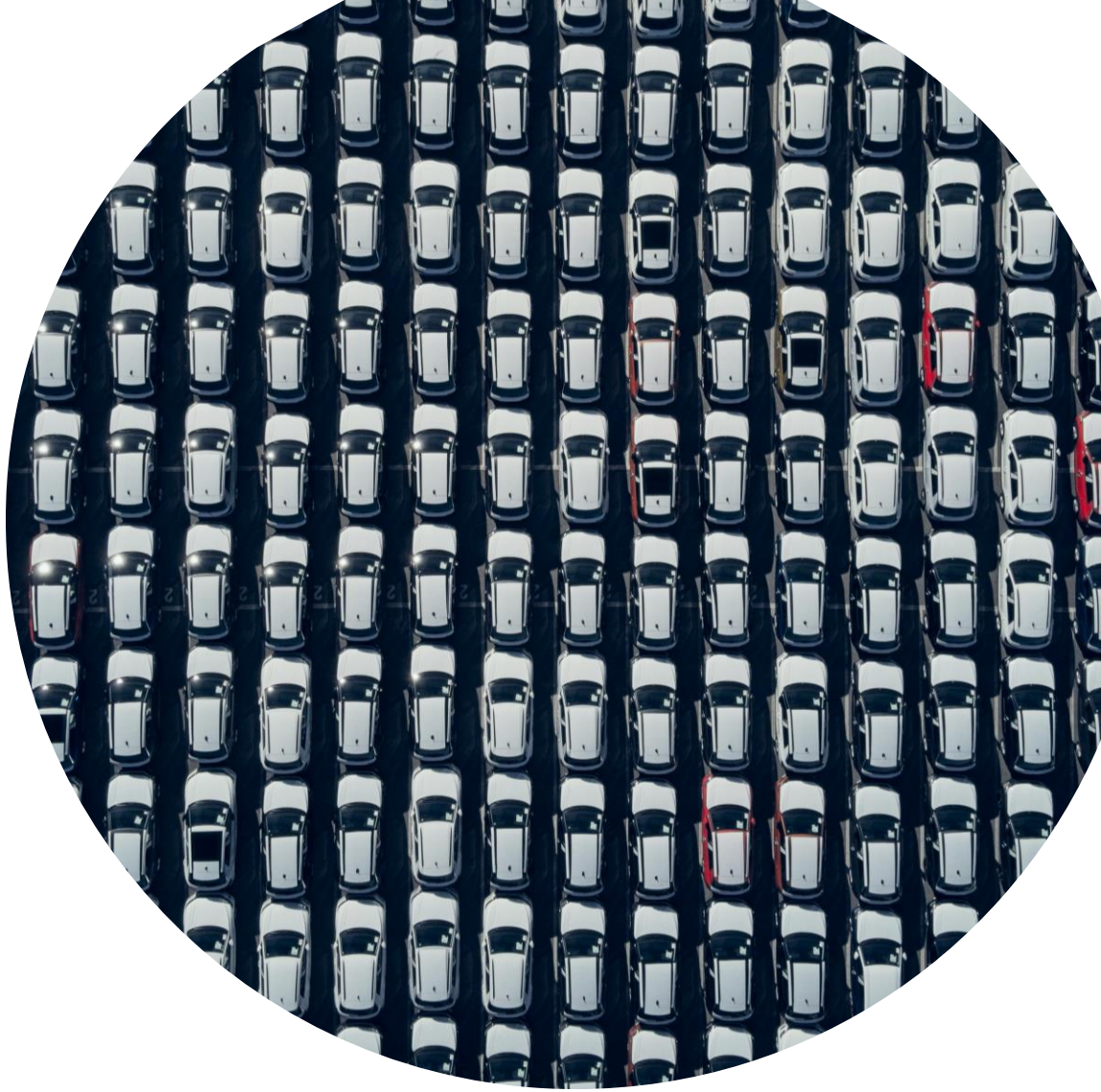
Policy	Key Elements
CHINA	
Circular Economy Promotion Law (CEPL) 2008 **Legal nature:** Legally binding	CEPL was adopted as a national development strategy and anchored in China's Five-Year Plan on Circular Economy (Green Policy Platform, 2008; Chen, 2023). CEPL requires companies and local governments to follow specific, punishable directives. Key elements include: •Increasing resource production •Reducing energy and water consumption •Building comprehensive waste recycling systems •Eco-industrial parks •Automotive battery recycling •Green consumerism and packaging
JAPAN	
Basic Act for Establishing a Sound Material-Cycle Society 2000 **Legal nature:** Legally binding	The Basic Act is complimented by the Growth-Oriented Resource-Autonomous Economy Strategy 2023 built on the earlier Circular Economy Vision 2020. The Strategy explicitly aligns with global trends, particularly EU CE strategies (Tanabe, 2024). This is led by The Ministerial Council on Circular Economy (Bocken & Shirahada 2025). Key elements include: •Ongoing five-year action plans setting targets for resource productivity •Individual recycling law targeting specific products including construction material and automobiles •Promoting plastic circulation throughout the product life cycle •Promoting 3R initiatives in industrial design and manufacturing

Funded by UKRI Engineering and Physical Sciences Research Council

4. Circular economy strategies in the automotive sector

4.1 Existing best practice in the automotive industry

The European Union (EU), led by Germany, France, the Netherlands and Sweden, is at the forefront of circular economy (CE) practices in the automotive sector, particularly for electric vehicles (EVs). Beyond the EU, Norway, China and Japan have also developed leading approaches. This section outlines the common characteristics shared by some of these countries in their CE strategies.



Design for sustainability

A core feature of successful CE strategies is the adoption of design-for-sustainability principles. Key focus areas include using recycled and bio-based materials, creating durable and repairable batteries, ensuring easy disassembly, and reducing production emissions (Tagesspiegel Background, 2024). Strategies take a whole-lifecycle approach, considering environmental impacts from raw material extraction through production, repair, reuse, and remanufacturing (Appendix 1, Box 1).

Battery regulation and data transparency

The introduction of compulsory Digital Product Passports (DPPs) for batteries in the EU from 2027 will provide accessible information on battery composition, carbon footprints, material sourcing and lifecycle data, aimed at increasing transparency, safety and circularity. DPPs support repair, reuse, remanufacturing and recycling by improving traceability and transparency throughout the battery value chain. Similar approaches are also being adopted in several non-EU countries (Appendix 1, Box 2).

End-of-life vehicle processing

End-of-life vehicle (ELV) management of EV's and ICEV (internal combustion electric vehicles) is experiencing strong, rapid growth in the EU and beyond driven by strict environmental regulations (European Commission, 2025b). Common measures include design for recycling, mandatory material recovery, digital battery passports, ambitious recycling targets and expanded processing capacity. In the EU, the ELV Directive (2000/53/EC) mandates safe disposal, strict recycling targets (95% recovery / 85% recycling by weight), and restricts hazardous materials like lead, mercury, and cadmium (Appendix 1, Box 3).

Industrial symbiosis

Industrial symbiosis plays a growing role in automotive circularity by enabling companies to exchange waste materials, by-products and energy streams (Baldassarre et al. 2019). This reduces reliance on virgin materials, lowers emissions and boosts industrial efficiency and profitability (Wadström et al. 2021). Several countries have integrated industrial symbiosis into strategies to achieve CE in EVs (Appendix 1, Box 4).

Industry-led initiatives

Industry collaboration is critical to advancing circularity in the automotive sector. Partnerships help establish common standards, facilitate data sharing and support second-life battery applications, which supports resource efficiency, reduces dependence on critical raw materials and help ensure compliance with emerging regulatory requirements (Appendix 1, Box 5).





4.2 Gaps in existing circular economy strategies

Several barriers continue to limit the effectiveness and scalability of circular economy (CE) initiatives in the automotive sector.

Battery production

- Significant environmental and social concerns, including habitat damage from critical mineral extraction and weak labour and welfare standards within supply chains (Bonsu, 2020).
- Heavy focus on reducing tailpipe emissions from internal combustion vehicles, with less emphasis on the significant emissions associated with battery production (Du et al. 2025).
- Low consumer confidence in reused batteries limits demand and creates challenges for expanding battery reuse, remanufacturing and recycled material markets (Zhang et al. 2011).

Regulatory and administrative challenges

- Legislative barriers coupled by the absence of meaningful industry consultations with sectoral leaders prevent integrating CE practices (Mubarik et al., 2024; Du et al. 2025).
- Lack of political will, lack of government support and administrative burdens (Du et al. 2025).
- Lack of industry-wide standards, ad-hoc protocols and liability management (Küpfer et al. 2023).

Absence of a holistic approach

- An exclusive focus on battery recycling with less attention paid to other components (Montemayor et al. 2023).
- A high amount of waste export, often to be processed by the Global South (Jensen, 2024).
- Lack of a well-defined value-chain approach (Kayikci et al. 2021), particularly in addressing globalised trade and the challenges of implementing circularity across interconnected global markets (Du et al. 2025).
- CE policies and incentives tend to focus more on recycling and waste management than on reducing overall consumption (Thalberg, 2022; Jaeger, 2025).

Resource gaps

- Countries face constraints such as insufficient financial resources, financial risks, lack of critical scale for business and investments, and lack of private sector engagement (OECD, 2021; Hoppe et al. 2025).
- Battery recycling often remains commercially unviable due to the early stage of EV battery adoption (Ahuja et. al. 2020).
- Low quality of remanufactured products and low quantity of returned products, combined with high investment risks hamper the progress of recycling (Urbinati et al., 2021).

Information and digitalisation

- Insufficient integration of material passports and digital technology to trace and manage materials throughout their life (Hoppe et al. 2025; Soufi et al. 2026).
- Risks over data security, sharing, and exchanging prevent adoption of technology (Sonar et al. 2022).
- Information asymmetry between original equipment manufacturers (OEMs), remanufacturers and recyclers regarding component specifications and disassembly (Du et al. 2025).

Cultural and organisational barriers

- Cognitive barriers on perceived low value and interest for used batteries (Olsson et al. 2018).
- Perceived lack of economic viability and the absence of a clear business case (Adams et al. 2017).
- Perception that early investors may not capture benefits (Adams et al. 2017).
- Additional time, labour, and recertification costs making reuse uneconomical (Akinade et al. 2017).

5. Circular economy strategies in the construction sector

5.1 Existing best practices in the construction sector

The construction sector employs a range of circular economy (CE) approaches, including design for disassembly, sustainable public procurement, urban mining, industrial symbiosis, material passports, extended producer responsibility, and cross-sector collaboration. This section outlines the common strategies adopted by leading countries.

Modular construction

Modular construction involves manufacturing building components in a controlled factory setting before assembling them on site. It supports circular economy (CE) principles by reducing material waste, enabling design for disassembly, allowing components to be reused or repurposed, and fostering the long-term adaptability of buildings. In some projects, modular components can account for up to 95% of the total building (Appendix 2, Box 1).

Public procurement

Public procurement strategies leverage public purchasing power to minimise waste and environmental impact by prioritising durability, repairability, and reuse over the entire life cycle of materials and projects (Stritch et al. 2018). Common approaches include incorporating circular criteria into procurement processes, engaging suppliers early to encourage innovation, and shifting from product ownership towards service-based models (European Commission, 2017; Vanhuyse et al., 2021); (Appendix 2, Box 2).



Urban mining

Urban mining involves recovering and reusing materials such as steel, concrete and copper from existing buildings and infrastructure during renovation or demolition (Foster 2020; Junior et al. 2023). The concept treats cities as ‘material banks’, reducing waste in landfills and the need for virgin raw materials (Appendix 2, Box 3).

Industrial symbiosis

Industrial symbiosis enables businesses to exchange waste, by-products and resources, creating circular material flows that reduce waste, lower disposal costs and decrease reliance on virgin raw materials (Fric et al. 2025) (Appendix 2, Box 4).

Digital product passports (DPP)

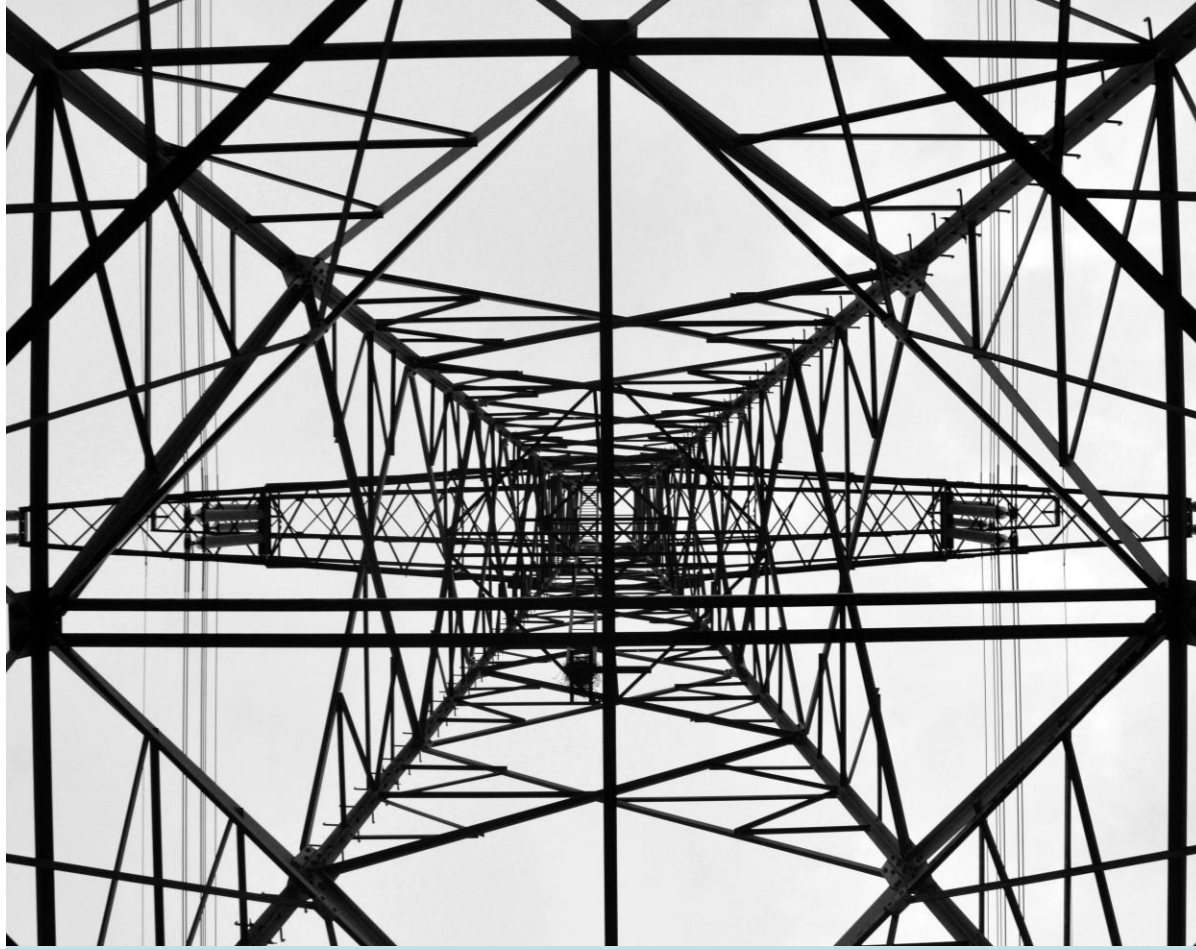
Digital Product Passports (DPPs) are digital records that provide traceable information on a product’s composition, sustainability, repairability and lifecycle, from material extraction through to recycling and disposal. By improving transparency, DPPs support material reuse, streamline deconstruction and improve recycling rates (Ruismäki et al. 2025) (Appendix 2, Box 5).

Extended producer responsibility (EPR)

EPR forces firms to take responsibility for the entire life cycle of their products, including disposal, recycling and reuse (Iqbal et al. 2025). The EU requires member states to achieve 70% recovery of construction and demolition waste (Appendix 2, Box 6).

Collaborations

Better collaboration between stakeholders can break down traditional, fragmented silos, enabling a better coordination of waste reduction efforts across the entire building life cycle (Konietzko et al., 2020). By sharing data, risks and innovations, partners can work together to maximise material reuse (Appendix 2, Box 7).





5.2 Gaps in the existing circular economy strategies

This section outlines the key barriers and implementation challenges that continue to limit the progress of CE strategies in the construction sector.

Regulatory and administrative challenges

- Building regulations are mainly geared towards new buildings and are ill-equipped to encompass reused products (Green Building Council Finland, 2024).
- Regulatory asymmetries and contradictions such as the tensions between policy ambitions for reuse and the rigidity of current regulations requiring performance tests (Condotta & Zatta, 2021).
- Lack of coordination between industry and policy (Boons et al., 2017; Silvestri et al. 2020).

Barriers to reuse

- Lack of suitable methods for reuse, doubts about long-term performance, and a stock of buildings not designed for reversibility (Akinade et al. 2017).
- Insurance issues such as additional costs, professional indemnity, demands of proof and third-party certification, and the absence of coverage for reclaimed material (Griffiths et al. 2025).
- Selective dismantling is labour-intensive, time consuming and costly (Nicolas & Sébastien, 2026).
- Irreversible connections including mortar, cement and welding hinder disassembly without damage (Nicolas & Sébastien, 2026).
- Lack of established markets for reused materials (Jin et al. 2017).

Absence of a holistic supply chain approach

- Fragmented supply chains remain a central obstacle to material recovery, with reverse flows from demolition to sourcing lacking coordination and market intermediation (Brandão et al. 2021).
- The project-based approach to construction hinders industrial symbiosis and material flows are interrupted by the fragmented and temporally inconsistent supply of waste material (Yu et al. 2021).
- The exportation of construction waste, particularly to the Global South remains a blind spot (Eurostat EU, 2024).
- Lack of storage causes frequent mismatches between available arisings and downstream demand (Densley Tingley et al. 2017; Ericsson et al. 2024).

Resource gaps

- High costs associated with testing, certification and documenting reused materials create a disincentive compared to using new materials (Jin et al. 2017; Griffiths et al. 2025).
- A temporal mismatch between significant upfront investment for circular construction and benefits that can only be accrued in the long term (Hart et al. 2019).
- The information system of waste supply chains is underdeveloped and fragmented across the sector (Geissdoerfer et al., 2018; Liu et al., 2020).

Cultural and organisational barriers

- Reuse is widely perceived as risky due to the uncertainties in availability, quality, and processing of recovered materials (Nicolas & Sébastien, 2026).
- Systemic organisational barriers such as linear practices, lack of knowledge, weak cross-sector collaborations, and limited commitment from management (Nicolas & Sébastien, 2026).
- Lack of societal awareness and acceptance of reused material (Du et al. 2025).
- Inherent conservative and risk averse nature of the sector with limited knowledge and scepticism of reuse associated with reduced quality, aesthetics, functionality, and safety (Knoth et al. 2022).



6. Conclusion: Learnings from existing CE practices



This report has examined circular economy (CE) approaches in the automotive and construction sectors across leading international examples. Successful strategies are commonly underpinned by national CE frameworks, legally binding measures, design-for-recycling principles, extended producer responsibility, industrial symbiosis, and digital tools such as product passports.

A key finding is the influential role of the EU in driving CE adoption. Through comprehensive and enforceable regulatory frameworks, the EU has translated broad sustainability ambitions into practical and scalable measures. As the world's largest single market, EU regulations increasingly shape global standards and benchmarks and drive industrial decarbonisation. Thus, non-EU countries are beginning to align their domestic CE strategies with EU requirements.

In spite of the advances made, CE strategies in these countries remain at an early stage of development, with notable policy and implementation gaps. Whilst the transition is achievable and would bring both environmental and economic benefits, implementation is often hindered by systemic barriers, market constraints and resource deficiencies. Waste management also remains a significant concern, with many countries continuing to export a substantial portion of their waste to developing countries in the Global South, despite waste management being a cornerstone of emerging EU directives and policies. Nevertheless, the evidence suggests that having a robust national CE strategy in place is an essential first step for transitioning from a wasteful, linear model to a sustainable, regenerative economy.



The review highlights five key lessons for the UK:

1. Develop a comprehensive national circular economy strategy.

A national CE strategy provides a coordinated, economy-wide framework that moves beyond fragmented sector-specific initiatives. By creating a consistent policy environment, it can accelerate investment, strengthen resource security, and drive systemic changes in product design and material use. A unified strategy has several advantages, in that it can:

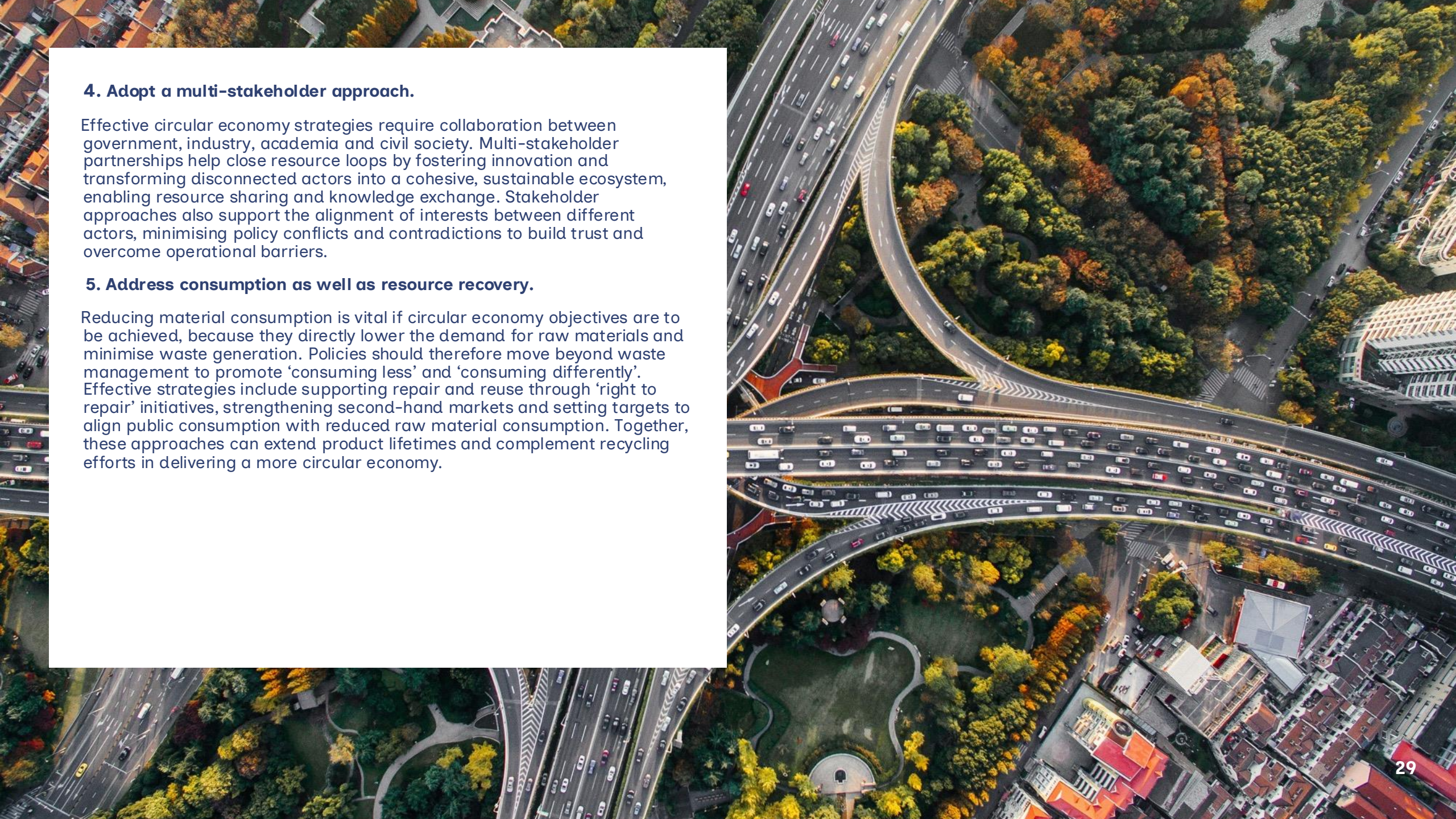
- Enable a whole-lifecycle approach encompassing eco-design, production, repair, reuse and consumption .
- Encourage systemic transformation rather than isolated measures.
- Promote long-term business investment in circular technologies through clear targets.
- Create a level playing field, ensuring consistent standards across sectors and industries.
- Support the setting of ambitious goals such as reducing raw material demand, essential for meeting net-zero targets and securing critical raw materials.
- Integrate action and data, connecting different sectors to national data platforms to monitor material flows and progress towards net zero.

2. Strengthen legal and regulatory frameworks.

Legally binding circular economy measures can be more effective because they create necessary governance accountability and legitimacy, if compliance is enforced and monitored correctly. They help overcome systemic resistance, avoid greenwashing and enforce consistency across industries. By moving beyond voluntary commitments, legally binding CE strategies establish enforceable requirements such as standardised reporting, and clear compliance obligations. With legal backing, the government can also introduce incentives, such as taxes, grants and subsidies, to encourage businesses and consumers to adopt circular practices.

3. Align national policy with international frameworks.

International policy alignment is critical because materials, products and waste move across global supply chains, making isolated national approaches less effective and more costly. This is especially so in the context of globalised production and consumption, where the UK depends on volatile global supply chains for critical raw materials, as well as for accessing markets. Close alignment with emerging EU circular economy policies is particularly important given the integration of UK and EU markets and supply chains. Policy alignment can facilitate cross-border trade and resource flows, reduce regulatory divergence and environmental leakage, and create stronger market scale and economic incentives for both businesses and consumers.



4. Adopt a multi-stakeholder approach.

Effective circular economy strategies require collaboration between government, industry, academia and civil society. Multi-stakeholder partnerships help close resource loops by fostering innovation and transforming disconnected actors into a cohesive, sustainable ecosystem, enabling resource sharing and knowledge exchange. Stakeholder approaches also support the alignment of interests between different actors, minimising policy conflicts and contradictions to build trust and overcome operational barriers.

5. Address consumption as well as resource recovery.

Reducing material consumption is vital if circular economy objectives are to be achieved, because they directly lower the demand for raw materials and minimise waste generation. Policies should therefore move beyond waste management to promote ‘consuming less’ and ‘consuming differently’. Effective strategies include supporting repair and reuse through ‘right to repair’ initiatives, strengthening second-hand markets and setting targets to align public consumption with reduced raw material consumption. Together, these approaches can extend product lifetimes and complement recycling efforts in delivering a more circular economy.

Appendix 1. Examples of existing circular economy practices in the automotive industry

Box 1: Design for sustainability

Germany
In Germany, in order for a vehicle to be approved, the manufacturer must prove that 85% of the vehicle is recyclable. Without this proof, a vehicle model will not receive *type approval certificate and certificate of conformity*, and may not be placed on the market (DW, 2023; Tagesspiegel Background, 2024). Type approval – granted by the Federal Motor Transport Authority – is the official certification process ensuring new vehicles, systems, or components meet EU safety, environmental, and production standards before sale or registration. Market leaders such as BMW and Volkswagen have already successfully integrated these principles to emphasise material efficiency and reduced environmental impact from production to end-of-life vehicle processing (ELV), with a growing focus on using natural materials.

Italy
Similarly, in Italy, new regulations require vehicles to be 85% reuseable/recyclable, and 95% recoverable, with a focus on eliminating hazardous substances (Legislative Decree 209/2003 aligned with EU Directive 2000/53/EC on end-of-life vehicles).

Sweden
In Sweden, material efficiency and repairability is embedded into the design process at the outset. Strategies include reducing or eliminating cobalt in battery chemistries, switching to high-nickel alternatives, and designing vehicles for easier dismantling, maintenance, and part replacement (Circularity Gap Report Sweden – CGR, 2022).

Box 2: Battery regulation and data transparency

Germany
In support of DPP, the German Federal Ministry for Economic Affairs and Climate Action (BMWK) established the 'Battery Pass' consortium, led by SYSTEMQ GmbH (Battery Pass Ready, 2025). The consortium includes 11 key partners from industry and academia. It aims to develop DPP standards for EV batteries to facilitate compliance with EU mandatory regulations from 2027. It will define technical standards, create a digital pilot, and ensure compliance with the EU Battery Regulation 2023/1542.

Norway
Norway has a legally binding battery regulation policy, adopted by the Ministry of Climate and Environment (Norway Action Plan for a Circular Economy 2024-2025). This policy supports a well-developed collection system and a newly established advanced processing facility for discarded EV batteries. Norway has implemented initiatives such as Catena-X to support decentralised, open data ecosystem to facilitate the transfer of data required for the passport between manufacturers and suppliers (Stretton et al. 2025). Further, with effect from February 2027, Norway plans to implement battery passports by aligning with EU regulations, requiring a digital record (QR code) detailing materials, carbon footprint, and ownership history for EV batteries over 2 kWh (Stretton et al. 2025). As a non-EU, European Economic Area (EEA) member, Norway enforces this through the National Transparency Act 2023 ensuring supply chain traceability and sustainability.

China
China implements a comprehensive digital battery traceability system, often referred to as a Digital ID or Battery Passport System to track EV batteries throughout the life cycle. (Losa & Torjesen 2025). In operation since 2018 through the National Power Battery Traceability Integrated Management System, it requires manufacturers to document production, usage, and recycling of batteries.

Funded by UKRI Engineering and Physical Sciences Research Council

Box 3: End-of-Life Vehicles (ELV) processing

Germany
Germany's regulations mandate significant material recovery – e.g. 50% lithium recovery by 2027, rising to 80% by 2031. Germany also requires high-efficiency recycling processes such as 65% for lithium-based batteries (European Commission 2025a). The German EV battery recycling market is experiencing a massive growth, projected to rise from $22.4mn in 2023 – over $646.8mn by 2030 (Grandview Research, 2026).

France
In France, the Anti-Waste and Circular Economy Law (AGEC Law) mandates that car manufacturers take back ELVs at no cost, extending producer responsibility to all vehicle types to curb illegal dumping, and enforcing stricter environmental standards on dismantling centres (Michalik, 2024). In authorized centres, over one million vehicles are processed annually, with key operators including Derichebourg Environnement, Paprec, and The Future is NEUTRAL (Renault Group, 2026). ELV processing under the AGEC is seen as highly successful in increasing recycling rates and reuse, with 2024 results showing a 15.9% reuse rate of parts and materials returned to circulation, far exceeding the 2026 target of 8.5% increase (Auto Recycling World, 2025).

Norway
Norway is a global leader in ELV processing of EVs, with specialised facilities like Hydrovolt – Europe's largest plant – processing up to 12,000 tonnes of batteries annually, with a recovery rate of 95% of materials (Northvolt, 2022). The system, managed by Autoretur and EPR regulations, focuses on recovering lithium, cobalt, and nickel. Recovered materials including black mass are sent to Northvolt for further refining into new battery production with a goal of using 50% recycled material in battery production by 2030.

China
China leads global EV battery recycling, controlling over 75% of global pre-treatment and 89% of refining capacity for black mass (Climate Home News, 2026). Example initiatives include: CATL/BRUNP (99% material recovery), BYD (in-house recycling), and NIO (swapping infrastructure). Key strategies of these interventions include 'cascade utilisation' (repurposing for energy storage) and high-efficiency hydrometallurgical recycling. The industry is rapidly scaling to manage over one million tonnes of retired batteries by 2030 with new, stricter regulations effective of April 2026 forcing batteries to remain with vehicles until they reach licensed recyclers.

Funded by UKRI Engineering and Physical Sciences Research Council

Box 4: Industrial symbiosis

Italy
The SUSTAINera Circular Economy Hub in Turin, Italy is a flagship collaboration led by Stellantis, dedicated to sustainable automotive manufacturing (Stellantis, 2023). The Hub works with partners such as Orano (battery recycling) and Galloo for ELV management. The hub focuses on remanufacturing used components (engines, gearboxes, high-volatile batteries) and dismantling ELVs to feed parts and materials back into the production loop, reducing the need for virgin raw materials.

Norway
Norway implements industrial symbiosis by connecting battery manufacturing, second-life applications, and material recycling (Liaise, 2025). This has fostered a business ecosystem where car manufacturers, recyclers, and battery producers collaborate to create value from used materials. Key initiatives include utilising hydropower for clean manufacturing, repurposing used EV batteries for stationary energy storage, and localising battery dismantling for recovery (e.g. cobalt, nickel) to support new production. Examples include Hydrovolt (battery recycling) and regional clusters in Møre and Romsdal (Grønn Hub Tjeldbergodden) that maximise waste-to-resource flows reducing emissions, costs, and reliance on virgin materials.

China
In China, industrial symbiosis is part of the 14th Five-Year Plan on Circular Economy (2021-2025) (Chen, 2023). In the EV sector, this involves deeply integrated supply chains, where battery manufactures, raw material processors, and vehicle assemblers co-locate to reduce costs and waste. In particular, China's green industrial parks promote industrial symbiosis by creating closed-loop systems that integrate battery production, dismantling, and material recycling through urban mining (see section 5.1.3 below), using by-products as raw materials, cascading energy use and sharing facilities like water treatment centres (Zhao, 2021). A prominent example includes the Zia Circular Economy Park in Tianjin, a major collaborative effort involving local governments, over 900 private enterprises including TCL Aobo and GEM Co., Ltd, and international agencies such as the UNDP. Established in 2003, the Park acts as a centralised 'urban mining' hub where companies share infrastructure and supply each other with recycled materials (UNDP, 2026).

Japan
Japan is actively taking an industrial symbiosis approach to its EV sector focusing on integrated battery production, recycling, and smart energy management to achieve carbon neutrality. This involves collaborations between major automakers (Toyota, Honda, Nissan), technology firms, and energy suppliers (TEPCO) to create sustainable, closed-loop ecosystems (Yoshio, 2026). Strategies include manufacturers and recyclers working together to recover, reuse, and recycle rare earth metals and lithium-ion batteries; partnerships between power companies and manufacturers aiming to connect vehicles to the grid for energy storage; and creating alliances to share costs in developing software-defined vehicles (SDVs), core components, and next generation battery technology.

Funded by UKRI Engineering and Physical Sciences Research Council

Box 5: Industry-led initiatives

Germany

BMW's Holistic Sustainability and Material Innovation (i3 & iX) hub in Germany is a 360° approach focusing on decarbonization across the entire vehicle life cycle – from supply chain to production and consumption (BMW Group, 2026). The hub emphasises on using renewable energy in manufacturing, increasing secondary, recycled materials up to 30%, and designing for circularity to reduce emissions and environmental impact.

France

In France, the Refactory, launched by Renault Group in 2021 is Europe's first CE factory dedicated to mobility. It is designed to extend the life of vehicles and components reducing the environmental footprint of EVs (Renault Group, 2024). Key aspects include battery management, material recycling, retrofit solution and industry collaborations. Refactory is Europe's largest used-car refurbishing center with a 45,000-vehicle annual capacity.

Netherlands

Stellantis N.V. (Netherlands) formed in 2021 is a group of 14 diverse brands investing in EV technology capitalising on high-margin commercial vehicle leadership. In 2023, Stellantis's remanufactured sales grew 14%, offering nearly 12,000 parts across 40 product lines, including electric vehicle batteries (Stellantis, 2024). Further, the sale of used, multi-brand original parts increased by 63%, with 7 million parts available. Additionally, 2 million auto parts were collected for recycling in 2023, featuring an 84% increase in parts recycling recovery (Stellantis, 2024).

Norway

Vianode, a Norwegian battery materials company is advancing the sustainable EV battery value chain by producing high-performance, low-emission synthetic anode graphite in Herøya, Norway. Through a partnership with Fortum Battery Recycling, Vianode is integrating recycled graphite into their production, aiming to reduce CO2 emissions by 90% compared to conventional methods (Smart Energy Management, 2025). Vianode aims to supply materials for 3 million EVs annually by 2030, supported by Norwegian government grants. The initiative is part of a broader Norwegian effort to build a sustainable, circular battery industry, including collaborations with companies like Morrow Batteries.

China

In China, CATL and its subsidiary Brunp are implementing battery recycling programmes using their Directional Recycling Technology (DRT). This is a highly efficient method that differs from traditional methods by combining material synthesis with recycling to directly regenerate battery-grade materials, optimising waste reduction and raw material recovery (CATL, 2025). Unlike methods that break down materials completely, this approach is designed to directly produce new battery materials. It is often paired with techniques like Flash Joule Heating for rapid, efficient separation. In 2024, Brunp processed over 120,000 tons of waste batteries and produced 17,100 tons of recycled lithium salts, reportedly helping alleviate China's dependence on the import of nickel, cobalt, and lithium resources. Brunp has reportedly achieved ultra-high recovery rates of 99.6% for nickel, cobalt, and manganese, and 96.5% for lithium through processes such as intelligent disassembly, hydrometallurgy, and material restoration (CATL, 2025).

Funded by UKRI Engineering and Physical Sciences Research Council

Appendix 2. Examples of existing circular economy practices in the construction industry

Box 1: Design for disassembly: Modular / prefabricated construction

Germany

In Germany, up to 90% of a structure is pre-manufactured indoors, as 3D room modules or 2D panels, and assembled on-site with high precision (PRAMO, 2025). Modular construction in Germany prioritises speed, sustainability, and quality through timber-hybrid and lightweight steel systems that meet stringent energy standards of KfW a state-owned investment and development bank. This method has helped Germany address housing shortages and skilled labour deficiency. The factory setting has also allowed unparalleled quality control ensuring every component meets German construction standards. Modular construction has been critical in shortening project timelines by 60% and achieving superior energy efficiency. As of 2024-2025, modular construction accounts for approximately 26% of new residential buildings in Germany (BAU, 2024).

Sweden

Modular construction in Sweden is highly industrialized driven by the use of timber, extreme climate constraints, and a long history of prefabrication. Key strategies include industrialised timber construction, automated production lines, and high-quality, high-volume manufacturing which reduce the overall construction site waste by 30-50% compared to conventional methods (Sweden Herald, 2025).

Netherlands

Modular construction in the Netherlands leverages high-tech offsite manufacturing, digital twining, and sustainability-focused designs to address housing shortages and reduce carbon emissions. Key strategies include using timber and concrete for volumetric, panelized systems, and utilizing AI for rapid, precise assembly (Businesswire, 2025). Key innovative strategies include: wood modules, 2D panels and 3D components; accelerating factory automation and robotics (i.e. robotics for bricklaying is already being tested in facades and structural assembly); rainwater harvesting and solar integration; business information modelling (BIM) adoption to support complex prefabricated workflows across trades and materials (Businesswire, 2025).

China

In China, the government encourages prefabricated and Modular Integrated Construction (MiC) to improve productivity, reduce material waste, and enhance construction quality (Zhang et al., 2024). China focuses on high-rise, multi-storey steel, and concrete modules to suit its dense urban areas. This strategy specifically addresses the need for fast housing delivery in metropolitan regions. China's strategy is centred on supply chain integration with companies such as the CIMC Modular Building Systems and China Construction Hailong leading the way. They offer end-to-end services (design-manufacturing-assembly) which help optimize the supply chain, reduce logistical risks, and manage the high upfront capital investment required.

Japan

Japan is a leader in off-site construction, producing 13-15% of new residential homes annually (UniSA Enterprise Hub, 2025). Japan's Construction Material Recycling Law (JCMRL) ensures over 90% recycling rates for key materials (Charef et al., 2022). Japan applies a supply chain approach to modular construction by integrating factory-based manufacturing with design, logistics, and on-site assembly, heavily utilising Totoya-style lean production (Kaizen) to ensure efficiency and quality (Shinka Management, 2026). This emphasizes high standardization, digital twin technologies, and just-in-time (JIT) delivery to reduce material waste, labour shortages, and construction times.

Funded by UKRI Engineering and Physical Sciences Research Council

Box 2: Public procurement

Denmark

Denmark has mandatory green public procurement rules in place for construction reinforced by mandatory CO2 emission limits in Danish Building Regulations (BR18) as of January 2023 (Haxholm & Konnerup, 2025). Additionally, Denmark's Partnership for Green Public Procurement is a free voluntary initiative with a diverse set of stakeholders including municipalities, regions, and central authorities (OECD, 2019). Partners commit to adopt a green procurement strategy and common green procurement goals for certain product categories including timber. Purchasing criteria emphasise life-cycle costs, material reuse, and waste reduction, enforcing strict sustainability standards in procurement. Together, partners in this initiative account for 20% of Danish public procurement (OECD, 2019).

Italy

Italy has integrated circular construction strategies into its public procurement, primarily through the legally binding Minimum Environmental Criteria (*Criteri Ambientali Minimi,* CAM) mandated in 2015. CAM was first introduced in 2008 as part of Italy's National Action Plan for Green Public Procurement (PAN GPP). CAM is updated regularly and further integrated into procurement law with the latest CAM coming into force in 2022 (Climate Catalyst, 2025). Moreover, Public Procurement Code 2023 (PPC / Article 57) specified that technical specifications and contractual clauses contained in the CAM must apply for the entire value of the tender. These criteria mandate minimum recycled content, pre-demolition audits, and construction / demolition waste recovery threshold in public tenders to drive sustainability. Additionally, clauses are included to impose obligations for monitoring and reporting during project execution. Further, CAM includes award criteria that allow contracting authorities to give additional points to tenders offering superior environmental performance. Due to its mandatory nature, in the last two decades, Italy has successfully integrated CE standards which cover the entire public tender life cycle for all construction and renovation projects (Selvaraju & Nicholls, 2026).

Sweden

In Sweden, public developers and municipalities use green public procurement (GPP) to set strict sustainability criteria for material recycling and reuse in projects (Eriksson et al. 2026). Procurement requirements of municipalities promote green initiatives, with public clients often including strict environmental criteria for construction contracts. Further, by moving away from lowest-price only bidding, public entities use tenders to encourage innovative, high-value, and eco-friendly construction techniques.

Norway

Norway government introduced regulatory amendments in 2024 with the general rule that climate and environmental requirements must be stipulated in all public procurements, either through a 30% weighting of criteria or through requirement specifications (Norway Action Plan for a Circular Economy 2024-2025).The purpose of these changes is for public entities to maximise their positive effect through procurements.

China

China is one of the earliest countries to use public procurement as a key policy tool to promote a CE, driven by the Circular Economy Promotion Law revised in 2018. Under this law, for procurement using public funds, priority will be given to energy-saving, water-saving, material-saving, and environmentally friendly and recycled products (Guo, 2025).

Funded by UKRI Engineering and Physical Sciences Research Council

Box 3: Urban mining

Germany

Urban mining in Germany focuses on transforming the built environment into a 'material bank' by extracting, harvesting, and reusing materials from existing infrastructure to foster a CE (Jegen et al. 2025). This is further facilitated by the Germany's Recovery and Resilience Plan (GRRP) which boosts green transition in housing construction (European Environment Agency, 2024a; Renovate Europe, 2024). Key strategies include digital passports that track material quality and properties which help minimise crushing materials; and direct reuse and on-site recycling to minimise transportation and environmental footprint. Additionally, technologies such as AI, GIS, and Building Information Modelling (BIM) are used to track material life cycles and estimate future material outflows from aging building stock (Mostert et al. 2022). The Federal Government, through the National Circular Economy Strategy and ProgRessIII, aims to institutionalise these practices, integrating them into urban planning and the Round Table on Future-Oriented Construction.

Finland

Finland's new Building Act (751/2023) promotes urban mining requiring digital material passports and enabling detailed, site-specific demolition plans that prioritize material reuse. The Act requires digital pre-demolition audits and comprehensive mapping of building materials before demolition, identifying valuable components for reuse rather than disposal (Finnish Ministry of the Environment, 2026). Further, regulatory requirements for demolition permits are structured to allow adequate time for careful dismantling, without delaying future construction. Additionally, complementary regulations such as the Waste Act (646/2011, updated 2021) support the creation of markets for reused materials, urging stakeholders to use digital platforms to manage construction by-products (Climate Change Laws, 2022).

Netherlands

Netherlands implements high-value reuse of materials – such as concrete, timber, and steel. An example is *Villa Welpeloo (Enschde)*, a residential home complex which was constructed using 60% salvaged materials, including steel from old textile machinery and conveyor belts from a salt factory (van Andel, 2012). Villa Welpeloo demonstrated that sustainable, high-quality residential architecture could be built using 60% locally sourced waste materials, a concept known as 'superuse' or 'recyclicity'. Designed by Superuse Studios, it reduced CO2 emissions by 90% by utilizing industrial waste – such as steel girders from a textile machine and cable reel wood – found within a 9-mile radius.

Japan

Japan focuses on recovering valuable materials – especially steel, concrete, and timber – from demolition waste to strengthen resource security and achieve a CE. Japan enforces strict recycling regulations particularly driven by the Construction Material Recycling Law 2000. A notable strategy includes high-value 'horizontal recycling' where construction firms engage in 'manufacturer recycling'. Here, waste is returned to the manufacturer for conversion back into the same product, rather than lower-grade materials (J & T Recycling Corporation, 2026). While recycling rates for concrete and asphalt exceed 90-95%, horizontal recycling for materials such as glass is also emerging.

Funded by UKRI Engineering and Physical Sciences Research Council

Box 4: Industrial symbiosis

Denmark

Denmark is known for pioneering Kalundborg Symbiosis, the longest-standing example of industrial symbiosis (https://www.symbiosis.dk/en/). Kalundborg Symbiosis is a partnership between 17 public and private companies in Kalundborg. It implements a systematic approach connecting all partners for full use and exchange of waste, heat, water, and materials. For example, a construction company (Gyproc A/S) received industrial plasters from a power plant (Dong Asneas) which is used as feedstock for producing plasterboards and excess gas as an input energy source from Statoil refinery (Gulipac, 2016).

Finland

The Finnish Industrial Symbiosis (FISS) has engaged over 700 companies and 14 regions, generating over 2,500 synergy opportunities across regional hubs and industrial parks. Key initiatives include material-efficient construction, valorisation of industrial by-products, and active concrete-element reuse projects (European Commission, 2025a). For example, ECO3 industrial park in Nokia, driven by 40 organisations fosters bio-economy and CE products by allowing local organisations to share resources easily. ECO3 processes demolition debris, soils, ash, and concrete to create reuseable construction materials, directly addressing the construction sector's high environmental impact.

Netherlands

Netherlands's industrial symbiosis practices are primarily driven by the country's Concrete Agreement 2018 (Yu et al. 2021). The Agreement unites the government, builders, and industry partners to reduce CO2 emissions, increases high-quality recycling materials and ensures 100% sustainable concrete usage (Cramer, 2021). Construction actors actively participate in the Agreement, and take up-cycling of concrete waste and demolition as a crucial practice to enable circular material flows and to further realise a resource-efficient built environment (Yu et al. 2021). Industrial symbiosis practice has enabled Netherlands to recycle over 95% of construction and demolition waste (CDW) with the bulk of CDW is used as foundation components of the road infrastructure (Schut et al. 2016; Yu et al. 2021).

China

In China, industrial symbiosis is driven by top-down, government-led eco industrial parks (EIPs), with over 200 approved parks utilizing waste-to-energy and material use. The construction industry increasingly focuses on initiatives like material-sharing networks and prefabrication. The government uses a 'command-and-control' approach paired with fiscal incentives such as tax breaks, subsidies, and land discounts to force heavy industries to share resources and reduce waste (Fang et al. 2025).

Funded by UKRI Engineering and Physical Sciences Research Council

Box 5: Digital products passports

Netherlands

Netherlands has adopted DPP through its material passport and resource matching policies. Material Passport which was formally established in 2017 is a circular constructions strategy aimed at eliminating waste by documenting building components digitally, primarily through the Madaster platform (Madaster, 2019). These passports record material composition, location, and circularity, enabling high-value reuse during renovation or demolition. The policy is supported by two tax incentive measures – MIA (environmental investment rebate) and Vamil (arbitrary depreciation of environmental investments). MIA is a tax scheme that allows entrepreneurs to deduct up to 45% of environmentally friendly investment costs from taxable profit, on top of regular depreciation. Vamil (*Vrije Afschrijving Milieuinvesteringen*) allows entrepreneurs to write off 75% of arbitrary environmental investment costs at any chosen moment.

Germany

In Germany, DPPs are designed to work alongside existing digital construction systems, such as Building Information Modelling (BIM) (Matthias, 2024). Implementation follows EU regulations requiring all construction products to have a digital passport, shifting form paper-based to electronic documentation for CE marking. In addition, the German Sustainable Business Council (DGNB) has introduced a Building Resource Passport (BRP) (ETC-CE Report, European Environment Agency, 2024a). It creates an information base for all phases of a building's life cycle and thus makes an important contribution to transparency about the materials used, the greenhouse gas emissions of buildings and their circularity. The difference between EU DPP and the DGNB BRP is that the latter looks at the entire building, while the DPP focuses on individual constructions and materials. BRP was established in 2023 and is currently in use as a voluntary initiative in order to achieve higher sustainability ratings for the buildings.

Japan

In Japan, aligning with DPPs, technologies such as Building Information Modelling (BIM) and Internet of Things (IoT) for material tracking and life cycle assessment are adopted to ensure high-quality material recovery (Asian Development Bank, 2024). The use of digital tools and material passports allows builders to track materials (i.e. steel and glass) for future reuse, ensuring they are not just recycled but reutilised. Further, increased utilisation of bio-based materials and the Plastic Resource Circulation Act 2022 encourage using recycled plastics and sustainable timber, lessening the environmental footprint of new projects.

Funded by UKRI Engineering and Physical Sciences Research Council

Box 6: Extended producer responsibility and material efficiency

France

France is the first country to implement EPR on Construction and Demolition Waste (CDW) in 2023. France's EPR regulation stipulates that all producers, including manufacturers, importers and distributors of the specified products and materials are accountable for managing the end-of-life of their products (Graaf et al. 2024). They are required to pay a fee (called eco-contribution) per unit of product placed on the market to a non-profit Producer Responsibility Organization (PRO - referred to as eco-organisation). PROs handle the waste management activities such as collection, recycling, and treatment. This system covers two categories of waste: inert waste; and other waste products such as metal, wood, chemicals, joinery, plaster, plastics, bituminous, membranes, glass wool, bio-sourced plastic, etc. Fees are determined based on the nature and weight of the product (Graaf et al. 2024).

Netherlands

EPR strategies in Netherlands include specialised take-back schemes for materials such as flat glass, strict regulation of demolition of waste, and encouraging voluntary, high-value reuse and recycling initiatives to minimize primary raw material consumption. In particular, the Netherlands has an EPR scheme that focuses on a single product category – flat insulation glass – which is more polluting and harder to recycle into other types (Graaf et al. 2024). The Generally Binding Agreement (GBA) on flat glass was initiated by the Dutch Flat Glass Recycling Foundation and the Dutch Construction Sector Association in 2000. Initially a voluntary scheme, the approval of the GBA by the Dutch Ministry of Infrastructure and Water Management has made it mandatory for all glass producers to contribute financially to the waste collection system (Graaf et al. 2024).

Germany

German construction sector focuses on mandatory waste sorting, recycling targets, and increasing producer responsibility for product life cycles, aiming for 70% reuse/recycling in line with EU targets. Key strategies include voluntary take-back of products, development of a digital "Gebäuderessourcenpass" (building resource passport), and strict regulation under the Circular Economy Act (KrWG). Germany also implements the 'Green Dot (Der Grüne Punkt) framework, where a manufacturer pays a fee to a national packaging recovery organisation to fund recycling systems adhering to the EU WFD Directive (94/62/EC).

Japan

Japan's' EPR strategies in the construction sector heavily focus on mandatory recycling, sorting, and material reuse, driven by the Construction Material Recycling Law 2000 (World Economic Forum, 2024) and the Basic Act on Establishing a Sound Material-Cycle Society 2000. Key approaches include strict demolition sorting, high recycling targets for concrete/wood/asphalt, and rising adoption of design for disassembly. A notable characteristic is the resurgence of traditional joinery – an innovative integration of traditional, nail-free joinery techniques (e.g., *tsugite* and *shiguchi*) with modern engineering (e.g. Glued-in Rods - GIR joints - a high-performance, adhesively bonded fastening system) to facilitate easier disassembly and reuse of wood components (Hage, 2025).

Funded by UKRI Engineering and Physical Sciences Research Council

Box 7: Collaborations and partnerships

Nordic region

The Nordic Networks for Circular Construction (NNCC), launched in 2021 was a strategic, multi-annual initiative funded by the Nordic Council of Ministers. Its aim was to spearhead the adoption of CE within the construction sector of Nordic countries, aiming to make the region a leader in sustainable and competitive construction and housing by 2030 (The Nordic Corporation, 2026). NCCC project mapped over 86 existing circular construction policies and developed actionable recommendations for harmonizing regulations across Denmark, Finland, Iceland, Norway, and Sweden, facilitating easier, cross-border trade in reused materials. Further, the project established national networks and fora in each Nordic country, connecting stakeholders such as architects, developers and contractors to disseminate knowledge, share best practices, and collaborate on pilot projects. Following the completion of NCCC initiative in 2024, the New Nordic Circular Construction (NNCC) project is running from May 2024 – March 2026 to transform the Nordic building sector into a sustainable, resource efficient eco-system by 2030. NNCC is supported by Nordic Innovation, focusing on scaling commercial re-trade programs for martials and creating a cohesive Nordic market (European Union, 2026a).

Netherlands

Stadstuin Overtoom project in Netherlands is a collaborative approach with partners (i.e. ERA Contour and Eigen Haard) that included intense knowledge sharing and cooperative risk-sharing, leading to time and cost savings (Modus, 2020). Here, 350 outdated buildings were demolished and 98% of the materials were repurposed for the construction of 470 new, climate-neutral homes. *Stadstuin Overtoom* was one of the first projects aimed at creating a completely climate-neutral neighbourhood in Amsterdam. The initiative focused on integrating nature, sustainability, and high-quality living spaces in Amsterdam Nieuw-West.

France

In France, major construction firms are actively creating networks and partnerships to achieve circularity goals. An example include *Noé Platform* - a member of the French Association of Private Enterprises (AFEP) committed to a voluntary CE approach (Eiffage, 2018). AFEP initiated 'Noé', a physical platform in Bordeaux that pools the needs of 170 members (SMEs, demolition firms) to manage logistics, storage, and material recovery. Another example is *Valobat and Collective Action* created by constructors and distributors to implement EPR requirements (Graaf et al. 2024). This initiative manages and collects construction waste, enabling free collection for builders and fostering a 'cradle-to-cradle' approach.

EU bloc

Overall, in the EU bloc, private investment is a key driver of innovation, infrastructure and development with growing private financial contribution to CE activities supporting recycling technologies, sustainable production, and waste management. The increase in private investment reflects the growing economic benefits of CE, particularly, companies' awareness of the financial benefits of reducing waste, reusing materials, and improving resource efficiency. It also reflects EU's commitment to broader economic planning and industrial strategies (Grybaitė & Burinskienė, 2024).

Funded by UKRI Engineering and Physical Sciences Research Council

References

Adams, K. T., M. Osmani, T. Thorpe., & J. Thornback. (2017). Circular economy in construction: Current awareness, challenges and enablers. *Proceedings of the Institution of Civil Engineers—Waste and Resource Management*, *170*(1), 15 - 24.

Ahuja, J., Dawson, L., & Lee, R. (2020). A circular economy for electric vehicle batteries: Driving the change. *Journal of Property, Planning & Environmental Law, 12*(3), 235-250.

Akinade, O. O., Oyedele, L. O., Ajayi, S. O., Bilal, M., Alaka, H. A., Owolabi, H. A., ... & Kadiri, K. O. (2017). Design for deconstruction (DfD): Critical success factors for diverting end-of-life waste from landfills. *Waste Management*, *60*, 3-13.

Asian Development Bank (2024). From building information modelling to society 5.0: Digital transformation and sustainability in Japan and abroad. Available at: https://www.adb.org/sites/default/files/publication/1001271/adbi-building-information-modeling-society-50-digital-transformation-and-sustainability-japan-and.pdf.

Auto Recycling World (2025). France's recycler mon véhicule: A scalable model for the future of end-of-life vehicle recycling. Available at: https://autorecyclingworld.com/frances-recycler-mon-vehicule-a-scalable-model-for-the-future-of-end-of-life-vehicle-recycling/.

Baldassarre, B., Schepers, M., Bocken, N., Cuppen, E., Korevaar, G., & Calabretta, G. (2019). Industrial Symbiosis: Towards a design process for eco-industrial clusters by integrating circular economy and industrial ecology perspectives. *Journal of Cleaner Production*, *216*, 446-460.

Battery Pass Ready (2025). Now published: Data attribute longlist v1.3. Available at: https://thebatterypass.eu/news/now-published-data-attribute-longlist-v1-3/

BAU (2024). Increased productivity through modular, serial construction. Available at: https://bau-muenchen.com/en/trade-fair/press/press-releases/detail/increased-productivity-through-modular-serial-construction.html#:~:text=Denny%20Ohnesorge%20of%20the%20Federation,policy%20for%20climate%2Dfriendly%20construction.

BMW Group (2026). The new BMW i3: Second Neue Klasse model continues holistic approach to sustainability. Available at: https://www.press.bmwgroup.com/global/article/detail/T0455828EN/the-new-bmw-i3:-second-neue-klasse-model-continues-holistic-approach-to-sustainability?language=en

Bocken, N., & Shirahada, K. (2025). Circular business models in Japan: Analysis of circular business transformation through an institutional approach. *Sustainable Production and Consumption*, *54*, 389-403.

Bonsu, N. O. (2020). Towards a circular and low-carbon economy: insights from the transitioning to electric vehicles and net zero economy. *Journal of Cleaner Production, 256*, 120659.

Boons, F., Chertow, M., Park, J., Spekkink, W., & Shi, H. (2017). Industrial symbiosis dynamics and the problem of equivalence: Proposal for a comparative framework. *Journal of Industrial Ecology, 21,* 938e952.

Brandão, D., Gonçalves, M., & Teixeira, J. (2021). Reverse logistics in construction and demolition waste: A literature review. *Waste Management and Research,* 39(10), 1234–1251.

Businesswire (2025). Netherlands prefabricated construction market databook 2025. Available at: https://www.businesswire.com/news/home/20250818339056/en/Netherlands-Prefabricated-Construction-Market-Databook-2025-Prefab-Housing-Could-Reach-Around-Half-of-Residential-Builds-by-2030-with-Panelized-and-Modular-Systems-Becoming-the-Dominant-Approach---ResearchAndMarkets.com

CEC (2025) Directive EU 2025/1892 amending Directive 2008/98/EC on waste. Commission of the European Communities. Brussels.

CATL (2025). Brunp recycling leads the formulation of battery recycling standards. Available at: https://www.catl.com/en/news/6595.html#:~:text=Xie%20Zaichun%2C%20Deputy%20Director%20of,%2D%20recycled%20materials%20%2D%20remanufacturing%22.

Charef, R., Lu, W., & Hall, D. (2022). The transition to the circular economy of the construction industry: Insights into sustainable approaches to improve the understanding. *Journal of Cleaner Production*, *364*, 132421.

Chen, R. (2023). China's circular economy policies: Review and reflection. https://circulareconomy.europa.eu/platform/en/knowledge/chinas-circular-economy-policies-review-and-reflection

Circularity Gap Report – CGR (2022). Drive a clean mobility forward. Available at: https://dashboard.circularity-gap.world/report/sweden/clean-mobility

Climate Catalyst (2025). Green public procurement: Italy's minimum environmental criteria. Climate Catalyist Report. Available at: www.climatecatalyst.org.

Climate Change Laws (2022). National waste plan 2027: From recycling to circular economy. Available at: https://climate-laws.org/document/national-waste-plan-2027-from-recycling-to-circular-economy_b360

Climate Home News (2026). China maximises battery recycling to shore up critical mineral supplies. https://www.climatechangenews.com/2026/02/09/china-maximises-battery-recycling-to-shore-up-critical-mineral-supplies/#:~:text=Recycling%20expertise%20in%20demand,critical%20minerals%2C%20EV%20batteries%2C%20Recycling

Condotta, N., & Zatta, F. (2021). CE- marketing reclaimed construction products: Regulatory challenges and opportunities under the EU construction products regulation. *Construction Law International 16*(4), 33 - 41.

Cramer, J. (2021). The transition to sustainable concrete in the Netherlands through network governance. Available at: https://www.betonakkoord.nl/wp-content/uploads/sites/43/193234/iabse-keynote-concrete-agreement.pdf

Densley Tingley, D., Davison, B., & Garmston, H. (2017). Design for deconstruction and reuse: steel structures. *Proceedings of the Institution of Civil Engineers – Energy, 170*(1), 59 - 66.

Du, B., Bryson, J. R., & Qamar, A. (2025). Aspiring towards automotive circularity: A critical review and research agenda. *Journal of Environmental Management*, *380*, 125150.

DW (2023). German EV manufacturers - greener than the rest? Available at: ß https://www.dw.com/en/german-ev-manufacturers-greener-than-the-rest/video-67392885#:~:text=German%20EV%20makers%20lead%20the,dw.com/p/4Yly1

Eiffage (2018). Noé platform: the first physical platform of circular economy organized in Bordeaux. Available at: https://www.eiffage.com/en/media/news/noe-platform-the-first-physical-platform-of-circular-economy-organized-in-bordeaux

Ericsson, F., Mjörnell, K., & Janson, U. (2024). Reuse of building materials - the perspective of Swedish clients. *Cleaner Engineering and Technology*, *23*, 100848.

European Commission (2017). Public procurement for a circular economy. Available at: https://circulareconomy.europa.eu/platform/en/knowledge/public-procurement-circular-economy

European Commission (2025a). CCRI success: Tampere region gives new life to used building materials and industrial material flows. Available at: https://circular-cities-and-regions.ec.europa.eu/news/ccri-success-tampere-region-gives-new-life-used-building-materials-and-industrial-material#:~:text=Finland's%20Tampere%20region%20has%20successfully,standard%20for%20reused%20construction%20materials.

European Commission (2026). Circular economy. Available at: https://environment.ec.europa.eu/strategy/circular-economy_en

European Commission (2025b). Moving towards a more circular automotive sector with agreement on end-of-life vehicles. Available at: https://ec.europa.eu/commission/presscorner/detail/en/ip_25_3043.

European Union (2026a). Launch of the Nordic Ecosystem for Circular Construction. Available at: https://circulareconomy.europa.eu/platform/en/news-and-events/all-events/launch-nordic-ecosystem-circular-construction#:~:text=Start/End%20date,sustainable%20practices%20across%20the%20region

European Union (2026b). Danish strategy for circular economy. Available at: https://circulareconomy.europa.eu/platform/en/strategies/danish-strategy-circular-economy#:~:text=In%202018%2C%20the%20Danish%20Ministry,out%20of%20buildings%20and%20biomass.

Eurostat (EU) (2024). EU exported 32 million tonnes of waste in 2022. https://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20240118-1

Fang H., Ming, L., & Guangli, Lu. (2025). Mapping two decades of China's industrial policies. Available at: https://fsi9-prod.s3.us-west-1.amazonaws.com/s3fs-public/2025-07/mapping_chinas_industrial_policies_7.1.25.pdf

Finnish Ministry of the Environment (2026). Construction Act streamlines construction and promotes emission reductions and circular economy. Available at: https://ym.fi/en/construction-act.

Fric, U., Levnajić, Z., Modic, D., & Rončević, B. (2025). Industrial symbiosis networks supporting circularity: Understanding complexity, cyclicality and resilience. *Environmental Technology & Innovation*, *37*, 104026.

Geissdoerfer, M., Morioka, S. N., de Carvalho, M. M., & Evans, S. (2018). Business models and supply chains for the circular economy. *Journal of Cleaner Production*, *190*, 712-721.

Government of the Netherlands (2023). National Circular Economy Programme 2023-2030. Available at: https://www.government.nl/documents/reports/2023/09/27/national-circular-economy-programme-2023-2030.

Graaf, L., Toth, Z., Broer, R., & Oriol, J. (2024). Extended producer responsibility in the construction sector. Available at: https://www.bpie.eu/wp-content/uploads/2024/06/Extended-Producer-Responsibility-in-Construction-June-2024.pdf

Grandview Research (2026). Germany electric vehicle (EV) battery recycling market size and outlook. Available at: https://www.grandviewresearch.com/horizon/outlook/electric-vehicle-ev-battery-recycling-market/germany

Green Building Council Finland (2024). Policy pathways for fostering circular transition in construction in the Nordic region. Nordic Council of Ministers. Available at: https://figbc.fi/julkaisut/fostering-circular-transition-nordic-region

Green Alliance (2025). Circular economy policy in the UK: A post-Brexit review. Available at: https://green-alliance.org.uk/briefing/circular-economy-policy-in-the-uk-a-post-brexit-review/

Griffiths, P., Itanola, M., Andabaka, A., & Atstāja, D. (2025). Hurdles to a circular built environment: A look at the economic and market barriers. *Buildings*, *15*(8), 1332.

Grybaitė, V., & Burinskienė, A. (2024). Assessment of circular economy development in the EU countries based on SAW method. *Sustainability*, *16*(21), 9582.

GOV.UK (2026). Circular economy taskforce. Available at: https://www.gov.uk/government/groups/circular-economy-taskforce

Gulipac, S. (2016). Industrial Symbiosis: Building on Kalundborg's waste management experience. *Renewable Energy Focus*, *17*(1), 25-27.

Guo, F. (2025). Impact mechanism in circular public procurement: Empirical insights from traditional public procurement and public private partnership in China. *International Journal of Economics and Finance*, *17*(3), 122.

Green Alliance, 2025. Circular economy policy in the UK: A post Brexit review. Available at: https://green-alliance.org.uk/briefing/circular-economy-policy-in-the-uk-a-post-brexit-review/#:~:text=Latest%20thinking,13%20January%2C%202026.

Hage, R. (2025). The untaped potential of Japanese wood joinery in American construction. Available at: https://www.structuremag.org/article/the-untapped-potential-of-japanese-wood-joinery-in-american-construction/.

Hart, J., Adams, K., Giesekam, J., Tingley, D. D., & Pomponi, F. (2019). Barriers and drivers in a circular economy: The case of the built environment. *Procedia CIRP* 80: 619–624.

Haxholm, L. G., & Konnerup, P. (2025). Denmark's ambitious new CO_2 standards for construction: What you need to know. Available at: https://www.burohappold.com/news/denmark-sets-stricter-co2-emissions-rules-for-construction-what-you-need-to-know/

Hill, J. (2016). Circular economy and the policy landscape in the UK. In: Clift, R., & Druckman, A. (eds) Taking stock of industrial ecology. Springer Nature: London. Available at: https://doi.org/10.1007/978-3-319-20571-7_13.

Hoppe, C., Schoormann, T., Winkelmann, S., & Möller, F. (2025). Tensions in implementing a circular economy - Empirical insights from the automotive industry. *Computers & Industrial Engineering*, *204*, 111090.

Iqbal, M., Fan, Y., Ahmad, N., & Ullah, I. (2025). Circular economy solutions for net-zero carbon in China's construction sector: A strategic evaluation. *Journal of Cleaner Production*, *504*, 145398.

Jaeger, J. (2025). These countries are adopting electric vehicles the fast. Available at: https://www.wri.org/insights/countries-adopting-electric-vehicles-fastest

Jegen, P., Huber, O., Gast, L., & Faulstich, M. (2025). Mapping urban building material stocks to understand potentials for circular construction: A case study in Germany's Ruhr area. *Sustainable Cities and Society*, 106942.

Jensen, V. (2024). Did you know? Europe's dirty secret. Available at: https://www.thenewfederalist.eu/did-you-know-europe-s-dirty-secret?lang=fr

J & T Recycling Corporation (2026). Horizontal recycling. Available at: https://www.jt-kankyo.co.jp/en/circular_economy/horizontal.html

Jin, R., Li, B., Zhou, T., Wanatowski, D., & Piroozfar, P. (2017). An empirical study of perceptions towards construction and demolition waste recycling and reuse in China. *Resources, Conservation and Recycling*, *126*, 86-98.

Junior, A. B. B., Martins, F. P., Cezarino, L. O., Liboni, L. B., Tenório, J. A. S., & Espinosa, D. C. R. (2023). The sustainable development goals, urban mining, and the circular economy. *The Extractive Industries and Society*, *16*, 101367.

Kayikci, Y., Kazancoglu, Y., Lafci, C., Gozacan, N. (2021). Exploring barriers to smart and sustainable circular economy: The case of an automotive eco-cluster. *Journal of Cleaner Production, 314,* 127920.

Konietzko, J., Bocken, N., & Hultink, E. J. (2020). Circular ecosystem innovation: An initial set of principles. *Journal of Cleaner Production*, *253*, 119942.

Küpfer, C., Bastien-Masse, M., & Fivet, C. (2023). Reuse of concrete components in new construction projects: Critical review of 77 circular precedents. *Journal of Cleaner Production*, *383*, 135235.

Liaise (2025). Industrial symbiosis from a business perspective: Challenges and opportunities. Available at: https://www.liaise-action.eu/wp-content/uploads/2025/07/PROCEDEINGS-2-REV02.pdf

Liu, J., Teng, Y., Wang, D., & Gong, E. (2020). System dynamic analysis of construction waste recycling industry chain in China. *Environmental Science and Pollution Research*, *27*(30), 37260-37277.

Losa, R., & Torjesen, S. (2025). The quest for more circular battery value chains: Implementing the EU digital battery passport and remaining challenges. *Cleaner Production Letters*, 100118.

Marino, A., & Pariso, P. (2020). Comparing European countries' performances in the transition towards the Circular Economy. *Science of the Total Environment*, *729*, 138142.

Matthias, U. (2024). Ecological footprint at the touch of a button, right from the design stage: Die Werkbank IT GmbH and EPEA develop first BIM-based Building Circularity Passport. https://diewerkbank.eu/en/bim-more-blog/passport

Michalik, C. (2024). Challenges and implications of the AGEC Law for France's end-of-life vehicle centers. Available at: https://autorecyclingworld.com/challenges-and-implications-of-the-agec-law-for-frances-end-of-life-vehicle-centers/#:~:text=This%20law%20requires%20each%20vehicle,will%20allow%20them%20to%20operate.

Ministry of Climate and Environment (2024). Action Plan for a Circular Economy. Available at: https://www.regjeringen.no/contentassets/0173313ba73941c6b5072c5a0ee27434/en-gb/pdfs/handlingsplan-sirkulaer-okonomi_eng.pdf

Modus (2020). Five Dutch masters of circular construction. Available at: https://ww3.rics.org/uk/en/modus/built-environment/construction/dutch-masters.html#:~:text=Stadstuin%20Overtoom%20Amsterdam,generates%20energy%20sustainably%20on%20site.

Montemayor, H. M. V., & Chanda, R. H. (2023). Automotive industry's circularity applications and industry 4.0. *Environmental Challenges*, *12*, 100725.

Mostert, C., Weber, C., & Bringezu, S. (2022). Modelling and simulation of building material flows: Assessing the potential for concrete recycling in the German construction sector. *Recycling*, 7(2), 13.

Mubarik, M.S., Kontoleon, A., & Shahbaz, M. (2024). Beyond the hurdles: exploring policy obstacles in the path to circular economy adoption. *Journal of Environmental Management, 370,* 122667.

Nicolas, J., & Sébastien, B. (2026). Barriers to reuse in the construction sector: A circular value chain perspective. *Business Strategy and the Environment*. DOI: https://doi.org/10.1002/bse.70549

Northvolt (2022). Europe's largest electric vehicle battery recycling plant begins operations. Available at: https://northvolt.com/articles/hydrovolt/#:~:text=Europe's%20largest%20electric%20vehicle%20battery%20recycling%20plant%20begins%20operations&text=As%20commercial%20recycling%20operations%20start,of%20battery%20packs%20by%202030

OECD (2019). OECD environmental performance reviews: Denmark 2019. https://www.oecd.org/en/publications/oecd-environmental-performance-reviews-denmark-2019_1eeec492-en/full-report/component-12.html

OECD (2021). Towards a more resource-efficient and circular economy The role of the G20. Available at. https://www.oecd.org/content/dam/oecd/en/topics/policy-issues/resource-efficiency-and-circular-economy/OECD-G20-Towards-a-more-Resource-Efficient-and-Circular-Economy.pdf

OECD (2024). Socioeconomic impacts of European Union circular textiles policies on trading partners. Available at: https://www.oecd-events.org/garment/session/6130b1b8-8ed2-ef11-88cf-6045bd903ca2/impact-of-eu-circular-textile-policies-on-european-partner-trading-countries-the-case-of-bangladesh-and-ghana.

Olsson, L., Fallahi, S., Schnurr, M., Diener, D., & Van Loon, P. (2018). Circular business models for extended EV battery life. *Batteries* 4(4), 57.

Osmanovic, S., Barth, H., & Ulvenblad, P. (2026). Paradoxical tensions in sustainable transitions en route to circular economy: the dynamic role. *Critical Perspectives on International Business*, forthcoming https://doi.org/10.1108/cpoib-08-2024-0099

PACE (2023). The circularity gap report 2020. Available at: https://pacecircular.org/sites/default/files/2020-01/Circularity%20Gap%20Report%202020.pdf

PRAMO (2025).Why modular construction in Germany is the future of building excellence. Available at: https://www.pramoprefabricated.com/modular-construction-in-germany/#:~:text=Firstly%2C%20Efficiency%20and%20Speed%20are,modern%20modular%20construction%20in%20Germany.

Regjeringen (2026). Norway's strategy for developing a green, circular economy. Available at: https://www.regjeringen.no/contentassets/a116f209e493471bb26c81cf645152a3/kld_strategi_sirkularokonomi_sammendrag_eng_0507.pdf

Renault Group (2024). Refactory: the Flins site enters the circle of the circular economy. Available at: https://www.renaultgroup.com/en/magazine/sustainable-development/re-factory-the-flins-site-enters-the-circle-of-the-circular-economy/

Renault Group (2026). The Future is NEUTRAL, innovating in the circular economy. Available at: https://www.renaultgroup.com/en/group/brands-entities/the-future-is-neutral/.

Renovate Europe (2024). Monitoring the national recovery and resilience plans – Germany. Available at: https://www.renovate-europe.eu/monitoring-the-national-recovery-and-resilience-plans-germany/#:~:text=In%20total%2C%20Germany%20plans%20to,on%20the%20signed%20operational%20arrangements)

Ruismäki, W., Zu Castell-Rüdenhausen, M., Pohjalainen, E., & Wahlström, M. (2025). Stakeholder perspectives on digital product passports for construction products. *Cleaner Logistics and Supply Chain*, 100275.

Schut, E., Crielaard, M., & Mesman, M. (2016). Circular economy in the Dutch construction sector: A perspective for the market and government. Available at: https://rivm.openrepository.com/entities/publication/bf4d441c-20d8-4c7d-a0c5-73fbebf5a231.

SDG 12 Hub (2021). Strategic programme to promote a circular economy. https://www.oneplanetnetwork.org/knowledge-centre/policies/strategic-programme-promote-circular-economy

Selvaraju, S., & Nicholls, M. (2026). Green public procurement. Italy's minimum environmental criteria. Available at: https://climatecatalyst.org/wp-content/uploads/2026/02/Green-Public-Procurement-Italys-Minimum-Environmental-Criteria.pdf.

Shinka Management (2026). Japan housing mission. Available at: https://shinkamanagement.com/japan-housing-mission/#:~:text=The%20integration%20of%20modular%20design,solutions%20to%20global%20housing%20challenges.

Silvestri, F., Spigarelli, F., & Tassinari, M. (2020). Regional development of Circular Economy in the European Union: A multidimensional analysis. *Journal of Cleaner Production*, *255*, 120218.

Smart Energy Management (2025). Vianode and Fortum battery recycling join forces to advance sustainable EV battery recycling value chain. Available at: https://smartenergy.news/article/121762/Vianode_and_Fortum_Battery_Recycling_join_forces_to_advance_sustainable_EV_battery_recycling_value_chain#:~:text=Vianode%20is%20an%20advanced%20battery,world%2Dleading%20financial%20company%20Altor.&text=Fortum%20Battery%20Recycling%20offers%20recycling,part%20of%20Fortum%20business%20portfolio.

Sonar, H., Mukherjee, A., Gunasekaran, A., & Singh, R. K. (2022). Sustainable supply chain management of automotive sector in context to the circular economy: A strategic framework. *Business Strategy and the Environment*, *31*(7), 3635-3648.

Soufi, C., Ayadi, A., Mesbahi, T., Samet, A., & Lallement, C. (2026). BPO—A battery production ontology for traceable, transparent, and sustainable electric vehicle batteries. *Journal of Web Semantics*, 100877.

Stellantis (2023). Stellantis inaugurates its first circular economy hub in Turin, Italy. Available at: https://www.stellantis.com/en/news/press-releases/2023/november/stellantis-inaugurates-its-first-circular-economy-hub-in-turin-italy

Stellantis (2024). Stellantis circular economy reported strong growth in 2023 and is on track to increase this trend in 2024. Available at: https://www.media.stellantis.com/em-en/corporate-communications/press/stellantis-circular-economy-reported-strong-growth-in-2023-and-is-on-track-to-increase-this-trend-in-2024

Stretton, C., Buzeti, Z., & Daphne, T. (2025). EU battery passport regulation requirements. Available at: https://www.circularise.com/blogs/eu-battery-passport-regulation-requirements#:~:text=Battery%20Regulation%20implementation.-,Interoperable%2C%20transferable%2C%20and%20trustworthy%20battery%20passports.which%20excel%20in%20data%20immutability.

Stritch, J. M., Darnall, N., Hsueh, L., & Bretschneider, S. (2018). Green technology firms and sustainable public purchasing. *IEEE Engineering Management Review*, *46*(1), 128-131.

Sweden Herald (2025). Building a sustainable future. What modular architecture tells us. Available at: https://swedenherald.com/article/building-a-sustainable-future-what-modular-architecture-tells-us

Tagesspiegel Background (2024). Circular economy: Thinking about the environment, climate and economy together. Available at: https://www.vda.de/en/news/articles/2024/guest-article-circular-economy

Tanabe, Y. (2024). Japan and the EU need to work together to present a circular economy model to the world. Available at: https://www.rieti.go.jp/en/columns/a01_0775.html#:~:text=Japan's%20Circular%20Economy%20Vision%20was%20formulated%20in,Environmental%20constraints%20and%20risks%20*%20Growth%20opportunities

Thalberg, K. (2022). The Swedish energy transition. A race far from won, Policy brief, Paris: Jacques Delors Institute. Available at: https://institutdelors.eu/en/publications/the-swedish-energy-transition-a-race-far-from-won-2/

The Nordic Corporation (2026). Nordic Network for Circular Construction. Available at: https://www.norden.org/en/publication/nordic-networks-circular-construction

Udendhran, R., Mohan, T. R., Uthra, R. A., Selvakumarasamy, S., Dinesh, G., Mukhopadhyay, M., ... & Chakraborty, P. (2025). Transitioning to sustainable E-vehicle systems–Global perspectives on the challenges, policies, and opportunities. *Journal of Hazardous Materials Advances*, *17*, 100619.

UNDP (2026). From informal recycling to a national circular economy hub: Lessons from Ziya circular economy park in Tianjin, China. Available at: https://www.undp.org/chemicals-waste/blog/informal-recycling-national-circular-economy-hub-lessons-ziya-circular-economy-park-tianjin-china#:~:text=The%20establishment%20of%20Ziya%20Circular,and%20other%20materials%20each%20year.

UniSA Enterprise Hub (2025). Insights from Japan's Prefabrication and Modular Construction Models. Available at: https://shinkamanagement.com/event-report-japan-prefabricated-housing/#:~:text=Comparing%20Australia%20to%20global%20leaders,and%20regulators%20along%20with%20us."

Urbinati, A., Franzò, S., & Chiaroni, D. (2021). Enablers and barriers for circular business models: An empirical analysis in the Italian automotive industry. *Sustainable Production and Consumption*, *27*, 551-566.

van Andel, F. (2012). Villa Welpeloo Enschede: 2012Architecten. *DASH| Delft Architectural Studies on Housing*, *7*, 148-155.

Vanhuyse, F., André, K., & Henrysson, M. (2021). Circular procurement for a sustainable future. Available at: https://www.sei.org/features/circular-procurement-for-a-sustainable-future/

Yoshio (2026). Japan electric vehicle market is accelerating toward a cleaner mobility future. Available at: https://vocal.media/01/japan-electric-vehicle-market-is-accelerating-toward-a-cleaner-mobility-future

Yu, Y., Yazan, D. M., Bhochhibhoya, S., & Volker, L. (2021). Towards Circular Economy through Industrial Symbiosis in the Dutch construction industry: A case of recycled concrete aggregates. *Journal of Cleaner Production*, *293*, 126083.

Wadström, C., Johansson, M., & Wallen, M. (2021). A framework for studying outcomes in industrial symbiosis. *Renewable and Sustainable Energy Reviews*, *151*, 111526.

World Economic Forum (2024). How Japan is promoting sustainability across its built environment. Available at: https://www.weforum.org/stories/2024/04/japan-circular-built-environment/#:~:text=The%20Japanese%20government%20has%20been,after%20the%20buildings%20are%20demolished.

WRAP (2026). WRAP and the circular economy. Available at: https://www.wrap.ngo/taking-action/climate-change/circular-economy#:~:text=WRAP%20is%20working%20in%20the%20following%20sectors:,are%20designed%20and%20made%20with%20recycled%20materials

Zhang, T., Chu, J., Wang, X., Liu, X., & Cui, P. (2011). Development pattern and enhancing system of automotive components remanufacturing industry in China. *Resources, Conservation and Recycling*, *55*(6), 613-622.

Zhang, Y., Pan, M., Pan, W., Yang, Y., & Wu, J. (2024). Enhancing modular construction supply chain: Drivers, opportunities, constraints, concerns, strategies, and measures. *Developments in the Built Environment*, *18*, 100408

Zhao, K. (2021). Industrial symbiosis: practices in China's industrial parks. Available at: https://journals.openedition.org/factsreports/6635?lang=fr



Thank you to our partners.

Contact: pactcentre@leeds.ac.uk

pact.ac.uk

Engineering and Physical Sciences Research Council

UNIVERSITY OF LEEDS

MANCHESTER 1824
The University of Manchester

UNIVERSITY OF SUSSEX