CIWM

Lost Opportunities?

Winning back materials to drive the UK's circular economy

CIWM Presidential Report June 2025

Dr. David Greenfield
President of CIWM 2025/26

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Foreword
A call to action to capture our lost resources

We live in a world increasingly shaped by what we throw away. From the everyday waste generated in our homes and workplaces, to construction and demolition materials, surplus agricultural output, and even debris from space exploration – waste is a defining challenge of our time. It mirrors our consumption patterns, economic priorities, and systemic inefficiencies.

This report sets out not only the scale of the challenge but the urgency of a **co-ordinated, cross-sector response**. Waste is no longer just a by-product of progress – it is an indicator of unsustainable systems and **lost opportunity**. Whether its food wasted while millions go hungry, valuable materials lost to landfill, or microplastics in our oceans, we are squandering resources our planet and our UK economy cannot afford to lose.

Waste is a design flaw, not an inevitability. And with the right policies, practices and mindsets, we can correct it. We must accelerate a shift to circular systems that retain value, prevent pollution, extend life and prioritise regeneration over extraction. That journey starts with reimagining waste not as an end point, but as a beginning – an opportunity for innovation, resilience and equity.

For product designers

This report is a call to embed circular principles at the earliest stages of design. From consumer goods to industrial infrastructure, we must design for longevity, disassembly, reuse and adaptability. Think beyond single-life cycles. Design products and systems that serve multiple purposes, use fewer virgin materials, and utilise materials that can return safely to nature or industry.

For policymakers

Our report shows that it is time to adopt bold, integrated strategies that treat all waste streams – from municipal and commercial to agricultural and construction – as interconnected. Good legislation can provide the pull factor to achieve the desirable outcomes. It can also level the playing field for stakeholders and provide the right conditions for investment.

There are opportunities to: **Align** waste policy with climate, health and economic development goals; **Introduce** binding prevention targets; **Incentivise** circular business models, and; **Support** innovation hubs.

All these measures provide real opportunities to turn local waste into local opportunities. We must not overlook the frontier of space waste – regulations must evolve to capture materials for future generations.

For chartered waste managers

The report lays out how you can be the architects of the transition from linear to circular. There are clear opportunities to embrace systems thinking and to design services that reduce waste generation, support reuse and repair, and recover value in ways that benefit communities. Now is the time to lead efforts to professionalise reuse logistics, measure carbon impacts and make the invisible visible – particularly around scope 3 emissions and embedded resource footprints.

For citizens

Our report shows that action begins with awareness and agency.
We can all:
Rethink consumption;
Reduce what we don't need;
Repair what we can;
Reuse what still has life;
Recycle only as a last resort;
Engage with local reuse schemes, community composting and zero-waste initiatives, and;
Advocate for change in our schools, workplaces and councils.

Foreword
A call to action to capture our lost resources

This report highlights the urgent need – and the real opportunity – for the UK to lead in the transition to a circular, inclusive and resource-efficient economy. Across diverse sectors, geographies and waste streams, the evidence is clear: Business as usual is no longer acceptable. The current linear model of take-make-dispose is undermining economic and environmental resilience as well as social equity. In contrast, circular interventions – rooted in reduction, reuse, repair and redesign – offer credible, scalable solutions with tangible benefits.

The complexities and scale of the challenges ahead are daunting, but as with any challenge, it often begins with taking a step back, assessing the issues and breaking the solutions down into manageable pieces.

The report therefore focuses on six commonly overlooked materials lost to the economy in the UK and overseas. Some of these materials are key in the transition to net zero and classed as critical by government. Through improvements in collection, policy interventions and circular innovation there are opportunities to harness these resources, benefiting the environment, society and the UK economy.

Our findings highlight both the challenges and opportunities we face, reinforcing the importance of rethinking not just how we manage waste, but how we define and prevent it. Collaboration is needed across value chains and new models of ownership, service delivery and public engagement. This report provides evidence and insights to guide our response informed by international policy and practice. But knowledge alone is not enough. We need action - coordinated, courageous and consistent. Let this be the moment we step up, reach across sectors and turn waste from a symbol of failure into a source of possibility.

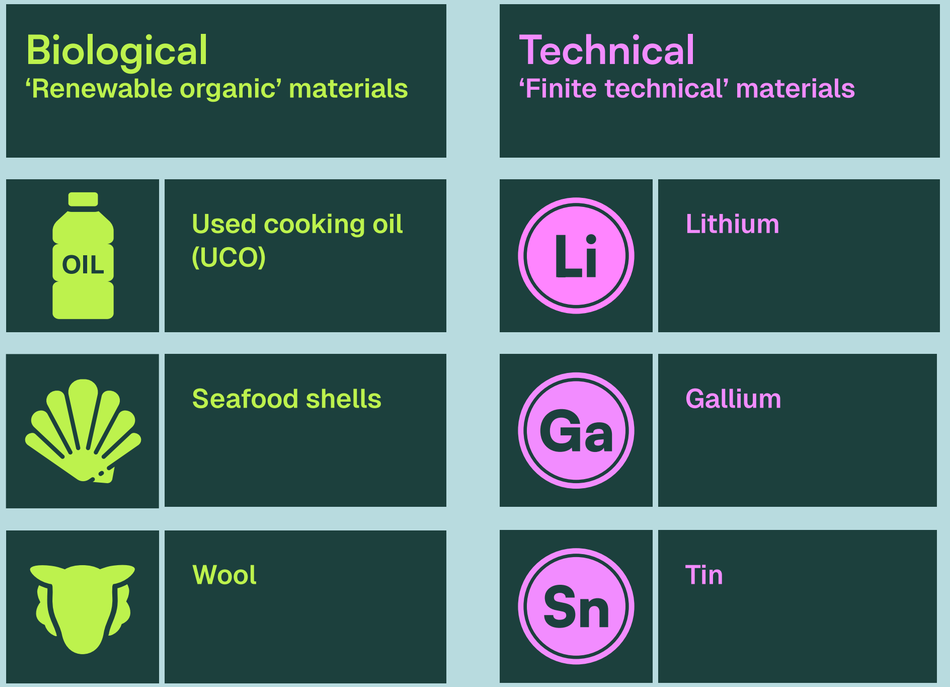
Dr. David Greenfield
President of CIWM 2025/26

Executive summary

We live in a world where valuable resources are readily squandered — lost.

Across the world a vast array of materials are discarded in residual waste, dumped or burnt. Recovering these resources presents opportunities to reduce the consumption of virgin materials, address resource security and increase UK productivity through domestic reprocessing.

This report highlights the global challenges of lost materials, and examines six of the many often-overlooked materials that are lost to the UK economy — all classified as critical minerals by UK government due to supply risks.



The report assesses how much of each material is generated and why, and presents current management pathways. The report also identifies circular innovations to harness these resources, and explores what the UK could learn from international practice, including policy to support the recovery of these materials.

Executive summary

Material specific findings

Used Cooking Oil (UCO)
Most UK household UCO is not recovered, instead entering residual waste or sewers, where it causes blockages. Biofuels are the main end-use market, but the UK relies heavily on imports of UCO to meet biofuel demand, with increased concerns over sustainability and fraud. Emerging opportunities for UCO include biopolymers and road construction, with increased potential recovery opportunities through Extended Producer Responsibility and in-store collection points —both of which are already implemented in other countries.

Seafood shells
Globally most shells are treated as by-products and enter residual waste, and the UK alone generates 30,000 tonnes/annum of scallop, cockle and whelk shells. A key emerging market is extracting natural polymers from shells for a range of applications including in packaging and textiles as an alternative to synthetic materials. Other opportunities include construction, conservation and agriculture.

Wool
With the income from wool sales no longer covering shearing costs, an estimated 20% of UK wool does not make it to market. Some countries discard wool as a by-product of food production. Innovation is driving new markets including insulation, soil amendments, and sound absorbers – boosting demand and supporting wool prices.

Lithium
Approximately 87% of lithium is used in rechargeable Li-ion batteries, and non-rechargeable primary batteries. Recovering lithium remains technically and economically challenging. Additionally, battery-related fires are a significant issue, costing the UK over £1 billion annually. With growing supply concerns, there is increasing investment in domestic recovery infrastructure. Businesses repurpose rechargeable Li-ion batteries for energy storage thereby extending battery life. Potential UK policy opportunities to stimulate investment could include specific lithium battery collection targets and mandatory recycled content targets in batteries.

Gallium
Through its use in integrated circuits gallium is present in most electronic and electrical equipment. Despite its value and relative scarcity, no end-of-life gallium recycling currently takes place due to its use in dispersed small quantities, and the difficulty of separating it from other materials. Whilst pilot/ demonstration projects show it is possible to recover gallium, policy interventions are needed to scale-up these solutions.

Tin
Through its use in solder, tin is present in virtually all electronic and electrical equipment. Large amounts of tin are lost in the processing of e-waste with focus on extracting other metals. The small quantities of tin in products also present challenges to recovery. Research shows promising results in recovering tin from end-of-life waste - the next step is to scale these solutions – policy interventions are needed to facilitate this.

Executive summary

Themes across materials

Innovation and environment:
The report highlights the versatility of the six materials with numerous circular and industrial symbiosis opportunities demonstrating environmental savings compared to virgin materials or traditional sources. These materials also have important roles in the net zero transition.

Supply and value chain:
There is an increased focus on material and product traceability, and quality to meet industry requirements. With investment in domestic infrastructure to recover these materials, it is possible to grow the UK economy whilst addressing supply security and providence risks.

Policy opportunities for the UK:
International policies facilitating the collection and processing of these materials include economic instruments, procurement policies and targets.

Challenges:
The infrequent generation, relatively small quantities of material, and the way products are designed present economic and technological challenges to recover the materials, and commercial scale-up of innovation. There are key data gaps on resource stocks and flows needed to inform government policy, and investment decisions. Past publicly funded research is no longer openly available – information is lost – this is particularly important for niche materials where limited research has been undertaken.

Recommendations

01 **Align UK policy to capture ‘lost’ resources:**
Evaluate policy opportunities to facilitate change and recover lost resources based on international practice.

02 **Develop the business case to capitalise on ‘lost’ opportunities:**
Evaluate the economic, environmental and social implications for collecting and processing materials lost in the UK.

03 **Align public sector procurement policies to stimulate the demand for UK materials and recovery of ‘lost’ resources**

04 **Co-ordinated cross-sector collaboration:**
There is the opportunity for CIWM to take a strategic leadership role engaging with other trade associations and professional bodies to highlight the benefits and opportunities in circularity.

05 **Implement a National Material Data Hub**

06 **Implement a co-ordinated cross-organisational open access research repository**

1. Introduction

1. Introduction

This report is in three parts and examines how and why six often-overlooked materials represent lost opportunities in the shift to a circular economy — specifically in enhancing resource security, reducing reliance on virgin materials and supporting economic growth in the UK.

This report is a summary of the full technical report available to view on the CIWM website which contains the methodology, detailed exploration of each material, case studies of circular innovation in the UK and overseas, and citations to all sources.

1.
Introduction
provides context to the research

2.
Key findings
presents key findings for the six materials and overarching themes

3.
Recommendations
A roadmap for realising the lost opportunities

The report focuses on both cycles of the circular economy

(see Figure 1):

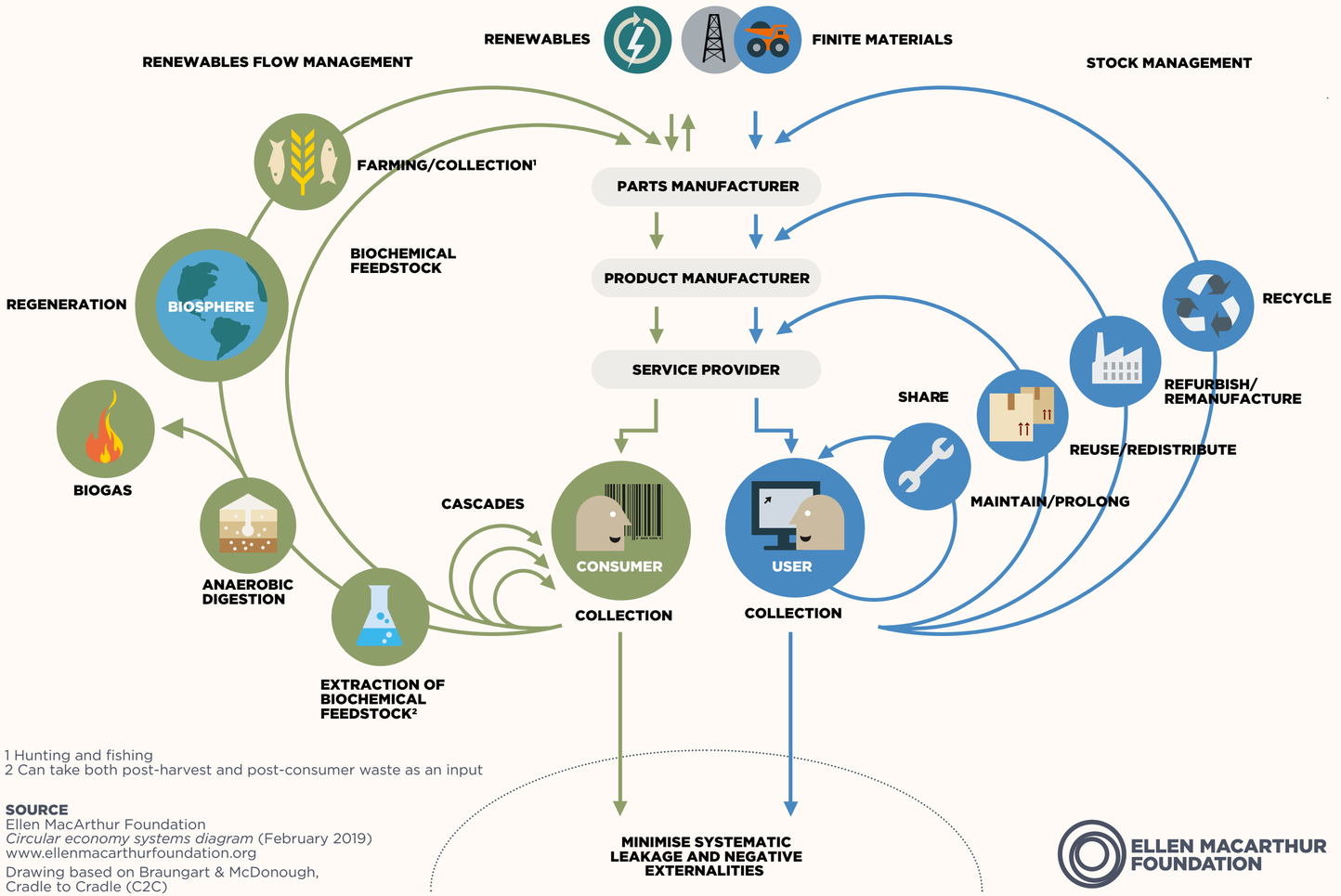
An assessment is presented of how much of each material is wasted and why, plus current and future management pathways. The report identifies UK and overseas innovation to recover materials within circular systems and create new markets. It also explores what the UK could learn from international practice including policy to support the collection and processing of these materials and to commercially scale innovation.

Renewable organic

Used cooking oil (UCO)

Seafood shells

Wool



1 Hunting and fishing
2 Can take both post-harvest and post-consumer waste as an input

SOURCE
Ellen MacArthur Foundation
Circular economy systems diagram (February 2019)
www.ellenmacarthurfoundation.org
Drawing based on Braungart & McDonough, Cradle to Cradle (C2C)

Finite technical

Lithium

Gallium

Tin

Figure 1:
Circular economy butterfly diagram and the six materials included in the report

Credit: Ellen MacArthur Foundation

1.1 Global context

Despite global commitments to reduce carbon emissions, publication of waste strategies and regulations, and the emergence of pioneering circular economy strategies, we continue to live in a world where scarce and valuable resources are all too easily squandered — lost.

They might be discarded in the residual waste stream or – even worse – dumped in communities or openly burned.

In just six years between 2016–2021 the world consumed 582 billion tonnes of virgin resources – in comparison, throughout the entire 20th century 740 billion tonnes were used.

Increased virgin resource use and extraction is the main driver of climate change, biodiversity loss, pollution and waste.

Despite the growing emphasis on circular thinking, virgin materials are increasingly entering the economy. The global share of secondary materials (those recovered, reused and recycled) declined from 7.2% in 2018 to 6.9% in 2021.

The United Nations Environment Program (UNEP) calls for a fundamental restructuring of the global production and consumption system aligned with the global drive to reduce carbon emissions whilst addressing resource supply chain risks.

Globally, 2.7 billion people still do not have their waste collected, equating to 540 million tonnes of municipal solid waste per annum, 27% of the global total. Thirty-eight per cent of this waste is handled without controls to mitigate environmental and public health impacts. Whilst we increasingly focus on circular thinking, in many communities the fundamentals of effective waste management have yet to be implemented.

2.7 billion

People who do not have access to waste collections

27%

Over 1 in 4 citizens worldwide

38%

Municipal solid waste (MSW) disposed of in an uncontrolled manner

540 million tonnes

Uncontrolled MSW disposal

1.2 UK context

The UK uses over 1 billion tonnes of virgin materials per year equating to 15.3 tonnes per capita, well above the global average and the benchmark considered sustainable (Figure 2).

The UK has a circularity rate of 7.5%, with over 90% of material used from virgin sources, of which 80% is extracted overseas.

Across all sectors key resources are being lost. Fifty-six per cent of UK household waste and 65% of English municipal business waste currently enters the residual waste stream. Whilst the recovery rate for UK construction and demolition waste is
94%, this is skewed by the re-use of high density, low value-inert material, with other resources lost.

Recent policy attempts to address the circularity gap, including the UK government establishing a Circular Economy Taskforce to co-design the Circular Economy Strategy for England, follows on from earlier initiatives in Wales, Scotland and Northern Ireland.

Much of UK waste policy under development focuses on packaging waste and this needs to change. Across all sectors a vast array of other materials are lost and discarded in residual waste or lost to the UK economy being processed overseas.

Alongside the Circular Economy Strategy for England, roadmaps are being developed to identify circular economy opportunities in priority, high-impact sectors, namely agri-food, built environment, chemicals, plastics, electrical and electronic equipment, textiles and transport. The findings and recommendations from this report should help shape some of the ongoing strategic development work in England and UK.

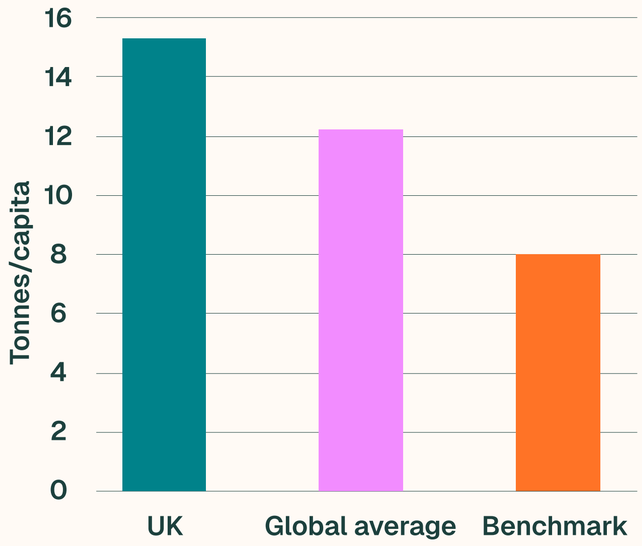


Figure 2:
Annual virgin material use in the UK per capita compared to global average and the ‘sustainable’ benchmark

56% of UK household waste and **65%** of English municipal business waste currently enters the residual waste stream.

2. Key findings

2.1 Material specific findings

The following pages present an overview of findings for each material — including background on the material, challenges and opportunities.

Used Cooking Oil (UCO)

Main sources

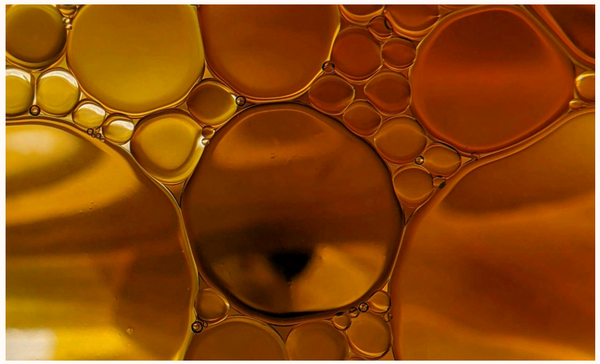
Hospitality

Manufacturing

Households

What is it?

In 2023/24, 218 million tonnes of vegetable oils were consumed globally. Palm, soy and rapeseed oils made up 79% of vegetable oils consumed by weight. UCO is a by-product of cooking using oils. Globally an estimated 15.4 million tonnes of UCO/annum is collected for use in secondary markets. However, large amounts remain uncollected – whilst China is the biggest exporter of UCO, it's estimated only 15% is collected. The global UCO sector is valued at £5-6 billion and the UKs at £255 million – biofuels are the principal UCO market.



Challenges?

Collections: The UK has an established system for collecting UCO from businesses, however, large quantities from households remain uncollected – resources are lost. UCO entering wastewater systems contribute to 300,000 blockages each year costing £200 million to manage.

Biofuels: In 2023 the UK sourced 1.5 billion litres of UCO biofuels from 89 countries – only 4.4% originated from the UK. Concerns surrounding UCO biofuel production include the sustainability of sources and fraud.

Opportunities?

Recovery of household UCO: International practice includes nationwide collection programmes, UCO Extended Producer Responsibility, in-store collection points and awareness raising.

Emerging markets: Biopolymers, road construction, recovery of by-products from biodiesel.

Seafood shells

Main sources

Seafood processing

Manufacturing

Hospitality

What is it?

Shellfish have an exoskeleton – a hard outer structure supporting and protecting the body. Global annual shellfish production stands at 43.5 million tonnes, worth £42 billion. In 2023, 114,600 tonnes of shellfish were landed at UK ports worth £359 million.

The UK also imported 86,326 tonnes of shellfish and Scotland has a thriving aquaculture industry. Shells are a by-product of processing shellfish with global shell estimates ranging from 6–18 million tonnes/annum. Past studies estimate UK arisings at ~100,000 tonnes/annum – recent research estimates 30,000 tonnes/annum of scallop, cockle and whelk shells alone.

Challenges?

Most shells are treated as by-products and enter the residual waste stream in the UK and overseas.

Opportunities?

Market development including:

Chitin and chitosan: Natural polymers with bioactive and biodegradable properties extracted from shells. The global chitosan market is valued at £6–12 billion with UK companies now producing chitosan from UK shells. Applications include pharmaceuticals, medical, packaging and alternatives to synthetic textiles.

Built environment: Calcium carbonate-rich shells can partially replace concrete and lime. In the UK, shells have been utilised in permeable concrete to address urban flooding.

Conservation of aquatic environments: Returning shells to marine habitats can restore pH balance, add essential minerals, restore reefs and boost oyster and kelp populations.

Agriculture: Calcium and nitrogen-rich shells can be returned to soil, addressing pH balance and returning minerals.

Wool (pre-consumer)

Main sources

Farm

Scouring plants

What is it?

Wool is a natural product of the sheep's life cycle. It is versatile, renewable and biodegradable and historically used in garment production. In 2023, 1 million tonnes of clean wool fibre was produced with Australia (26%), China (15%) and New Zealand (9%) the main producers. The UK makes up 2% of the market.

Challenges?

Changing markets: The global textiles market is dominated by synthetics leading to less demand for wool. In 2023 the average UK wool price at auction was 81.9p/kg – to cover shearing costs alone £1.20/kg is needed. With revenue failing to cover costs, an estimated 20% of UK wool does not make it to market – other countries face similar challenges.

Fleece composition: Fort per cent of a fleece consists of by-products removed through the wool cleaning process that require management.

Coarse wool: Most wool is coarse, with limited demand and commanding lower prices. EU countries produce 200,000 tonnes of wool/annum with 70%–80% lost due to lack of markets and economics. The UK has a legacy of processing wool – other countries have historically discarded wool as a by-product of food production.

Opportunities?

New markets: Innovation using wool in new products increases demand and stimulates higher prices.

Examples include: insulation, sound absorbers, fertilisers, and displacing synthetic materials.

By-products recovered: including lanolin for skin care, biological waste for animal feed or energy generation.

Finer wool: Increase wool value by producing finer wool through breeding, genetics and enzyme treatment.

Lithium

Main sources

Manufacturing

Batteries

E-waste

What is it?

Lithium is the lightest metal with excellent electrical conductivity. It is extracted from rock or brines with 85% of global supply from Australia, Chile and China.

Lithium is refined into compounds such as lithium carbonate, with China holding 57% of global refining capacity. Eighty-seven per cent of lithium is used in batteries.

Driven by growing battery demand, the global lithium market is projected to increase from £24 billion in 2023 to £56 billion by 2030.

Challenges?

Critical material: Lithium is classed as a critical material by governments including the UK due to supply risk.

Low recycling rate: The disparate quantities of lithium within products make end-of-life recycling technically and economically challenging – 3% of lithium is currently recycled globally.

Inappropriate management: There is an increased risk of fires due to the improper handling of batteries, with lithium-bearing equipment still entering residual waste. The estimated annual cost of the impacts of UK battery-related waste fires is over £1 billion.

Opportunities?

Policies: Whilst the EU requires batteries to contain minimum levels of recycled lithium and sets lithium recovery targets from batteries – the UK lacks policy to stimulate lithium recovery.

Recycling infrastructure: Countries and industry are investing in domestic processing infrastructure, including the UK. In 2025 the UK's first battery cells were produced using lithium recovered from UK electric vehicle batteries.

Repurposing: Businesses are repairing or repurposing batteries for deployment in energy storage, thereby extending – sometimes doubling – battery life.

Lithium extraction from UK natural resources: To address supply risk and complement end-of-life sources, projects are under way to extract lithium from UK rock and geothermal waters. Research is investigating lithium recovery from desalination plants and sea water.

Gallium

Main sources

Manufacturing

LED Lighting

E-waste

What is it?

Gallium is an excellent conductor of electricity and heat, has a low melting point, and is magnetic. Gallium is extracted from bauxite and sphalerite and processed to manufacture compounds.

Gallium arsenide (GaAs) converts electrical power into light, making it an important material in electrical components and lighting. Forty-four per cent of gallium is used in integrated circuits, meaning gallium is present in most electronic and electrical equipment.

Through its use in LEDs, solar PV cells, and magnets in electric vehicles and wind turbines, gallium has an important role in the net zero transition.

Challenges?

Supply risk: Gallium is classed as a critical material by governments including the UK due to supply risk.

Low recycling rate: The global recycling rate for gallium is 17% – this is attributed to recycling industrial waste, and no end-of-life gallium recycling currently takes place.

Small quantities per product: At the most, gallium makes up 0.3% of an LED, and integrated circuits require little gallium per device. Gallium distribution across products and its combination with other materials are barriers to recovery.

Product lifetime: Of the gallium produced globally between 2000–2021, 45% is embedded in products still in use, such as solar PV cells (~25 years). As such end-of-life waste flows are currently small and infrequent.

Opportunities?

Recovery technology: Pilot/demonstration projects show it is possible to recover over 90% of gallium from end-of-life products. The next step is to scale these solutions – policy interventions are needed to facilitate this.

Alternative sources: To address supply risk and complement end-of-life sources, extraction of gallium from brine and seawater is being explored.

Tin

Main sources

Manufacturing

E-waste

What is it?

Tin is resistant to corrosion, conductive, has a low melting point and is malleable. In 2023, 288,806 tonnes of tin were mined from 24 countries. Fifty-one per cent of tin is used in solder – through printed circuit boards it is present in electronic and electrical equipment.

Due to its resistance to corrosion, a thin layer of tin is applied in steel packaging. Tin has a role in the net zero transition with use in solar PV cells trebling in the last five years.

Challenges?

Critical/conflict material: Tin is classed as a critical material by UK government, and a conflict material by the EU due to sourcing concerns.

Low recycling rate: Large quantities of e-waste are still discarded – the global e-waste stream contained £1 billion worth of tin in 2022.

Processing e-waste/steel: Tin is lost with focus on extracting other metals. Low tin concentrations in products present challenges to recovery.

UK capacity: E-waste containing tin is sent overseas due to lack of UK capacity.

Substitutes: Tin substitutes are also critical materials and typically more expensive with inferior performance.

Opportunities?

Development of new recovery technologies: Pilot/demonstration projects show promising results in recovering tin from end-of-life waste using bioleaching and sorting technologies. The next step is to scale these solutions – policy interventions are needed to facilitate this.

Design: Most tin is used in solder for printed circuit boards. Interventions include reducing solder use, design for disassembly and minimising the mixture of materials to increase recovery.

Domestic extraction: To address supply risk and complement end-of-life sources, projects are under way to re-establish the UK tin mining industry.

The research highlights the versatility of materials and industrial symbiosis opportunities

All six materials play an important role in our everyday lives and failure to recover these materials could impact on lifestyles.

There is innovation across circular economy chains (see Figure 1): electric vehicle batteries are **repurposed** for energy storage systems **prolonging life**; oyster shells reused in **habitat regeneration**; **recycling** lithium from batteries as material for new batteries; and **extracting biochemical feedstock** from shells.

Table 1
Examples of different applications for 'renewable/organic' materials across different sectors

Sector	Application	OIL		
Built environment	Acoustic panels	-	-	✓
	Construction	✓	✓	-
	Paint	-	✓	-
Design	3D filament	-	✓	-
	Bio polymers	✓	✓	-
	Furniture	-	✓	✓
	Interior design/arts & crafts	-	✓	✓
	Packaging	✓	✓	✓
	Textiles/clothing	-	✓	✓
Energy	Batteries	-	✓	-
	Energy efficiency	-	-	✓
	Energy generation	✓	-	✓
	Heating of buildings – fuel	✓	-	-
	Transport fuel	✓	-	-
Health/beauty	Cosmetics	-	✓	✓
	Medical	-	✓	-
	Soap	✓	✓	✓
Natural environment	Animal feeds	✓*	✓	✓
	Soil amendments	✓	✓	✓
	Food production – human consumption	-	✓	-
	Habitat Restoration/conservation	✓	✓	✓
	Improve water quality	-	✓	-
Other	Bedding	-	-	✓
	Chemical extraction	✓	✓	✓
	Distillation	-	✓	-
	Garden products – decorative/plant protection	-	✓	✓
	Rope	-	-	✓

*** (glycerine only)**

2. Key findings

2.2 Themes across materials

Supply and value chain implications

Increased scrutiny on traceability of materials/products:
There is increased scrutiny on the origins of materials and emphasis on traceability. Traceability secures the trust of customers and can command higher prices for materials. In the European Union (EU), Digital Product Passports (DPP) aim to enhance product transparency and support a circular economy.

Electric vehicle batteries sold in the EU will require a DPP from February 2027 with other sectors to follow. The UK government has not announced policy to mirror this or develop similar policies, potentially placing UK industry at a disadvantage.

Response to resource security concerns:
Reliance on imported materials highlights challenges and vulnerabilities in UK resource security particularly for critical materials.

Countries and industry worldwide are investing in domestic recycling infrastructure or exploring extracting virgin material from their own resources. UK examples include companies recovering lithium from Li-ion batteries, the extraction of lithium from rock and geothermal waters, and plans to reawaken our tradition of tin mining. Analysis suggests virgin material extraction from UK resources can supplement those from end-of-life streams and utilise existing infrastructure whilst demonstrating environmental benefits compared to overseas extraction.

Securing resources throughout the supply chain:
Strategic partnerships are being established to guarantee material supply. Recycling companies have agreements with battery and car manufacturers to take battery waste, recover lithium, and return it as feedstock for new battery production. Guaranteeing the supply of material is pivotal in securing investment needed to process materials.

The importance of material quality:
The importance of quality was a theme across materials – the poor handling and preparation of fleeces devalues wool. Concerns surrounding the quality of household UCO have been a barrier to kerbside UCO services – and in the past oil contamination has led to high-profile public health incidents. Effective separation and processing of Li-ion batteries is needed to ensure the high-quality material demanded by manufacturers.

Contribution to the UK economy:
If the UK secures investment in electric vehicle and battery manufacturing an estimated 35,000 jobs could be created, and 65,000 additional jobs in the battery supply chain. The domestic extraction of lithium from three projects has the potential to create 1,000 skilled jobs. Two gallium extraction projects in Cornwall and County Durham could contribute £2 billion to the UK economy.

2.2 Themes across materials

Environmental implications

Resources are being lost key to the net zero transition:
Whilst relying on imports we continue to waste domestic resources key in the transition to net zero. In 2023, UCO-derived biofuels were supplied to the UK from 89 countries – only 4.4% originated from the UK and most household UCO is currently lost. 7.9 million UK households do not have insulated lofts – yet wool to insulate our buildings is being lost. Critical materials for batteries, solar and low-energy lighting are being lost.

Replacement for oil-derived plastics:
All three 'renewable/organic' materials have the properties to replace oil-derived plastics thereby reducing carbon emissions and the impact of plastic in the environment. Woolen products replace synthetic packaging, insulation, textiles and rope. Biopolymers are being developed from seafood shells and UCO. Wool and shells are effective alternatives to synthetic fertilisers.

Environmental benefits of circular innovation:
The research highlights the environmental benefits of circular innovation compared to virgin materials or traditional sources. UCO biodiesel saves 87% in carbon emissions compared to oil-derived diesel. Shell-derived textiles produce 80–90% less carbon emissions and use 0.1% of water compared to leather. Recycling of Li-ion batteries into battery-grade materials uses 80% less energy and water than conventional mining.

UCO biodiesel saves **87%** in carbon emissions compared to oil-derived diesel.

Recycling of Li-ion batteries into battery-grade materials uses **80%** less energy and water than conventional mining.

Policy opportunities

Changing global markets:
Changes in global manufacturing and supply chains impact traditional markets. The dominance of synthetics in global textile production has had a devastating impact on the wool supply chain. Whilst innovation might exist to recover materials, government policy and mechanisms are needed to support industry and navigate changes.

Opportunities in UK policy:
International policy opportunities are identified which the UK could learn from to stimulate markets and prevent material loss. This includes tax credits for businesses, Extended Producer Responsibility for UCO, prioritising material use in government and public sector projects, battery recovery and recycled content targets, and surcharges to support sustainable industries.

UK battery regulations and targets are outdated, not reflecting current markets and criticality of materials. Collectively these policy interventions can provide incentives for industry to invest.

The importance of collaboration:
Most circular innovation examples involved collaboration between industry and academia – many were supported by Innovate UK. This highlights the importance of government and private sector funding facilitating collaboration and knowledge exchange.

The balance of economic, environmental and social aspects

Collection and processing
Whilst innovation exists there are challenges in collecting and processing materials due to their infrequent generation, relatively small quantities, plus economic and technological constraints.

This presents the question of what do we ‘value’ and the balance of economic, environmental and social aspects of sustainability:

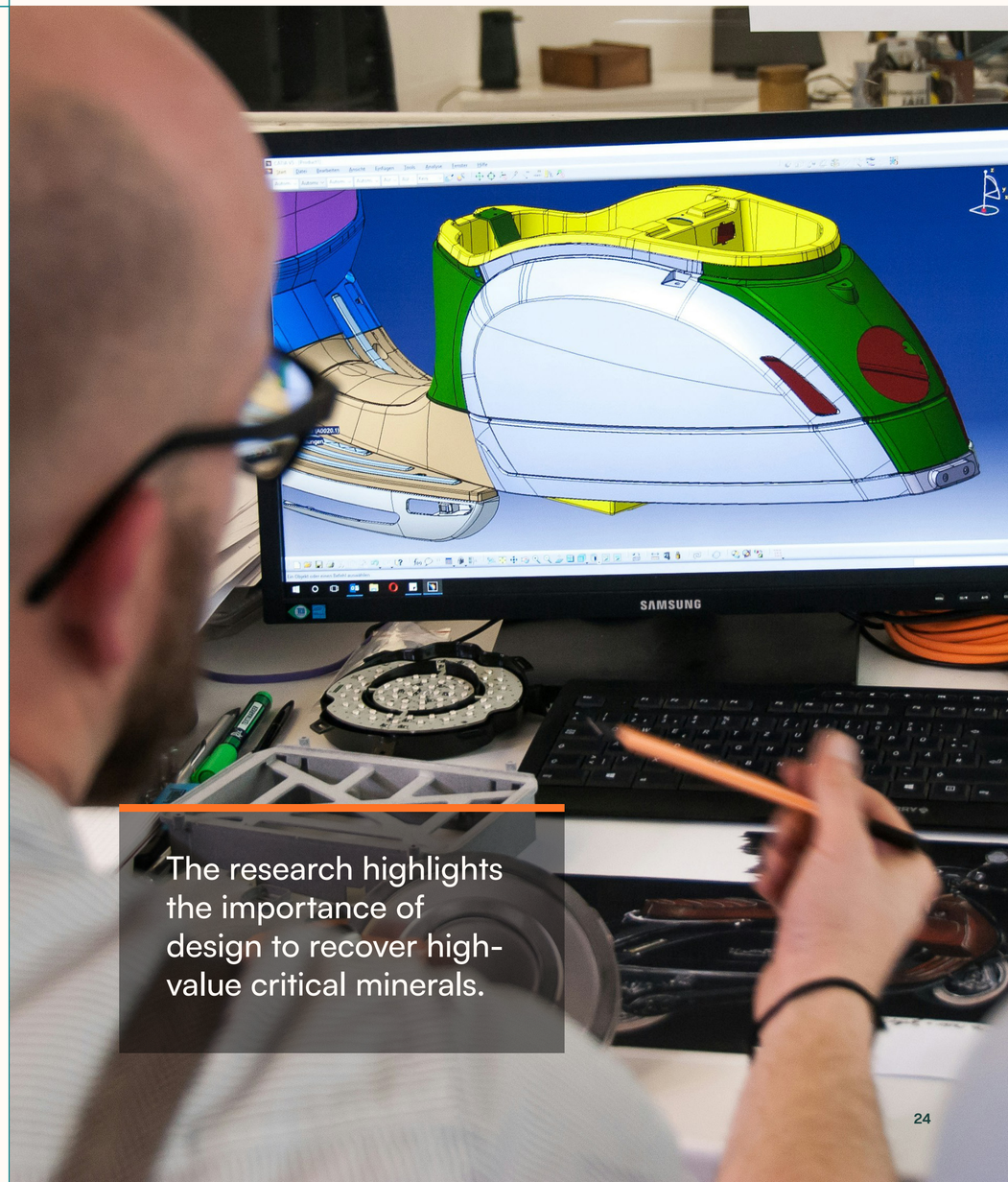
- For critical materials, is it economically viable to recover small amounts of high-value material disparate in end-of-life equipment?
- Or given their critical nature, and the impacts associated with primary production, do we have a choice?
- Given challenges recovering these materials, and the associated risks to investors including global events impacting markets, cheap imports and the long-term return on investment, should the UK be implementing policy to subsidise and support industry?
- What are the economic, environmental and social implications of extracting resources from UK end-of-life products as opposed to domestic and overseas virgin extraction?

Importance of design
The research highlights the importance of design to recover high-value critical minerals. The way products are designed and materials are bonded present barriers to recovery. Effective design has a crucial role – however, this is challenging for materials in very low concentrations. Whilst substitute materials might exist, they are also typically critical materials.

Knowledge gaps

Reliable data
Data for all materials was limited and often outdated. Understanding resource stocks and flows is paramount to inform policy, industry, infrastructure and investment decisions. There have previously been calls for a National Waste Data Hub and this research reinforces the need.

Research repository
The research highlights the lack of ‘circularity’ of information with many past projects and associated outputs that received public or European Union funding no longer in the public domain. This knowledge is lost – and mechanisms are needed to ensure this information is available to inform policy and enterprise, particularly for niche waste streams with limited research. Outputs might end up in peer-reviewed journals which are not widely available.



The research highlights the importance of design to recover high-value critical minerals.

3. Recommendations

Whilst innovative and pioneering work is being undertaken, there is still much to do if the UK is to narrow the circularity gap, address resource security risks and build resource resilience. It is expected that the circular economy strategies, acts, and accompanying roadmaps across England and the devolved nations will help to increase resource efficiency and identify policy and practice improvements. However, evolving UK policy and the putting in place of appropriate mechanisms to capture lost resources is urgently needed. Ongoing delays in UK policy also present uncertainty to UK industry.

3. Recommendations
A roadmap for realising the lost opportunities

A co-ordinated cross-sector approach is needed to overcome these challenges — with the CIWM collaborating with policy makers and stakeholders to:

01

Align UK policy to capture ‘lost’ resources:
Evaluate international policy opportunities across value chains to recover lost resources. Technological solutions exist for many materials, but support is needed to scale operations. Fiscal and legislative policy interventions can address these challenges, facilitate change and harness these opportunities to grow the UK economy.

02

Develop the business case to capitalise on ‘lost’ opportunities:
Evaluate the economic, environmental and social implications for collecting and processing materials lost in the UK. This includes analysis of recovering materials from end-of-life streams compared to extraction of virgin materials in the UK and overseas. This analysis should incorporate the feasibility and impact of policies supporting collection and processing as identified in Recommendation 01.

03

Align public sector procurement policies to support resource recovery:
Review government procurement policies and explore mechanisms to stimulate the demand for UK materials and recovery of lost resources. This can be achieved through altering specifications to support secondary resources and low-carbon materials.

04

Co-ordinated cross-sector collaboration:
Some sectors still perceive waste as a by-product and hindrance. There is the opportunity for CIWM to take a strategic leadership role engaging with other trade associations and professional bodies to highlight the benefits and opportunities in circularity – and collaborate on overcoming challenges.

05

Implement a National Material Data Hub:
Better data is urgently needed on material arisings and flows to inform government policy, industry, infrastructure and investment decisions. This includes collaborating with relevant trade associations and professional bodies to fill existing data gaps.

06

Implement a cross-organisational open access research repository:
Facilitating an open access research repository preserving knowledge which is currently being lost. This is particularly important for overlooked waste streams where limited research has been undertaken.

Fiscal and legislative policy interventions can address these challenges, facilitate change and harness these opportunities to grow the UK economy.

CIWM

For more information or to download the full report visit:
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