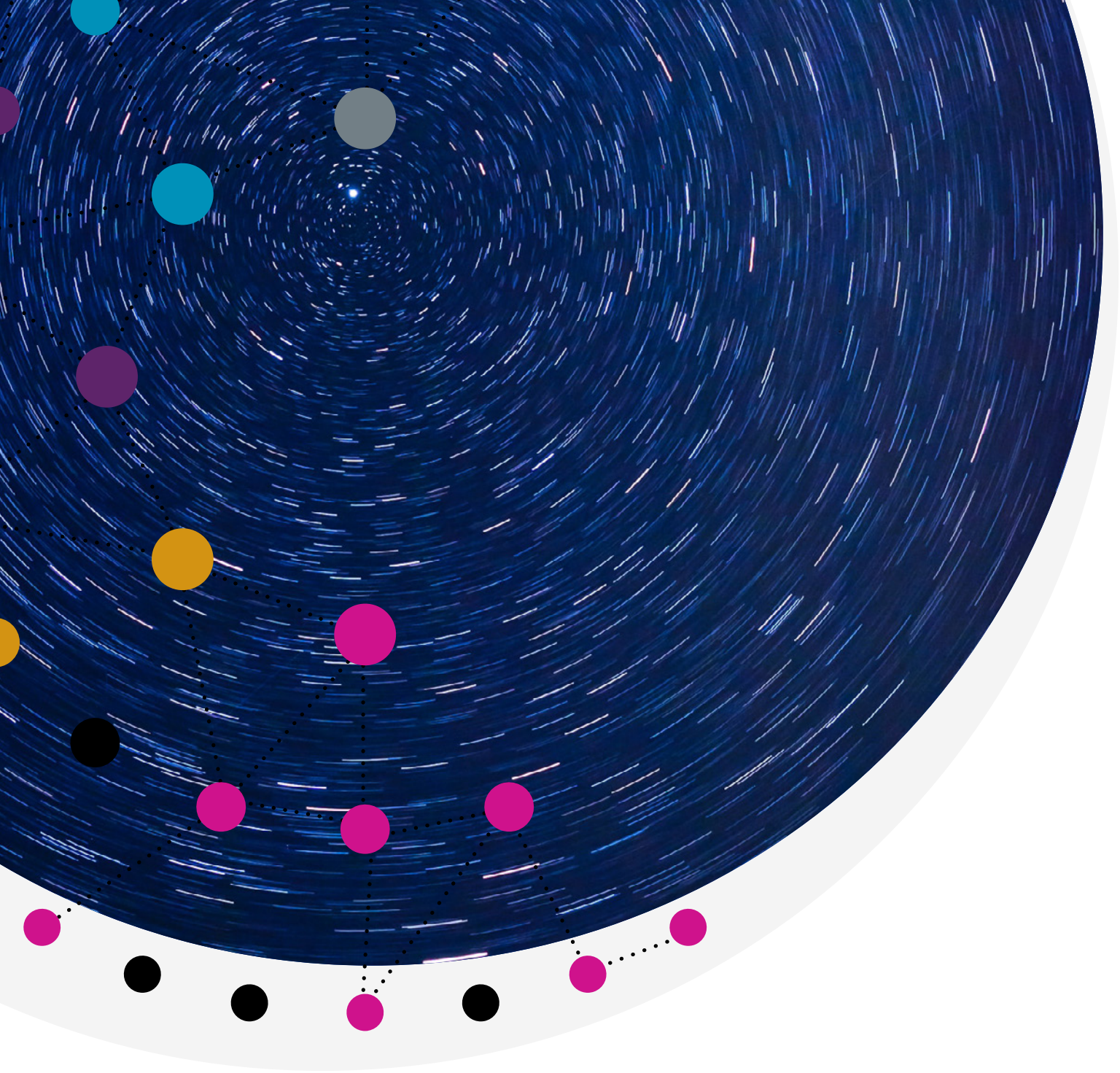

PUBLIC POLICY TAXONOMY FOR A UK CIRCULAR ECONOMY

CE-Hub Working Paper

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Oliver Lysaght, Peter Hopkinson, Markus Zils, Ryan Nolan, Fiona Charnley, and Nicky Cunningham

CE-HUB
UKRI National Interdisciplinary Circular Economy Research

NICER PROGRAMME

University of Exeter

UK Research and Innovation

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About the National Interdisciplinary Circular Economy Research Programme

The National Interdisciplinary Circular Economy Research (NICER) programme is a £30 million four-year investment from UKRI to deliver the research, innovation and evidence base needed move the UK towards a circular economy. Launched in January 2021 and comprising initially of 34 universities and over 150 industrial partners, NICER is made up of five Circular Economy Research Centres each focused on a specialty material flow, and the coordinating CE-Hub:

- The National Interdisciplinary Circular Economy Research Hub (CE-Hub), led by the University of Exeter
- The Textiles Circularity Centre (TCC), led by the Royal College of Art
- The Interdisciplinary Circular Economy Centre for Mineral-based Construction Materials (ICEC-MCM), led by UCL
- The National Interdisciplinary Centre for the Circular Chemical Economy (CircularChem), led by Surrey University
- The Interdisciplinary Circular Economy Centre for Technology Metals (Met4Tech), led by the University of Exeter
- The Interdisciplinary Centre for Circular Metals (CircularMetal), led by Brunel University London.

NICER is the largest and most comprehensive research investment in the UK Circular Economy to date. It has been delivered in partnership with industrial organisations from across sectors and the Department for Environment, Food and Rural Affairs (DEFRA) to ensure research outcomes contribute to the delivery of industrial implementation and government policy. A core aim of the programme is growing the Circular Economy community through a significant programme of outreach and collaboration.

This discussion paper can be referenced as follows:

Lysaght, O., Hopkinson, P., Zils, M., Nolan, R., Charnley, F. and Cunningham, N. (2024) Public Policy Taxonomy for a UK Circular Economy. UKRI Circular Economy Hub, Working Paper Series (CE-Hub WP 2024-2). Available at: https://ce-hub.org/knowledge-hub/public-policy- taxonomy-for-a-uk-circular-economy

Executive summary

To build a shared understanding of the circular economy (CE) as a systemic innovation framework among stakeholders in the UK, the CE-Hub has identified the need for a taxonomy or classification of terms and entities as a key first step to concisely describe the current state of play, a desired CE target state and chart the transformation steps and inputs required to get there. As a core component of this and synthesising lessons from across the UKRI NICER programme, the CE-Hub has developed an agnostic value-chain based framework to structure the actors, activities and steps involved in the transformation of resources from materials through to components and products, disposal or re-circulation and revalorisation pathways (Figure 1). This has been applied within the NICER programme to date to help retrieve and map data across cases and support consistent visualization.

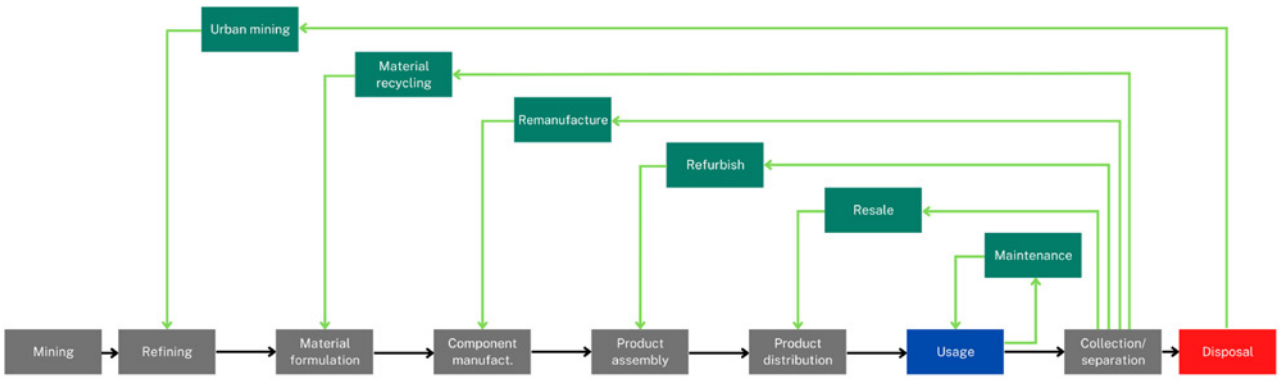


Figure 1. The CE-Hub value chain taxonomy schematic (Zils, 2023)

Anchored to the value chain taxonomy and focusing initially on levers available to public sector actors in the regulation landscape, this discussion paper outlines a high-level classification of public policy tools or instruments that can be applied by government actors to enable CE-related outcomes in the UK. 'Regulation' here refers to instruments or tools employed by an actor (or group of actors) to set controls and deliver change in a desired way/towards a desired state. CE-related outcomes include improved product design, extended and optimized product lifespans and greater revalorisation of materials, components and products at end of life, which have the potential to generate positive environmental, economic and social impacts in the UK. The taxonomy of public policy instruments outlined in the document is intended to help:

1. Give a structure for building evidence on the scope, depth and stringency of the current UK regulatory landscape as it relates to the CE, to aid the comparison of options and identification of shifts and gaps; and
2. Provide a framework for making consistent recommendations for policy pathways to effectively and efficiently move the UK towards a more circular, resource efficient and sustainable economy.

Accordingly, Section 1 of this CE-Hub working paper sets the scene of why we need a UK CE, guiding principles, key potential benefits and the rationale for a taxonomic approach. Section 2 then defines actors with a potentially significant role in aligning UK value chains with the principles of a CE and provides examples of the different roles (and responsibilities) each can have. This builds off a classification developed by the UNECE, while recognizing actors can be sub-divided in different ways. With actors mapped, Section 3 classifies instruments available to government actors to enable CE outcomes and provides examples of how these have been deployed to date.The instruments covered are set out in Table 1. We include also a list of wider forms of soft influence that Governments and the public sector can have to enable, promote and facilitate CE outcomes.

Table 1. Key taxonomy components and categories

Value chain actors		Policy tool/instrument type
Wider business ecosystem	Central government	No intervention
	Local government	Voluntary instruments
	Non-governmental organisations and civil society	Information-based approaches
	Intergovernmental bodies	Procurement requirements
	Education, research and training providers	Strengthening consumer rights
Extended enterprise	Standardisation bodies	Responsibility-based approaches
	Finance sector	Price & market-based instruments
	Technology providers	Trade policy and international governance
Core market actors	Extractive and processing industry	Planning and permitting requirements
	Manufacturers	Direction setting
	Startups and SMEs	Standards
	Retailers	Bans
	Waste management companies	Project-level support
	Reverse loop sectors	Public sector delivery

Section 4 sets out key criteria for policy tool selection, considering the type of CE outcome sought to be targeted and how, as well as criteria that can be used to appraise options. These criteria include effectiveness; efficiency; financial cost to the public sector; long-run effects; distributional and equity considerations; positive and negative spillovers and strategic fit. Section 5 builds off the value chain taxonomy defined to illustrate a series of potential policy pathways for CE change at a systems scale in the UK through to 2040 based on CE-Hub policy work to date. We present illustrative examples of policies to initially impact materials and products, technological, social and economic changes, and some of the actors who would be (need to be) incentivised or disincentivised.

Examples of similar specific CE interventions from the five NICER CECs in relation to their resource flows will be published in the future. Policy instruments in this report will be discussed in more detail in a forthcoming short series, starting with the role of bans and standards in driving a UK CE. The overarching value chain taxonomy forms the core analytical framework for the NICER CE data observatory, which integrates data and CE intervention analysis across the NICER programme, and will be launched in 2024. Other working papers published by the CE-Hub cover publicly accessible data sources relevant to measuring and modelling a UK CE (Lysaght et al. 2022), key performance indicators (KPIs) (Zils et al. 2023) and analytical methods to support and improve the consistency of CE measurement and appraisal (Khedmati-Morasae et al. forthcoming). CE-Hub working papers be found at the following link: www.ce-hub.org/knowledge-hub

Section 1. Introduction

Section 1 describes the historical context and why we need a CE in the UK (and globally), guiding principles, key potential benefits and the role that a taxonomic approach can play.

Prologue

In the Paleolithic when our Homo genus predecessors lived as scavengers and then hunter-fisher-gatherers, material accumulation was limited as mobility and adaptability to nature were the key traits conducive to survival (Barbier, 2015). At the advent of the Neolithic Revolution (around 10,000 BC), global material use was an estimated 7 million tonnes per year (Mt/yr) (Krausmann, Weisz and Eisenmenger, 2016). This was at a time when the human population was between 6-10 million people, and that of the British Isles is thought to have been as low as 5,000. The Neolithic Revolution in the UK saw what population there was shift from hunting and foraging alone to swidden and then permanent farming practices, with an expansion in cultivated natural capital and foodstuff increasingly an output of joint production of ecosystem and economic production (Jones and Rowley-Conwey, 2007). Biomass was the primary material group relied upon at the time, including for the purposes of heating, clothing and shelter alongside some minimal use of non-metallic minerals such as clay and stone for uses likes tools and utensils.

The British Isles has a significant history of metallic mineral extraction stretching back over several thousand years, with a complex geological history giving rise to a diverse range of mineral deposits (Bloodworth, 2014).[1] The use of copper in the UK, the earliest metal for which there is evidence of extraction, marked the transition from the Stone to Chalcolithic Age around 2500BC and its alloying with tin brought about the subsequent Bronze Age. The extensive cassiterite deposits in the Southwest of England led to the region to be integrated into the Mediterranean economy early in economic history (Gerrard, 2000). The Iron Age, beginning around 1000BC in the Eastern Mediterranean and moving through Europe in the centuries after, was associated with the growing use of metal for tools to the benefit of agricultural productivity. Food surpluses supported specialization and urbanisation, with increasingly complex and populous societies across the globe evolving into civilizations for whom the most valuable forms of capital were fertile land, natural resources, labour, dwellings, tools and domesticated animals (Barbier, 2015). The earliest available evidence of coinage is from approximately 500BC (in Western Anatolia), and this offered a fungible medium of exchange for trade in surpluses. By around 0AD, the global human population was an estimated 170-400 million people (US Census Bureau, 2022), while that in the British Isles is thought to have reached around 2 million people by then.

[1] mineral deposits including: fossil fuels such as coal, oil, gas and shale-gas; ferrous metals such as iron and manganese; non-ferrous metals such as tin, copper, lead and silver; stone resources such as limestone and brick clay; and rare minerals such as china and ball clay, gypsum and potash (Bloodworth, 2014).

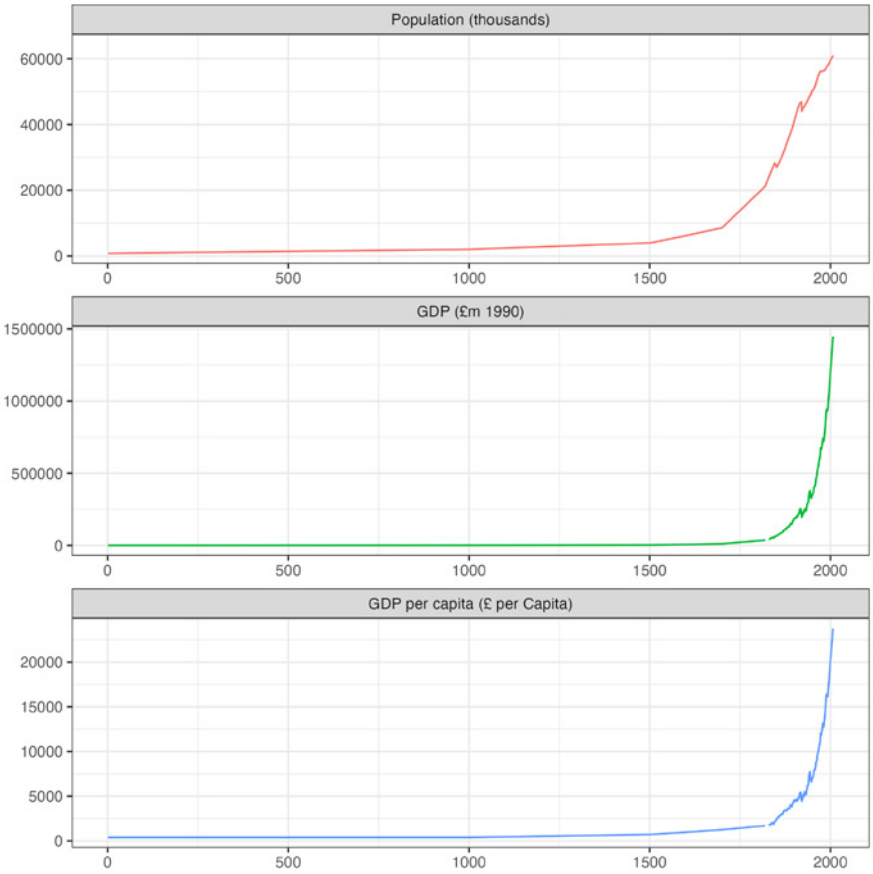


Figure 2. Population, GDP and GDP per capita, UK 0AD-2008AD (Maddison, 2008)

While the division of labour, technological innovation and other aspects of cumulative culture provided the underpinnings for economic growth, between 0AD and 1650, average annual incomes in Britain were estimated to have stayed roughly constant at around £1,000 per capita in today's prices (Figure 2) (Broadberry et al. 2015; Thomas and Dimsdale, 2017).[2] It is thought that around 1550AD, a growing scarcity of firewood in Britain incentivised the increased exploitation of coal, the use of which removed the biomass fund-based energy reliance that had acted as a constraint on the growth of the prior agrarian regime (Georgescu-Roegen, 1971; Fisher-Kowalski and Haberl, 2007). The 1st Industrial Revolution, facilitated by developments in scientific knowledge and trade, enabled by cheap labour and materials and fuelled by coal and the steam engine, took place in the UK from the mid 1700s, bringing with it an increased build-up of man-made or reproducible capital assets which quickly overtook agricultural land as the major component of wealth in the UK and other early-industrialising economies (Barbier, 2015). The invention of coke by Darby in the 1700s reduced the cost of producing steel and in conjunction with the widespread availability of iron, saw British heavy industry grow. With these developments, the material and energy throughput of UK society also increased, with increased production enabling greater consumption.

By 1850, material use globally had reached approximately 4 billion tonnes per year (Gt/yr) with this skewed towards the wave of industrialising countries (Krausmann, Weisz and Eisenmenger, 2016). Increases in per capita consumption of fossil fuels and non-metallic minerals at this time were largely additive to that of biomass. During the 18th Century, lead and iron vied for second place behind wool as England's main export (Barnatt and Penny, 2004). The 2nd Industrial Revolution, occurring from around the 1870s in the UK and powered by electricity, was associated with an expansion in mass production and particular developments in the technologies of illumination, mobility and communication. Management innovations, including Fordist mass production of the 1920s and Demming's quality movement of the 1950s drove frontier productivity and their diffusion, total output. Happening alongside was a consistent increase in material use, and from an estimated 7Gt/yr of material consumption in 1900 when the global population consisted of roughly 1.6 billion people, humanity's use of resources worldwide had reached approximately 27 Gt/yr by 1970 (Figure 3) (Krausmann, Weisz and Eisenmenger, 2016).

[2] Historic estimates of global GDP (DeLong, 1998) similarly suggest that up to 1750, growth in the global economy was minimal, averaging only around 0.01% per year (DeLong, 1998).

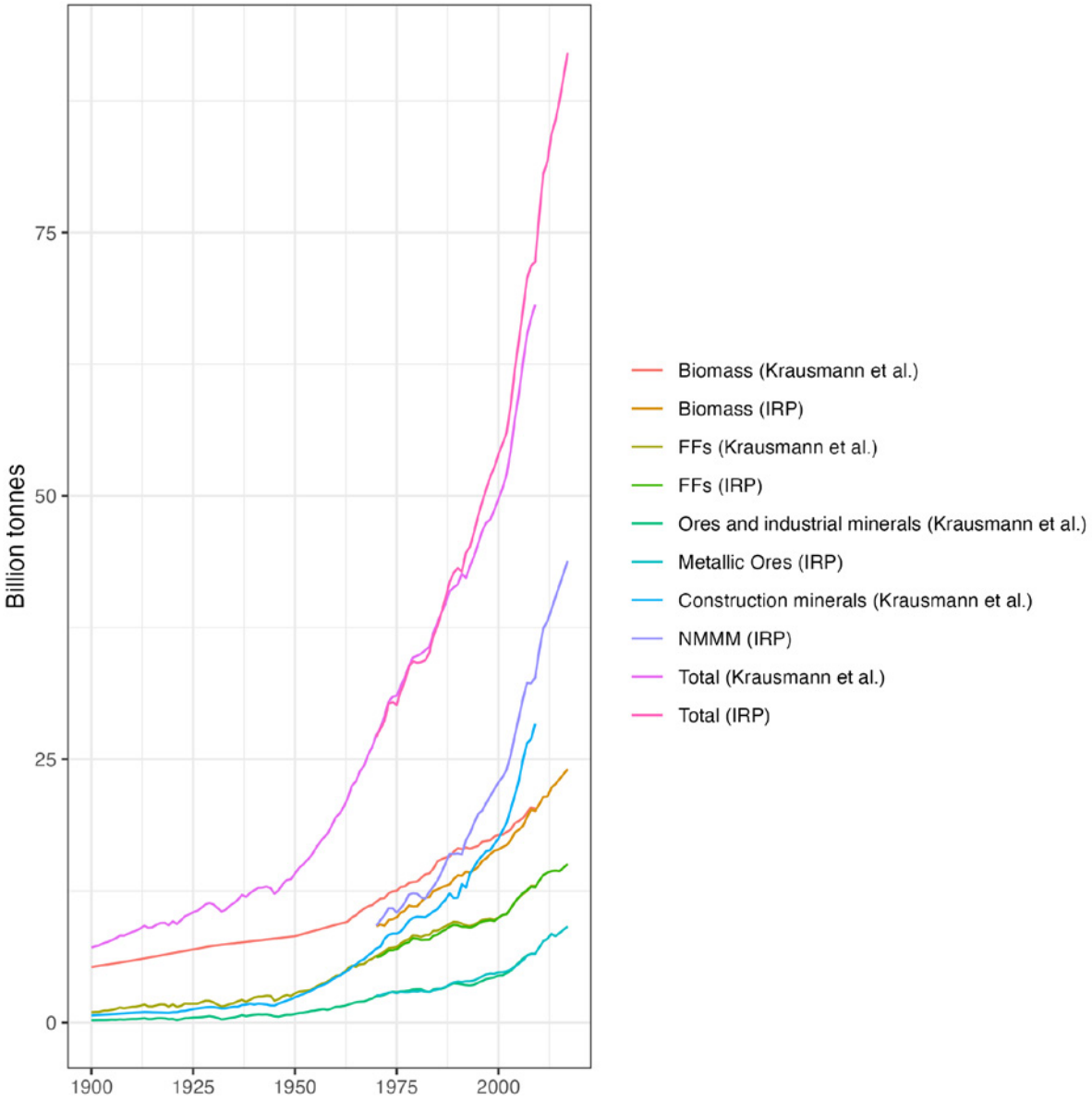


Figure 3. Global resource use 1900-2017, billion tonnes (Krausmann, Weisz and Eisenmenger, 2016; IRP, 2021)

The 3rd Industrial Revolution beginning from the 1950s, has been associated with the rise of digital technologies and the 'Information Age', while the 4th Industrial Revolution has seen these technologies applied to an increasing number of areas such as artificial intelligence, robotics and quantum computing. In the UK, economic growth had led to, and resulted from, structural change in the output mix of the domestic economy, with higher value opportunities for labour in information-intensive sector and loss of competitiveness in other sectors. Consumption of outputs from sectors such as manufacturing remain and is generally met by imports. Notwithstanding evidence of relative dematerialization against population and output globally, from the 1970s, the rate of increase in global material consumption has accelerated. Material consumption stood at over 90Gt/yr in 2017 and continues to rise.

Changes in societal metabolism over the last millennia have not been restricted to scale, marked also by a shift from a reliance on biomass and renewable materials associated with primarily agrarian-based economies and traditional technologies, towards growing quantities of fossil fuels and metallic and non-metallic mineral resource use associated with modern technologies of increasingly industrial and post-industrial societies. Key materials of civilisation today include ammonia, steel, plastic and concrete alongside a massive proliferation of new chemicals for which the environment frequently has limited or no assimilative capacity (Smil, 2022). Relatively inert and homogenous solid waste streams have resultantly been replaced by an increasing array of materials in the UK (Figure 4).

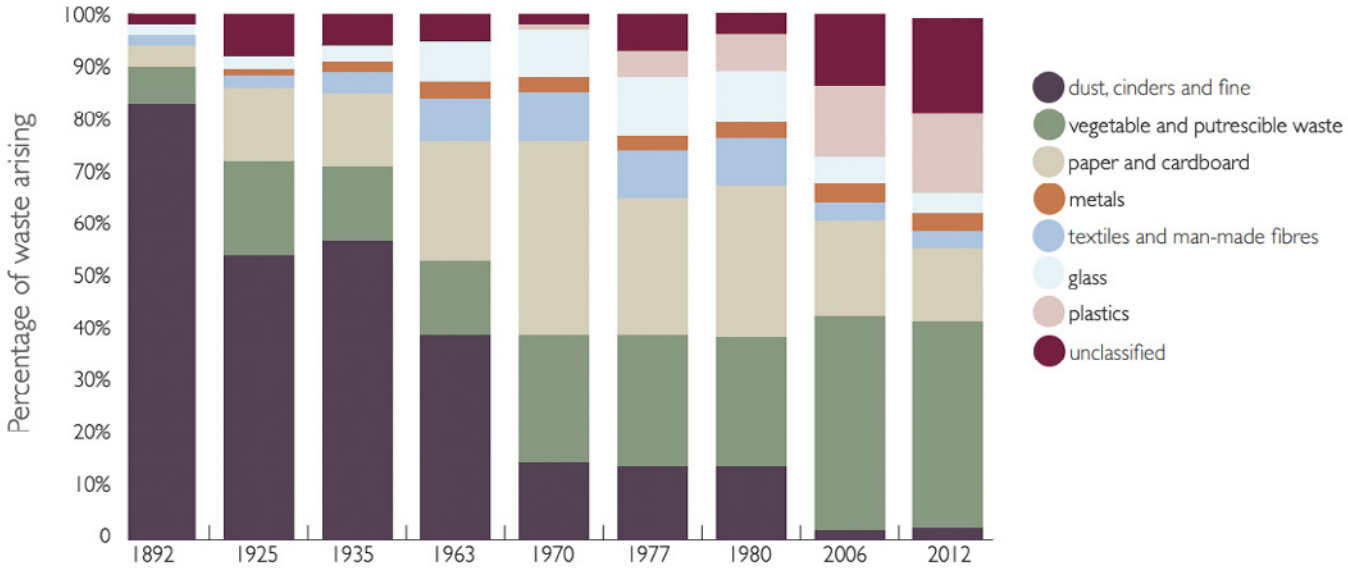


Figure 4. The composition of waste from households 1892-2012 (Greenfield and Woodard in Government Office for Science, 2016)

In 2020 (± 6 years), anthropogenic material stocks globally, by weight, were estimated to have surpassed all living biomass - partially driven by humanity having roughly halved the mass of plant life since the first Agricultural Revolution (Elhacham et al. 2020). As now the most significant geomorphological driving force on the planet (Cooper et al. 2018), humans and the materials that they extract, harvest and cultivate, move, transform, consume and dispose of are a key driver of the gradual, yet continuous, systemic and accelerating degradation of many of our natural capital assets seen around the world today – with a general trend towards net environmental degradation, biospheric decline and loss of non-provisioning ecosystem services in many places (Goudie and Viles, 1997; Ruddiman, 2003; Dasgupta et al. 2021). This is apparent across indicators including mineral resource depletion, declines in wild fish stocks, the accumulation of persistent toxic chemicals, loss of top soil, build-up of greenhouse gases (GHGs) and species extinction. Today, the planet's extractive industries are thought to be responsible for at least half of the world's carbon emissions and more than 90% of biodiversity loss (UNEP, 2019).

Though there have been positive developments in several areas relating to the use of resources in the UK in recent decades such as a shift away from landfilling of local authority collected waste, many indicators point to a continued high degree of linearity in the economy, unsustainable levels of resource consumption and natural capital loss and depletion. In 2021, the mass of materials directly entering the UK economy to meet domestic demand stood at around 500 million tonnes (ONS, 2023a), while when accounting for the full upstream material extraction along international supply chains to satisfy domestic final demand, the UK's material footprint in 2020 was only slightly short of 1 billion tonnes or 14 tonnes per capita (ONS, 2023b). Per capita raw material consumption in the UK remains significantly higher than the global average and many times greater than the average levels of material use seen in low-income countries - where footprints can be as small as 1 t/yr.

In 2018 (the latest year for which data are available), over 220 million tonnes of total waste were estimated to have been generated in the UK, almost 10% more than in 2010 (Defra, 2023a). An estimated 60 million tonnes of this came from construction and demolition activities (Defra, 2023a), 10 million tonnes came in the form of food waste (WRAP, 2022) and 2 million tonnes, textiles (WRAP, 2019). Of the waste generated in the UK, a significant quantity continues to be lost from the economy each year, with roughly a third entering landfills or incineration and an appreciate amount entering the natural environment via fly-tipping and littering (Defra, 2023a; Defra, 2023c; KBT, 2020).

While it remains difficult to say what a sustainable rate of resource use might be at the global level today, many signs point towards current levels already being too high and contributing to humanity overstepping multiple planetary boundaries (Bleischwitz, 2010; Richardson et al. 2023).[3] Assuming current systems of production and consumption remain unchanged furthermore, it is estimated that the extraction of materials to meet the

anticipated demands of a global population in 2060 of around 10 billion people could rise to more than double current levels or approximately 160 Gt/yr (OECD, 2019). Notwithstanding the significant uncertainty associated with such estimates, Dittrich et al. (2012), point to a sustainable level of global material extraction likely not exceeding 50Gt/yr - a level echoed by Hoekstra and Wiedmann (2014) (O'Neill et al. 2018). On a per capita basis, this would equate to a global limit of 8 tonnes per year by 2030, broadly reflecting a level recommended to target by UNEP's IRP (2011) of between 6 and 8 tonnes per year by 2050 (in Bringezu, 2015).

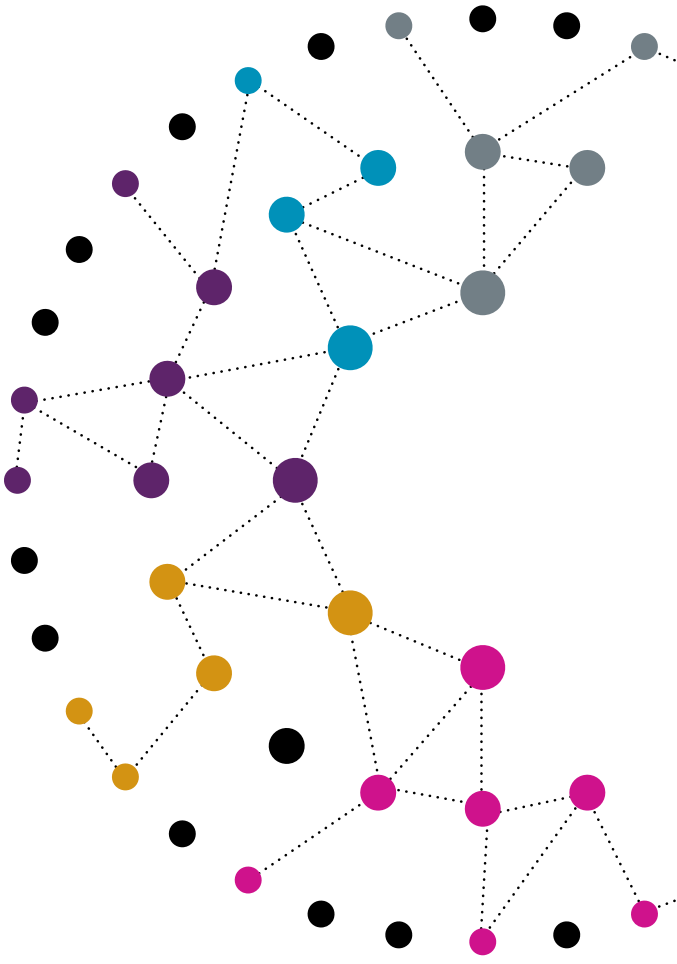
The circular economy as a way to deliver societal objectives

Against this backdrop, the concept of a CE has emerged as a transformative strategy to deliver sustainable economic development within planetary boundaries. Alongside a shift towards renewable energy sources, core principles of a CE include:

1. the absolute decoupling of resource consumption, waste production and pollution from economic activity to bring these within scientific planetary boundaries;
2. maximising the value created from resources and products produced and used in the economy; and
3. by moving towards a more circular economy, restoring and regenerating natural capital for nature (including humans) to thrive.

CE strategic value drivers and measures

Realising the potential benefits associated with aligning the UK with the principles of a CE will require changes throughout the economy (Lieder and Rashid, 2016; Aguilar-Herndandez et al. 2018; Zils, Howard and Hopkinson, 2023). These changes can be referred to as measures, which will carry private and public costs and benefits and be associated with risks and opportunities. Determining which of these to target can often be a key part of defining policy interventions. For example, whether minimum standards might be applied on repairability, durability, reusability or recycled content. Measures can be grouped into several broad strategies or value drivers (Hirsch and Schempp, 2020; Zils and Hopkinson, 2023) which in line with a systems-based approach, need to be applied in combination to achieve large-scale CE change (Figure 5). These strategies are described further below.



[3] Complicating this is the fact that environmental impacts vary by material type, and thus not only overall tonnages but also the composition of material use must be considered. In addition, the environmental intensity of resource use can be moderated by technologies of extraction and production which may improve with time.

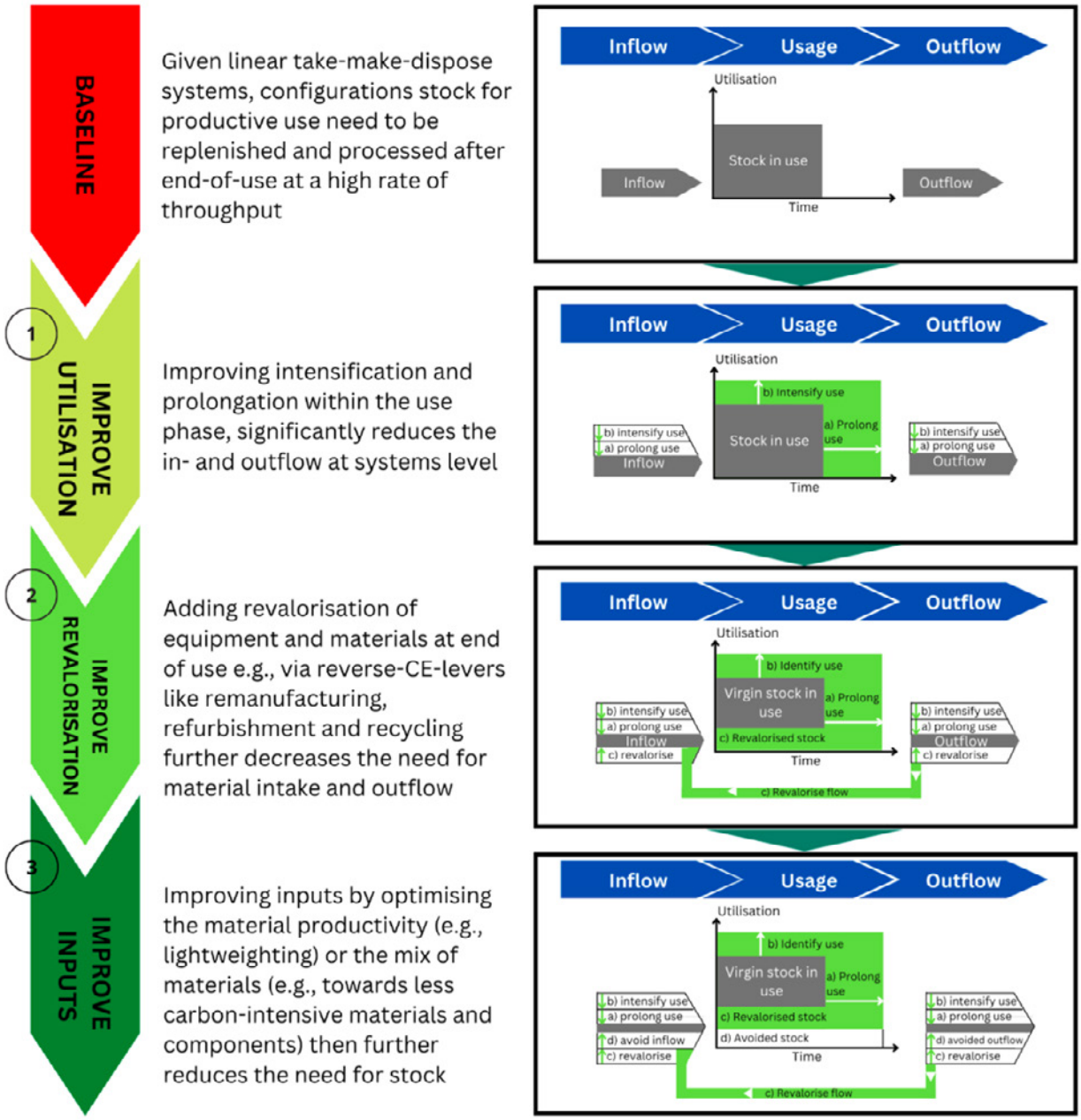


Figure 5. CE and resource efficiency levers along the value chain (Zils, 2023)

Circular design and production (input) strategies
Measures to improve inputs at the design and production stage of a value chain focus on altering existing products, developing new products or altering production methods. These include:

1. Alternative production technologies to improve technical efficiency and reduce yield loss;
2. Product lightweighting;
3. The substitution of virgin materials with secondary raw materials or by-products;
4. The use of alternative materials altogether, including reductions in substances of concern to support value retention at subsequent lifecycle stages; and
5. Changes in design, including towards greater durability and repairability or rationalization of material types.

Circular and optimal use strategies
Circular and optimal use strategies aim to increase the value and use of a product, component and material during its lifetime in use in the economy and the reduce the material intensity of the system in its entirety. These include:

1. Prolonging product lifespans, including through maintenance and repair;
2. use intensification, such as via product-to-service, reuse and sharing models; and
3. Reductions in consumption.

Intercept and revalorization strategies
Measures falling under this strategy aim to increase revalorisation by intercepting legacy resource flows and maximising the recovery and recycling of materials from these. They include:

1. Increasing collection rates, including waste segregation where beneficial;
2. Improving efficiencies in recovery processes; and
3. Increased reuse, repair, refurbishment, repurposing and remanufacturing of products, their components and assets otherwise discarded.

Linking CE strategies to societal objectives

More prosaically, delivering a circular economy at UK scale has the potential to help achieve strategic/overarching objectives of public policy making such as enhancing economic prosperity, tackling climate change and maintaining resource security (HM Treasury, 2022a).

Maximising the value of resources
Measured in terms of annual GDP, the UK is the sixth wealthiest country globally and the thirty first wealthiest country in terms of GDP per capita (World Bank, 2023). In a context of steeply rising prices and relatively stagnant economic growth however, living standards in the UK (proxied by per capita real household disposable income) are projected to fall by up to 10% in the 2023-24 financial year, while growth in productivity has slowed since at least 2008 (OBR, 2022). Several studies have pointed to the potential economic benefits from the more effective, circular and sustainable stewardship of materials. This includes to firms, through cost reductions including from no/low-cost investments (Lee, Walsh and Smith, 2007; Lee, Bell and Bertham, 2017), gains in total factor productivity (Baptist and Hepburn, 2013), increased competitiveness and new business models and reductions in exposure to price fluctuations in the supply chain alongside associated risk premia for inputs e.g. capital (Lee et al. 2012; Flachenecker, Bleischwitz and Rentschler 2018). To households, this includes through increased disposable income (Pearce, 2001). To government, through cost-reductions associated with e.g. solid waste management (which makes up the largest proportion of all UK government environmental protection expenditure) (ONS, 2023c).

Tackling climate change and maintaining natural capital
Respondents to the 2020 OECD Survey on the Circular Economy in Cities and Regions identified climate change as the number one driver of interest in the circular economy at the city and region-level (OECD, 2020a). At a national level, concern for the impacts of climate change can be traced back to at least the 1980s in the UK (Lorenzoni and Benson, 2014). To achieve the 2008 Climate Change Act's goal of reducing UK carbon emissions by 80% by 2050 vs. 1990 levels and later amended to commit the UK to 'net zero', a significant overhaul of the UK energy system was identified as a primary objective from the outset. The improved treatment of material resources (as key intermediaries of environmental pressures such as greenhouse gas emissions) has received growing interest across government departments as a promising route by which to deliver against carbon budgets and reduce consumption emissions. The UK Climate Change Committee's recommendations for achieving the 6th Carbon Budget featured resource efficiency measures including design optimization, increased recycling and reuse and heightened product longevity and utilisation as means to reduce UK territorial emissions (CCC, 2020). Recent reports by the CE-Hub have shown why CE is an essential driver for carbon reduction and net zero (Figure 6), and the principles and value creation implementation strategies can be applied to sectors as diverse as the NHS (Hopkinson et al. 2023) to flood risk management (Hopkinson et al., forthcoming).

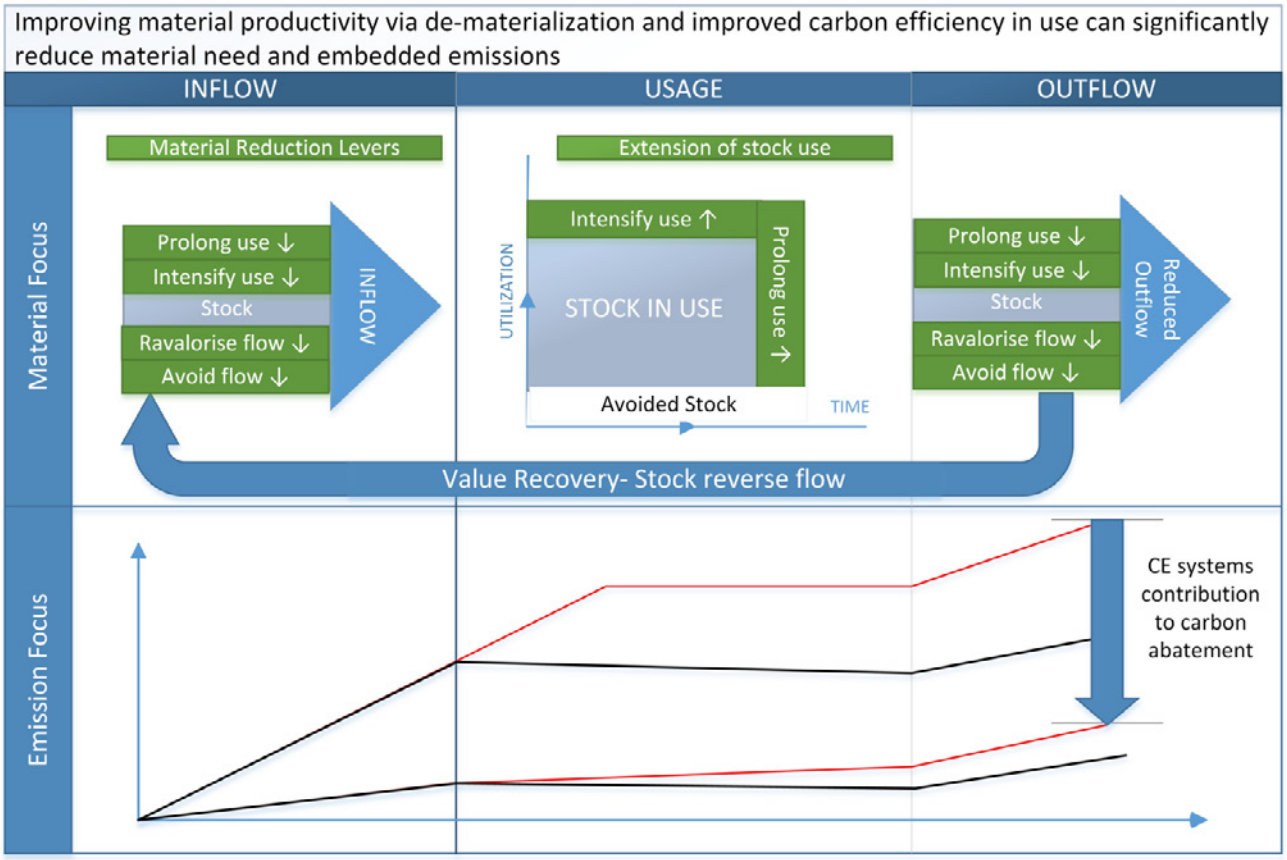


Figure 6. Reducing material input requirements and embedded emissions through improved material productivity

Bolstering resource security

While 'geoeconomic concern' featured as only the tenth most significant perceived risk over the next decade by respondents to the 2021-2022 annual World Economic Forum Global Risks Perception Survey (WEF, 2022), there is evidence of a shift away from China-centric globalisation and closer international economic integration since at least the 2008 financial crisis, with 'on-shoring' and 'friend-shoring' dynamics have accelerated with the invasion of Ukraine by Russia in early 2022. Resource security has been a concern for the UK government for some time, reflected for example in the 2012 Resource Security Action Plan led by Defra and then BIS which focused on metals and minerals perceived to be of particular strategic importance but with uncertain supply. Most recently, the 2022 Critical Minerals Strategy and 2023 Critical Minerals Refresh has highlighted supply chain risks to, for instance, rare earth elements of importance to technologies for meeting 'net zero' objectives – reflecting the overlapping nature of these policy goals. The strategy outlines accelerating to a more circular UK economy in these metals as a key means by which to lessen import dependency and associated supply risks.

A taxonomic approach to the circular economy

Given its potential, as interest in the concept of a CE has grown, so too have the number of questions about its potential advantages, consequences, costs and 'how to'. This has led to a great deal of research papers each adding to an increasing number of definitions, classifications and visual representations of the CE. This is understandable given that the scope of CE implementation can be categorized at many different scales—encompassing activity, process, value chain stages, whole value chain or multi-tier systems. These can also operate at many different levels, whether individual actors, sectors, the local, regional or global.

The way that goods and services are produced, used and disposed of within the global and UK economy is often complex, involving multiple actors spanning institutional and industrial sectors and activities across different countries. The term 'value chain' refers to the full range of activities needed to create a product or service. This includes across the 'linear' stages of extraction, production, processing, manufacture, distribution, retail, use and disposal as well as those typically associated with a 'circular' economy – such as recycling, repair and remanufacturing – where being

undertaken (Figure 8). Other actors are involved in functions ranging from monitoring and regulating to investment, the administration of imports and exports and transactions more widely.

To facilitate a shared understanding of CE among and between stakeholders, there is a need for an agreed taxonomy or classification of terms and entities relevant to the field of interest, including what constitutes eligibility criteria for activities to be labelled circular. This is an important first step to be able to concisely describe the current state of play in relation to a desired CE target state and chart the transformation steps required to get there (Figure 7).

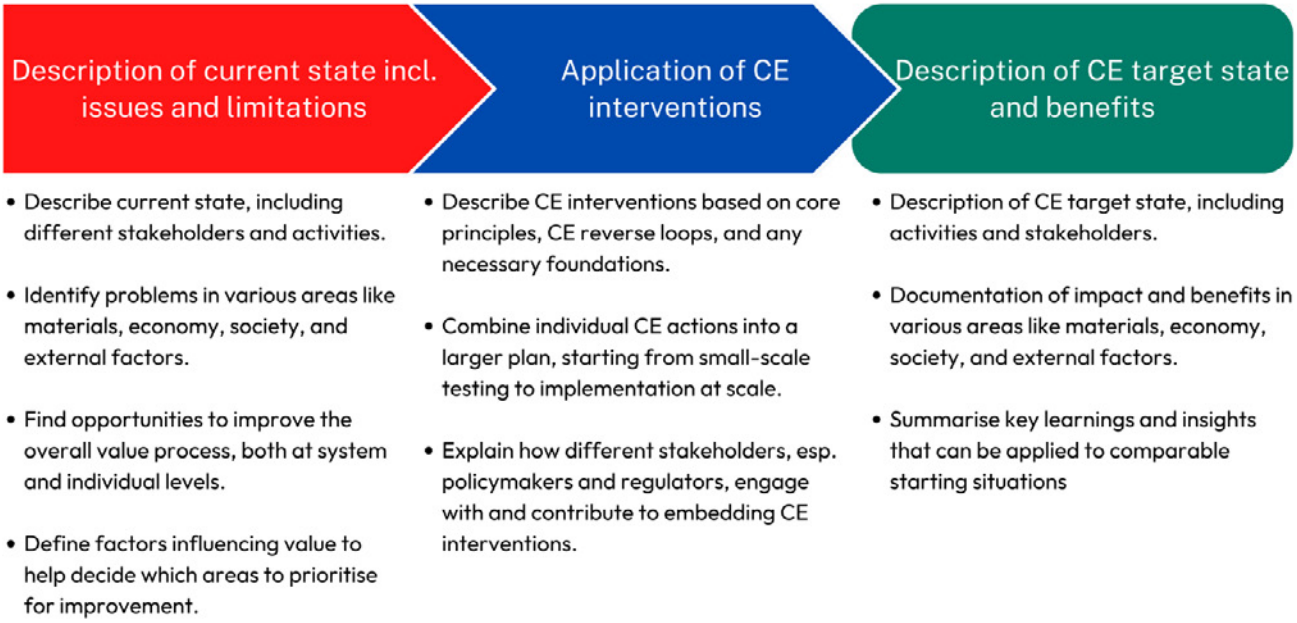


Figure 7. Steps in a CE value chain assessment

A taxonomy is a hierarchical classification system used in enterprises, organizations, and administrations to categorize various entities, encompassing both physical and conceptual elements (Smith, 2005; Hodgson, 2019). These may include processes, products, knowledge domains, human groups, and actors, all adjustable to different levels of granularity. Taxonomies can serve as a consistent and comparable framework, providing the basis for data collection, integration and in-depth description of a current value chain and its inputs. A hierarchical structure plays a crucial role in facilitating additional analyses related to the CE, such as quantifying value added at each step of the value chain, assessing externalities (via processes such as life cycle assessment and quantifying social impact), delineating collaboration and responsibilities and identifying opportunities for CE value creation.

A key benefit of a taxonomic approach to CE is to provide a powerful approach to map retrieve unstructured and structured data (Lysaght et al. 2022) and allow for efficient, transparent and navigable visualisation in the management of resource and waste flows. This is particularly beneficial in the context of complex organizational models for value chains, workflows, knowledge resources or relationships across relevant entities. An effective CE taxonomy is one that meets the interests, challenges, needs and questions raised by different stakeholder groups—that is, one that stands up to scrutiny. A taxonomy must therefore be able to support the segmentation, comparability and measurement of CE interventions, including product life extension, material substitution, changes in a policy against key performance indicators and metrics, for example national resource consumption to a product carbon footprint.

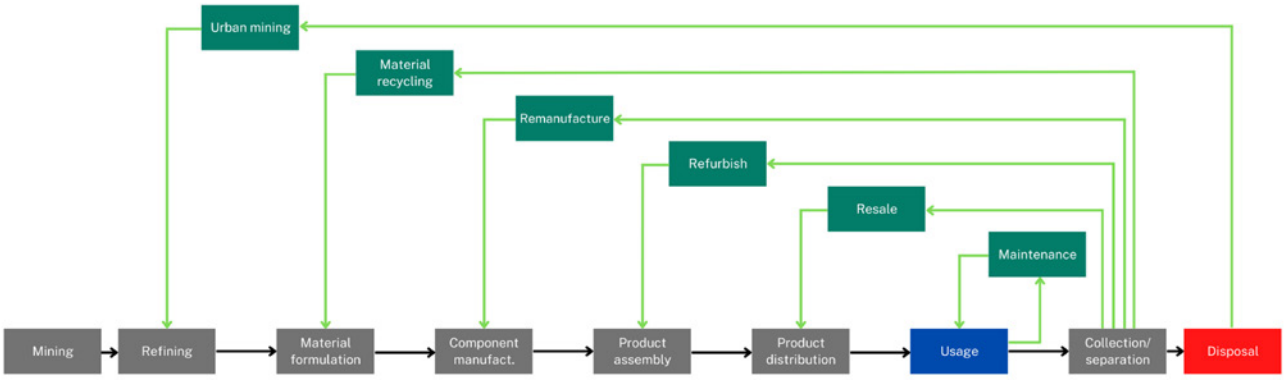


Figure 8. The CE-Hub value chain taxonomy

Significantly, the creation of our agnostic taxonomy is also the foundation for the NICER CE data observatory which quantifies the stocks and flows of strategic materials, components and products through the UK economy and the size of the benefits and target state for future CE transformations (columns 1 and 3 in Figure 7). This paper adds to these, by classifying many of the policy interventions (column 2) and relevant actors and stakeholders who need to be engaged and incentivised across the value chain to bring about CE transformation.

Building a robust baseline data model is a first step in spotting economic opportunity, and an evidence-based approach to explore and quantify prospective CE policy interventions. Questions around the CE are often approached as one-off data requests or studies, which both individually and cumulatively, can be expensive, time consuming, and restricted to single use, the very opposite of a circular economy. Having a systems view of data collection and value-analysis, requires a different approach, one we term 'circular data' (Nolan et al. 2022; Nolan, 2023). The CE-Hub value chain taxonomy and data modelling framework (Figure 9) has been designed to address different stakeholder questions (diagnostic/synthesis layer) about biophysical materials flows and impacts, economic, social and environmental costs and benefits at a variety of scales. Adding a business dynamics capability supports CE value creation exploration at a range of scales, cross value chain and with high customization potential aligned back to stakeholder questions and KPIs, including the choice and mix of policy instruments and actors, discussed in the next section.

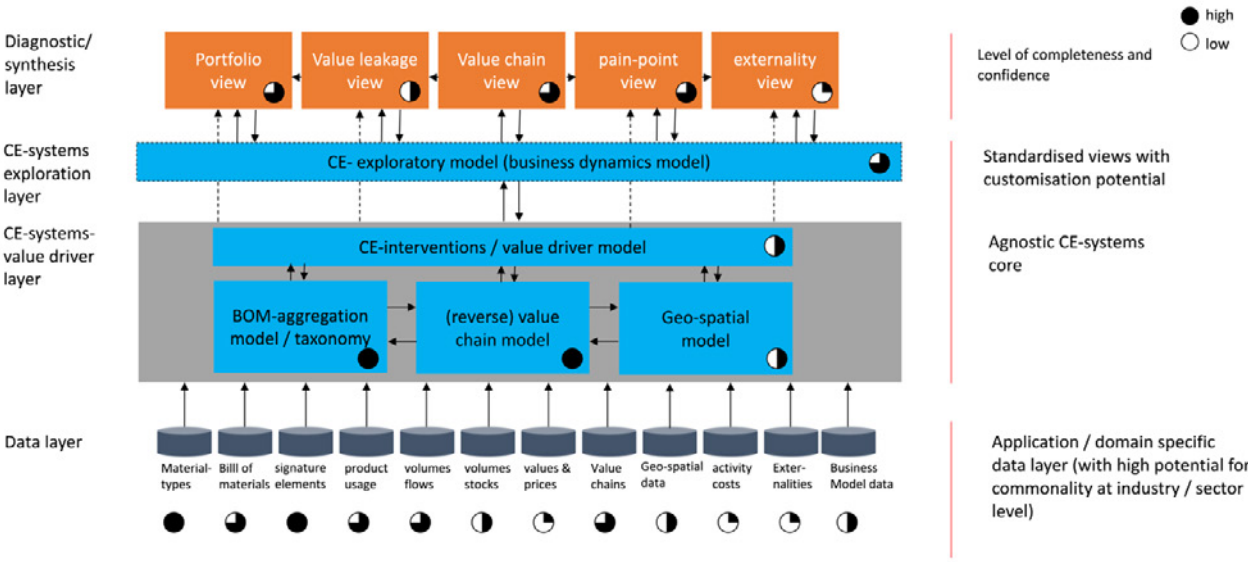


Figure 9. A circular economy data modelling framework

Section 2. Taxonomy of value chain actors and activities

A range of actors can, and in some cases are already, having a role in aligning the UK with the principles of a circular economy (CE). Section 2 sets out categories of actors critical to CE transformation in the UK and describes the types of influence they can have/functions they can play.

Value chains actors and activities

A key first stage in any CE intervention modelling is to map who the relevant stakeholders are and define the activities they undertake which can impact flows and stocks of materials, financial value and information. This provides a basis to assess drivers and stress points, power relations and information gaps and failures which can be relevant to designing interventions.

Circular systems, whether technical or biological, incorporate a range of activities that reduce demand for material inputs and revalorise, recover or reuse materials already in use (Wentworth and Burgon, 2016). For example, a technical cycle may involve a car being well maintained and then resold, its components being reused and constituent materials, recycled (Wentworth and Burgon, 2016). Moving to a more circular economy will require shifts in practices of actors undertaking these activities as well as linked technical and economic change (Wijkman, 2021). In addition, it may involve the emergence of new actors and stakeholders and redistribution of value (Zils and Hopkinson, 2023c). Some of this may come about voluntarily including as part of profit-seeking by firms and changes in consumer preferences, however processes of engagement, incentivization and more hierarchical forms of regulation are likely to also be neede given a range of market, system, transition and government 'failures' (van Ewijk, 2018. see Section 4).

There are different ways to map and describe actors and stakeholders of relevance to value chains and CE. The UNECE (2021) programme on sustainability in value chains proposes a three-way clustering (Figure 10):

1. The core value chain business actors and activities involved in the production of products and service including users and end of life recovery and processors (to which we add consumers);
2. The extended network of actors and activities that enable the value chain to function including certification bodies, technology providers, auditors; and
3. A wide business ecosystem that creates and shape/ influence the enabling conditions for value chains, actors and activities including policy, regulation, academia, think tanks and financial institutions.

Actors across these groups undertake functions that can contribute a UK CE to different extents, parameterised by the types of activities they engage in, responsibilities, incentives and resources. This also includes as both a source of regulation and target of it. For this report, we have used their diagram as a reference guide, and focused on a smaller sub set of categories considered most relevant to UK CE policy. exchange for trade in surpluses.

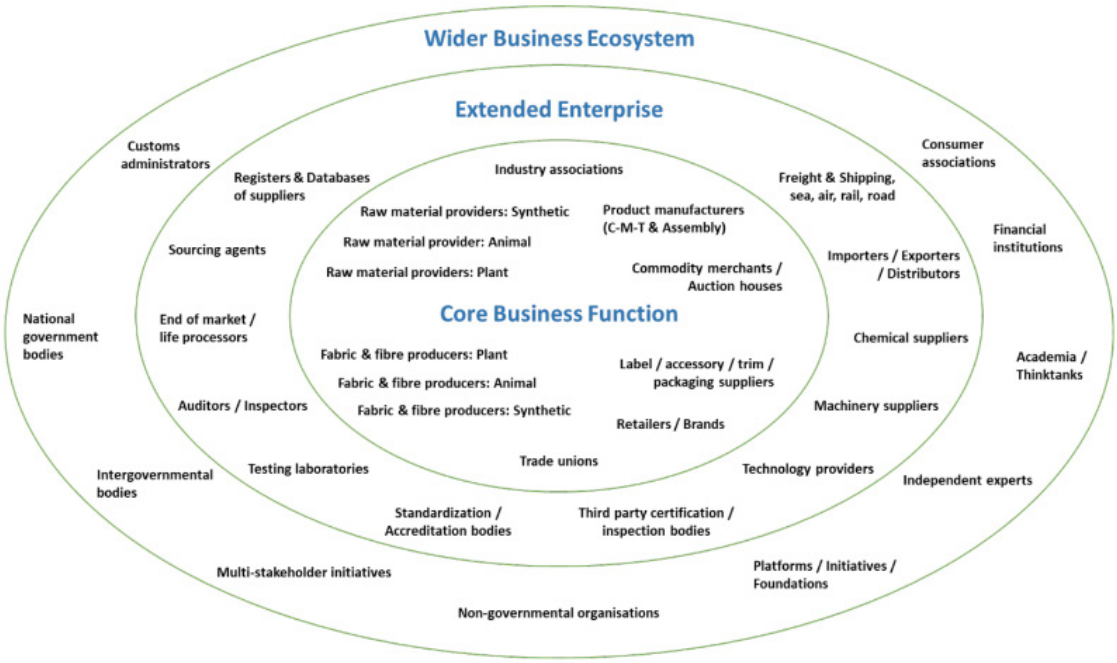


Figure 10. The Ecosystem Model (UNECE, 2021)

Wider business ecosystem stakeholders

Starting from the outermost concentric ring in Figure 10, 'wider business ecosystem' stakeholders such as government/state bodies, non-governmental organisations and academia can shape and parameterise the landscape in which value-chain-activities occur in various ways and in many cases, have a mandate or responsibility to do so.

Central government

Over 80% of UK business leaders surveyed in a 2022 poll agreed that government policies are required to bring about the economy-wide changes needed to tackle climate change, as a closely linked area to the CE (CISL, 2022). Regulation is often thought about solely as control by a government furthermore, with the OECD (2021a) defining regulation as 'instruments by which governments set requirements on enterprises and citizens'. Given their responsibilities and resources, primary avenues of influence available to central governments across the UK include:

1. the ability to issue legislative and policy instruments prescribing or prohibiting certain behaviours or technical conditions;
2. the distribution or redistribution of financial and other resources which can enable activities to be undertaken;
3. the means to collate and generated information by being in the centre of knowledge networks; and
4. the capacity to create organisations conducting activities such as public bodies or committees (Steurer, 2013; Duit, 2014). This includes at the international level such as participating in the G7 Alliance on Resource Efficiency.

Since the 1990s, many areas of law and policymaking relating to waste and resource management have been devolved across the countries making up the UK. This means that central government departments with jurisdictions relating to CE exist not only in the UK Government (as the central executive authority of the United Kingdom of Great Britain and Northern Ireland) but also in the Scottish Government, Welsh Government and Northern Ireland Executive - though devolution has been asymmetrical in the powers devolved across the four nations. With devolution, different stated objectives relating to the CE, approaches to achieve objectives and varying levels of activity have also emerged (OECD, 2022; Zils et al. 2023).

Key strategies published by governments across the UK include the Defra 2018 Resources and Waste Strategy for England, recently updated by the report 'Maximising Resources, Minimising Waste[4] and which sets out the future actions government will take to maximise resources and minimise waste across key resource intensive sectors such as construction, textiles, food and drink, packaging and electricals. Which sets out the future actions government will take to maximise resources and minimise waste across key resource intensive sectors such as construction, textiles, food and drink, packaging and electricals. Scotland's first CE strategy was published in 2016 'Making Things Last'[5] while a Scottish Circular Economy Bill was published in June 2023[6], with proposals for statutory targets and indicators to measure progress towards reducing waste and the national carbon footprint. The Welsh Government published its Circular Economy Beyond Recycling report in June 2021,

[4] https://www.gov.uk/government/publications/waste-prevention-programme-for-england-maximising-resources-minimising-waste/maximising-resources-minimising-waste-policy-summary-table,

[5] https://www.gov.scot/publications/making-things-last-circular-economy-strategy-scotland/

[6] https://www.gov.scot/news/circular-economy-bill-published/

to track progress of their circular economy strategy.[7] Beyond Recycling included indicators to scale up prevention and re-use, and placed circular economy beyond a purely material focus by linking to the national indicators under the Well being of Future Generations Act.[8] The Northern Ireland Department for the Economy is currently consulting on a circular economy strategy for NI[9], with a focus on innovation, sustainable production and consumption.

Local government

The structure of local government varies by country in the UK, with N. Ireland, Scotland and Wales having a single level of local government bodies while in England there is a combination of single-tier authorities in some areas and two-tiers of local government in others (OECD, 2022). Local authorities (LA) across the UK (referred to as local councils in N. Ireland) have statutory responsibility for council services including the collection and treatment of local-authority collected waste (LACW) and street sweepings (Rezaie et al. 2022). Historically, LAs organised as either individual or combined waste collection and/or disposal authorities have had localised discretion over budgetary allocations for waste management, materials collected, how frequently and treatment arrangements (Abbott, Nandeibam and O'Shea, 2011). There has been a move to greater consistency of these aspects in recent years through The 2021 Environment Act covering England and with similar interventions planned or in place in Scotland, Wales and N. Ireland.

In addition to potentially altering council services for which they are responsible, LAs as well as regional bodies and cities can help provide other enabling conditions for a CE transition (Figure 11) (EMF, 2019). This includes through setting ambition and direction (e.g. the West Midlands' Circular Economy Routemap), community engagement, financial resource allocation, advice and in-kind support (e.g. ReLondon's Business Transformation programme), planning, the management of public assets and as a purchaser of goods and services. Reports submitted by signatories to the Circular Cities Declaration show key trends including growing national and supra-national support to cities, the adoption of circular strategies and roadmaps to steer the transition (Abu-Bakar et al. 2023), investment in infrastructure, using public procurement to achieve objectives, establishing innovation programmes and projects and empowering citizens with a particular focus on the construction and food sectors (CCD, 2022).

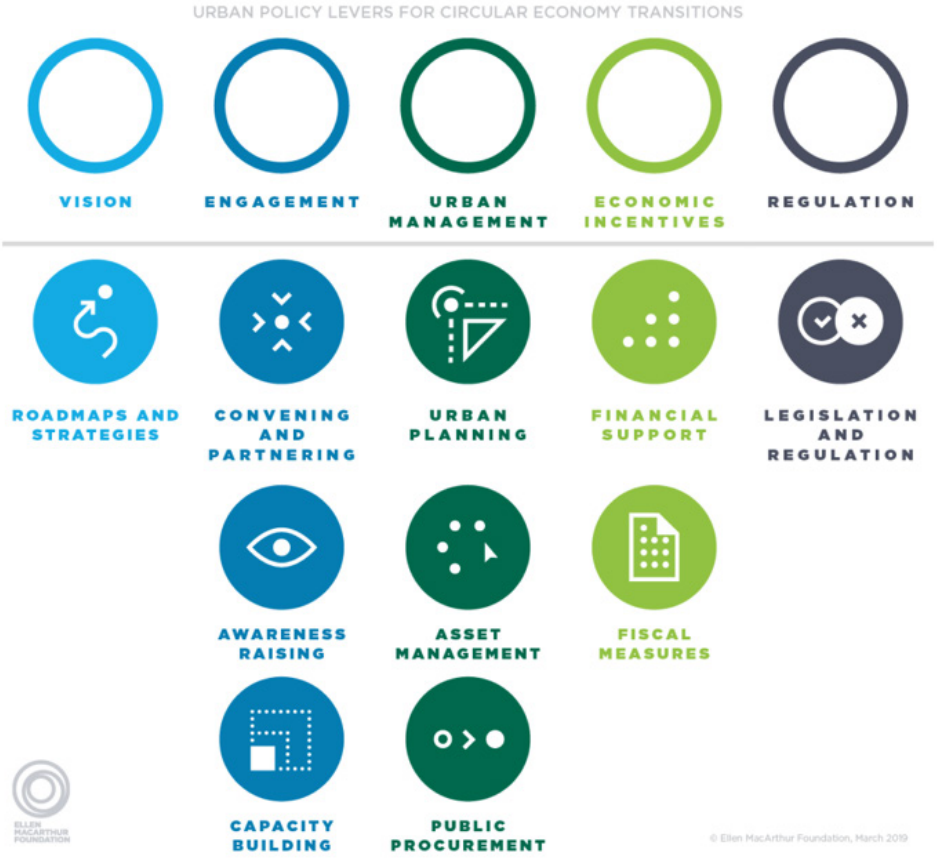


Figure 11. Urban policy levers for circular economy transitions (EMF, 2019)

[7] https://www.gov.wales/recycling-waste-circular-economy

[8] https://www.gov.wales/sites/default/files/publications/2021-10/well-being-future-generations-wales-act-2015-the-essentials-2021.pdf

[9] https://www.economy-ni.gov.uk/sites/default/files/consultations/economy/draft-circular-economy-strategy-for-northern-ireland-main-report.pdf

Non-governmental organisations and civil society

Through growth in opportunities for participation in the policymaking process and outside of it, civil society actors have acquired greater status in the landscape of environmental regulation. 'Civil society' broadly refers to stakeholders (interacting as) neither the government nor market and which includes the general public and those organised. Organised publics in the form of non-governmental organisations (NGOs) perform a variety of regulatory and steering functions relevant to the CE that include:

1. Inputting to agenda-setting and policy formulation via government facilitated routes of engagement such as consultations and outside of these;[10]
2. Collecting, analysing and disseminating information e.g. to monitor compliance;
3. Coordinating with other actors e.g. the Circular Economy Task Force convened by the Green Alliance to broker greater collaboration within sectors, improve product design and company reporting;
4. Pressurising firms and the government (such as through organising boycotts or legal routes e.g. the work of Client Earth) and whistle-blowing; and
5. Developing localised schemes, including inputting to production activities (Maitre-Ekern and Dalhammar, 2019).

In addition, NGO influence has increasingly taken on new forms such as establishing unilateral partnerships with firms and creating, promulgating and monitoring formalised standards. In many cases, this has arisen through the need to fill regulatory gaps emerging e.g., at the international level, such as the Forest Stewardship Council[11] (Klooster, 2005) and the Aluminium Stewardship Initiative.[12] Particularly prominent NGOs in the CE area include those closely tied to UK government bodies such as WRAP and Zero Waste Scotland as well as the Ellen MacArthur Foundation, the Green Alliance, Business in the Community and Circle Economy. Philanthropic groups which blur the line between public and private can too be active.

Intergovernmental bodies

The frequent global nature of environmental issues and upward scalar shifts in the governance landscape has seen supranational bodies at the international and regional levels take increasingly key positions in trying to tackle environmental pressures due to human activities. For instance, the United Nations' Environmental Programme (UNEP) has played a role in coordinating international scientific advisory bodies such as the IPCC and establishing international frameworks for climate change mitigation and adaptation, desertification and biodiversity. UNEP also has an important role in brokering information (e.g. the Global Material Flows database) and wider thought leadership.

Another particularly active supranational body in the area of CE is the World Economic Forum (WEF), with programmes developed including the Platform for Accelerating the Circular Economy (PACE) which works to develop commitments towards the circular economy via a range of value-chain partnerships. Other international bodies such as the World Bank are now active in this area through the production of reports and other outputs (World Bank, 2022). Many international agencies and organisations covering finance, shipping, energy and food production also have the potential to contribute to more circular and sustainable practices via their own routes of influence.

At a regional level, the UNECE is leading on many CE issues such as relating to data and value chain mapping, whilst the Circular Step[13] dialogue platform brings together CE focal points from over 27 UN countries to exchange policy developments, innovations, evidence of what works on the ground and build capacity to mobilise actions at various scales and sectoral ambitions, with the CE-Hub acting on behalf of the UK. The United Nations Economic Commission for Europe (UNECE) and OECD are also preparing joint guidelines on measuring circular economy,[14] comprising core and complementary indicators, with a view to developing implementation guidelines in 2024.[15]

[10] For example, the CE Hub submitted responses to the Circular Economy Strategy for Northern Ireland (March 2023) and the Circular Economy (Scotland) Bill (August 2023).

[11] A voluntary third-party mechanism covering global wood production chains.

[12] See: https://aluminium-stewardship.org/

[13] For more on Circular Step, see: https://unece.org/circular-economy/press/unece-launches-platform-policy-dialogue-circular-economy

[14] See: https://unece.org/sites/default/files/2023-03/S3_2_CE_Guidelines_SEEA_Sem2023-ML_update.pdf

[15] Recognising that the proliferation of standards and reporting mechanism is causing confusion, the EU has recently updated the Non-Financial Reporting Directive 2014/95/EU (2014) (NFRD) for reporting environmental information and opens the door for greater visibility of company level CE activity, progress and KPI metrics. A core aim of the NFRD is to increase disclosure on environmental and climate risks and opportunities and provide investors with greater detail about the sustainability of their investments.

Education, research and training providers

Making a shift from a linear to a circular economy represents a profound shift in the way we think about and the actions we all take in every facet of the economy and society. To make such a transformation requires education and training from preschool through to post 16 technical training, university education, apprenticeships, in-work skills and training programmes, as well as informal lifelong learning for everyone. Countries such as Finland (Tiippana-Usvasalo et al. 2023) have started this process, and case examples can be found in schools, colleges and universities and many businesses through organisations supported by the EMF.[16]

Overcoming barriers to, and designing enablers for, CE adoption and implementation will require new technologies, scientific solutions, social innovations, engineering and manufacturing systems, digital and data-driven approaches. This requires a clear focus on impact and outcomes at various scales, while dealing with complex and contested trade-offs and systems shifts as CE scales up. To overcome these barriers, an engaged research community is required. This includes universities, companies, government departments, NGOs and citizen groups, combining and collaborating in new, inter and trans-disciplinary formations. Collaborations should hold a shared or consistent perspective on the end states to maximise the potential from CE. Academic researchers and research programmes such as NICER, contribute to, among other things, the ability to evaluate and evidence the benefits, costs and risks of different CE options, including at the direct request of government policymakers.

The extended enterprise

The 'extended enterprise' consists of organisations such as auditors and standardisation bodies, testing labs, logistics and insurance firms and technology providers who through their activities, goods and services support, administer and enable value chains to operate and function. We outline the potential role of several of these actors below, while other relevant actors to CE transformation include ratings agencies and wider service suppliers such as the insurance sector (Farkova et al. 2023).

Standardisation bodies

Standardisation bodies help unify terminology and play an important role in providing frameworks and guidance to support, among other things, consistent testing, measurement, inspection and validation assessments as well as the uptake of relevant product requirements and information provision as part of environmental management standards. All of these can support the development of a more circular UK economy, including through the more efficient exchange of information between market actors by removing ambiguity in terms used, building trust and reducing risk.

An example of a private standards-issuing body is the British Standards Institution (BSI). BSI standards are typically broad in nature (covering e.g. principles and terminology) and for use by technical committees or actors when producing their own horizontal, generic or product-specific standards. Examples of BSI standards relevant to the circular economy include:

- BS 8001:2017 – Provides a framework for applying circular economy principles in organisations; and product-group specific frameworks e.g. for electronics:
- BS EN 45552:2020 - General method for the assessment of the durability of energy-related products;
- BS EN 45555:2019 - General methods for assessing the recyclability and recoverability of energy-related products; and
- BS EN IEC 62474:2019 - Material declaration for products of and for the electrotechnical industry.

In addition, the widely used ISO family of industry-based environmental management standards have been extended to include circular economy guidance such as:

- ISO 59020 – Provides a framework for measuring and assess circularity in organisations; and
- ISO 59000 – To set a conceptual framework of terms, measures, and indicators relating to the CE concept.

ISO and BSI standards are voluntarily adopted and maintained by private organisations. They are also widely accepted by public actors, adding to their perceived legitimacy and are therefore sometimes referred to as a form of 'hybrid governance' between actors (Falkner, 2003).

[16] For more on EMF's education and learning support, see: https://www.ellenmacarthurfoundation.org/resources/education-and-learning/overview

Finance sector

With money the lifeblood of market-based economies such as the UK, the finance sector holds a strategic role in driving a more circular economy. Public equity, private market funds and wider debt and equity instruments are frequently needed to develop and scale CE interventions, while a lack of finance frequently is quoted as a barrier to scaling or innovation in the first place (Mähönen, 2019). Investments in the linear economy can also run counter to CE aims, suggesting the need for a reconfiguration in places. Investor action on the circular economy is relatively nascent, but as with climate considerations, may be expected to come in the form of commitments and policies by firms and bodies in the finance sector as well as the uptake of metrics and ESG criteria (UN PRI, 2022). Central banks and wider financial supervisory bodies ranging from the international to national scale can also contribute to aligning the financial sector with societal objectives given their uniquely close links to capital markets (Couto, 2023).

Technology providers

Technology providers can work to fill new markets generated by government regulation or proactively offer a technology solution to core market actors and those throughout the business ecosystem. Government has an important role here, in regulating claims and in providing a stable environment for innovation and reducing investment uncertainty. Innovate UK, for example is the UK's national innovation agency, who support business-led innovation in all sectors, technologies and UK regions and provide private investor insights (Innovate UK, 2023). Private sector entities can also anticipate future government regulation or otherwise. For example, QSA is a CE business modelling company, funded by IUK through the NICER CR&D fund to develop data-led evidence to support future EPR for the British Fashion sector.[17] Examples of relevant technology providers include those working in the area of data (e.g., distributed ledgers, AI, IoT, sensors), for example, SAP and Topolytics, who offer products to support improved material tracing and internal accounting.

Core market actors

Core market (CM) actors including producers such as raw material providers, manufacturers and recyclers on the one hand and consumers on the other, are bound together through the production, processing and use of products along a given value chain.

Producers

In the CE-Hub's value chain taxonomy, core-market actors undertaking production activities across the linear value chain from mining through to product distribution, collection and disposal are primarily non-financial corporations as well as households as producing units (B2B, B2C and B2G). For reverse loop activities, non-financial corporations and households (as producers) are too particularly active, but as are NGOs/NPISHs and government bodies in some cases.

Shifts in business models have been conceptualized in different ways, ranging from symbolic and philanthropic on one end to integrative and finally innovative or transformative - though the development of new business models to solve issues and leverage CE approaches for competitive advantage (Clarkson, 1995; Halme and Laurila, 2008; Hopkinson and Zils, 2023a; 2023b). The adoption of more circular business models can occur at the firm or industry level in the absence of regulation for reasons including (Ambec and Lanoie, 2008; EMF, 2015):

- Reducing production costs and increasing competitiveness;
- Gaining differentiation advantages and entering new markets to increase sales and revenues;
- Establishing a positive corporate image and brand integrity;
- Managing risks threatening financial returns, including on the supply side to physical inputs or financing, on the demand-side such as changing preferences and from wider stakeholders e.g. regulators; and
- Influences from organizational culture and normative drivers, including non-instrumental values.

We explore the role of key production sectors further below.

Extractive and processing industry

Metallic mineral extraction to meet UK demand for metals is almost if not entirely met by overseas extraction currently, with no domestic extraction of iron ore reported to have taken place in the UK since 2008, UK domestic extraction of non-ferrous metals in 2021 standing at just 1,300 metric tonnes and no bauxite/other alumina nor copper reported to have been extracted in the UK over the 30 year period since

[17] For more on QSA, see: https://www.qsapartners.co.uk/news/

1992 (ONS, 2023a). In 2021, mining and quarrying of non-metallic minerals contributed £19.5 billion to UK GVA, with 205 million tonnes of non-metallic minerals extracted in the same year and of which over 90% was sand, gravel, limestone and gypsum. 70.4 million tonnes of 'fossil energy materials/carriers' were also extracted in the UK in 2020 (ONS, 2023). While industrial mineral extraction in the UK makes up a relatively small proportion of national GVA, foundational industries such as chemicals, ceramics, paper, glass and cement process large quantities of materials (e.g. around 28 million tonnes of material output per annum in the UK) and emit 50 million tonnes of CO2 per year, or 10% of the total CO2 emitted by UK homes and businesses. Changes in production practices in line with CE principles among these industries may hold decarbonization potential.

Farming, Forestry and Fisheries

Agriculture, forestry and fishing contributed approximately 3 billion GBP to UK GVA in 2021, with 136 million tonnes of biomass extraction/cultivation taking place in the UK in 2021, 95% of which was crops or crops residue and 6 million tonnes of wood (ONS, 2023a). Approximately 71% of UK landcover is managed by farmers and other land managers and these activities have a significant impact on people's health, access to the countryside, land, air and water quality and biodiversity. Agricultural, forestry and fishing practices impact on energy and material inputs furthermore (fertilisers, pesticides, automation), wildlife and fishery populations and the benefits of numerous ecosystem services. Developments around regenerative agriculture (EMF, n.d.), blue economy (LSE, 2023) and nature-based approaches to flood risk (Hopkinson et al. forthcoming) highlight the potential for applying CE principles to the biological sphere of the economy, for higher overall value creation across many different value chains.

Manufacturers

'Manufacturing' covers a broad number of activities, ranging from the creation of highly specialised metal components for aerospace to the production of fast fashion garments. The manufacturing sector forms a key component of the UK economy, with manufacturing product sales at £429.8 billion in 2022, and over 2.5 million people employed (ONS, 2023d; ONS, 2023e). Linear business models in the manufacturing phase involves a company procuring and sourcing raw materials, components, and semi-finished products from the upstream market and employing labour, capital and knowledge inputs to assemble and deliver products sold to users or consumers in a downstream market with little consideration for value recovery. The nature of competition in a linear throughput arrangement typically leads to two issues:

1. low cost, point of sales, transaction focus (versus quality or longevity)
2. no systematic end-of-use recovery and re-circulation of value

In many cases, there is no natural incentive for manufacturers to improve durability and/or to design products to be of higher (perceived) value at end of use. For some materially intensive products, such as a car, the embedded value of products at end of use is apparent and substantial and there are many value loops that take advantage of the residual value at the end of customer use. These include second-hand car dealerships, repair and refurbishment shops. At the end of product life there are very widely established scrap metal dealerships and recycling operations that capture value from the components and raw materials. For many other products however, there is no natural incentive for manufacturers to design products to maintain their value, resulting in limited revalorisation opportunities. An important example of this structural market leakage is in plastic packaging or plastic use in general where an estimated market value in excess of $80-$120 billion is disposed of every year (EMF, n.d.).

Startups and SMEs

A key barrier to more circular practices in businesses is the economics as well as technical and additional aspects (explored further in Section 4) which mean incumbent firms, especially larger businesses can't be relied upon alone to integrate CE practices and government at speed. Start-ups and SMEs, which make up the larger majority of businesses in all national economies, can be more agile and able to spot opportunity, take risks or fail fast, and therefore have the potential to develop potential key solutions. NICER CECs and the CE-Hub have featured and showcased many innovative start-ups and SMEs operating in different sectors and value chain segments, including through Collaborative Research and Development funding with Innovate UK.[18] Trade bodies, such as AMDEA and network organization, such as Federation of Small Business, provide important gateways to reach this huge, diverse, and often difficult to reach sector of the economy.

Retailers

Retailers act as the interface between producers and consumers, influencing demand for goods and services and how they are delivered. Retailers are therefore subject to a range of pressures, with growing environmental awareness, stakeholder pressures

[18] To view case studies of projects funded through the CR&D fund 'Innovating with the NICER Programme', in partnership with Innovate UK, see: https://ce-hub.org/knowledge-hub/nicer-and-innovate-uk-case-studies/

and government rules and regulations reportedly encouraging e.g. UK retailers to embrace circular business models in their operations in some sectors (Upadhyay, Kumar & Akter, 2021). Retailers can also influence post-consumption phases through the adoption and promotion of alternative business to the traditional sales-ownership transaction. Various forms of pre-competitive collaboration can be seen among these actors such as the 'Retailer Net-Zero Collaborative Action Plan' facilitated by WRAP and WWF to align carbon accounting approaches.

Waste management companies

Waste management companies are a key group who manage and coordinate the collection, processing and disposal of products and materials from different economic sectors and households, frequently on behalf of LAs. They do so as private entities ranging from small-medium enterprises (SMEs) to multinational corporations, for whom the need to generate profit including via markets for secondary materials, drives investment and interest in public and private sector contracts. Recycling, waste and wastewater management activities in the UK generated a gross value added (GVA) of £16.1 billion in 2020 and were associated with 156,000 FTE job roles (ONS, 2023c). Data on the flows of wastes held by many of these companies also form a key building block for understanding the quantity, quality, spatial distribution and disposal pathways for products and materials of interest. It should be noted that the environmental performance of waste management companies varies significantly and criminality within the sector is increasing (Environment Agency, 2021).

Reverse loop sectors

While aligning the UK economy with CE principles can be expected to involve changes in the practices of industries already represented along value chains such as manufacturers and retailers, structural shifts can be also be anticipated in other areas of the economy including the emergence of new sectors. For example, a growth in an assortment of activities which constitute the CE's 'reverse loops' and involve resource flows otherwise discarded, being intercepted and processed in a way that retains the value of materials, components or products in the economy, including collection. There are various schema to classify reverse loops, including the following activities (based on Cramer (2017) and Kirchherr, Reike and Hekkert (2017)):

- Maintenance/repair – fixing a defective product so it can be used with its original function;
- Reuse/resale - a further use of a product still in good condition;
- Refurbishment - restoring an old product for further use;
- Remanufacturing - using parts of discarded products within a new product with the same function; and
- Recycling - processing products or components into their constituent materials to obtain the same (high grade) or lower (low grade) quality.

It should nevertheless be highlighted that maintaining or circulating materials and products that are toxic, hazardous, or more environmentally damaging than new products is inconsistent with foundational CE principles.

Consumers

In addition to influencing value-chain activities as citizens through exercising the right to vote, advocacy or reputation shaming, households can also drive change through their consumption behaviours (Newell, 2008). For instance, consumers may: move patronage to a retailer who offers refillable solutions; purchase second-hand or remanufactured goods instead of new; or buy products less often and seek out repair opportunities for goods currently held. The responsiveness of consumers is a key determinant of the effectiveness of interventions such as mandatory information disclosure via labelling furthermore. Environmentally significant household behaviour change can be classified in different ways, including, for example, the avoid-shift-improve model based on:

1. Avoiding unnecessary consumption or impactful behaviour e.g. reducing food waste;
2. Shifting consumption activities to less environmentally impactful alternatives e.g. sharing instead of buying new; and
3. Improving environmental performance of activity in question e.g., using BEVs instead of ICEs.

Of the actors outlined, central and local government though not the only source of regulatory authority/capacity, have a prominent and critical role in the regulatory landscape for a UK CE. This including through an ability to issue laws, redistribute resources, provide services and set direction. The next section therefore looks in more detail at the instruments available to these bodies to drive change.

Section 3. Taxonomy of Public Policy Tools

With operationalizing CE value drivers a potential means to achieve public policy objectives, governments have a key role and responsibility in the CE regulation landscape. This section outlines the range of instruments available to government actors to help implement CE measures across the UK and provides examples of how these have been deployed to date.

Overview

Policy at its broadest refers to a course of action taken by a policy-producing entity on an issue at the decisional agenda, implemented through procedures or protocols in order to achieve certain objectives (British Ecological Society, 2017). At its simplest, it refers to a decision to do nothing or something on a particular issue by a policy-producing entity (Dye 1972). Tools or instruments are the specific means by which government actors exert influence and attempt to drive improvement. These can include:

1. The creation of plans (such as the 25 Year Environment Plan) that outline strategic objectives and strategies (such as the Resources and Waste Strategy or Critical Minerals Strategy) which further detail how these objectives will be met;
2. The introduction of legislative instruments, including primary legislation (i.e. the main laws passed by legislative bodies of the UK), and secondary legislation (i.e. delegated legislation including Statutory Instruments, Statutory Rules and Orders) made by a person or body under authority contained in primary legislation;
3. The ability to distribute and redistribute financial resources across the economy via fiscal and monetary policy and wider economic tools designed to raise revenues and increasingly also incentivise behaviour such as taxes, subsidies, grants or public procurement;
4. Soft tools such as voluntary approaches, advice-oriented information-based tools and participatory mechanisms; and
5. The allocation of organisational/administrative resources to conduct particular activities.

Regulatory modes (and links to actors)

Over the last few decades, instruments employed by government actors in the area of the environment in the UK have expanded beyond conventional 'hierarchical' regulatory instruments such as standards, bans, statutory targets and mandatory permitting procedures to include new environmental policy instruments (NEPIs). Hysing (2009) distinguishes between government as an actor and government as a form of steering therefore, recognising this growing number of ways governments seeks to bring about change - including as a purchaser, delegator, convener and promoter across market and network modes (Sørensen and Torfing, 2007). Government actors hold unique resources in the regulatory landscape in that they can regulate via hierarchical, market and network modes[19] (Kooiman, 1993):

1. Hierarchical - involving a pyramid of control with actors bound by a central authority as with traditional government. Instruments impose explicit obligations such as the exercise of formal laws and regulations;
2. Market - involving actors interacting as producers and consumers, communicating via prices and enabled by institutions such as property rights; and
3. Network – involving actors voluntarily coming together to achieve common goals through negotiation and connections.

NEPIs encompass economic and market-based instruments such as taxes, subsidies and public procurement on one hand (which seek to harness market dynamics to influence behaviour) and soft instruments such as information-disclosure, voluntary agreements and other network modes on the other - which seek to create boundary conditions to deliver change on a more discretionary basis through influencing knowledge levels and network and governance structures (Evans, 2012; Circle Economy, 2019; Nachtigall et al. 2022).

As well as changes in the regulatory modes leveraged by government, there has also been shifts in which actors are involved in regulation. Although governments have traditionally been the locus of regulatory authority, they are not the only actor with regulatory capacity today.

[19] Regulatory 'modes' refer to 'bundles of rules guiding interactions based on general principles about how actors are best motivated' (Evans, 2012, p.34) or expected and resourced to behave (Steurer, 2013).

The past several decades have seen a growth in non-state market-driven approaches such as certification schemes which are often led independently by private sector actors as well as industry self-regulation initiatives. This includes to fill gaps in the regulatory landscape arising through an increasingly globalized world, with firms able to transmit regulatory objectives upstream and downstream across geographies beyond where individual national governments have authority. The influence of organised and non-organised citizens to environmental objectives via network forms of regulation can also be seen in a wide number of cases. In addition, various forms of 'co-regulation' have emerged, when actors from different societal domains achieve objectives jointly (Steurer, 2013; Abbott and Snidal, 2009). An example is the industry-led, UN-convened, Net-Zero Banking Alliance or the EMF's Global Plastics Pact.[20] [21]

While network forms of regulation benefit from being flexible and responsive to emerging needs, they can nevertheless be susceptible to break-ups due to their voluntary nature. In addition, market-driven forms of regulation that take place at the level of individual firms or industries such as the use of codes of conducts, customer charters, standards, accreditation or offsets, can be limited in their effect by being contingent on market conditions. Firms may also try to derive the benefits of a 'greener' image without actually doing so given the potential economic benefits. In a more polycentric and varied regulation we see today, national and local governments therefore remains key actors in driving change, including as they are subject to public democratic oversight and accountability while having many difficult, if not impossible, to replicate regulatory and wider functions (Scharpf, 1997; Abbott, 2012).

Policy instrument types

Policy instruments available to public sector actors have been subdivided in different ways. Most broadly, into mandatory regulation (government bodies defining binding rules enforced by executive and judicial branches); regulation on one hand, and voluntary regulation (more suggestive or facilitative approaches without legal mandate) on the other. At a more detailed level, into hierarchical, market and network forms (as outlined above). Policy instruments can also be classified in terms of the level of 'regulatory intensity', bindingness and formalisation used in an attempt to bring about change (NAO, 2014; Hepburn, 2010). This continuum is evident not only across the instrument groups outlined below, but also within instrument groups. For example, information-based approaches range from mandatory information-reporting requirements to the state, to the market exchange of data, formal but voluntary data-sharing agreements and scraping data available online. Levels of enforcement and design aspects such as the availability of fixed-term regulatory exemptions and on which actor lies the burden of proof of compliance are also aspects of relevance to this stringency. We further define policy instruments available to government below.

No intervention

One option available to policy-makers is to simply let otherwise uninterrupted market and societal dynamics alongside existing regulations define outcomes, while engaging in little to no proactive intervention to go beyond this. The Green Book recommends a 'do-nothing' option is explored in policy appraisal. The NAO (2014) include making use of existing regulation or simplifying and clarifying these, improving enforcement and making legal remedies more accessible as options available under a 'do-nothing' scenario.

Voluntary instruments

Voluntary and cooperative instruments broadly involve action towards a desired outcome in the absence of a legal mandate. Voluntary environmental instruments have been used increasingly in the UK since the 1990s, including as part of a wider trend towards 'better regulation' (NAO, 2014). Voluntary approaches are diverse, ranging from private-sector unilateral action through to voluntary purchases by consumers of products with improved environmental performance. From the perspective of government but too other actors, a key motivation for the use of voluntary instruments is being able to achieve sought outcomes without the need for additional regulation. This can lessen costs for government and the private sector, while in some cases sidestepping the inertia that can be associated with the policy-making process. Voluntary instruments can be either brokered by the government or where developed by a non-state actor, alternatively supported, recognised and/or resourced by government actors in some way. These include (OECD, 2003):

[20] The Plastics Pact Network by the Ellen MacArthur Foundation links global national and regional initiatives, working collaboratively to enact solutions that drive the transition towards a circular economy for plastic. See: https://www.ellenmacarthurfoundation.org/the-plastics-pact-network

[21] Co-regulation doesn't always have to be explicitly coordinated between actors e.g. rating agencies have increased the competitiveness of corporate environmental performance by making raw data more legible to investors.

1. Voluntary industry standards - private codes of conduct to improve organisational performance promoted often by standardisation bodies, non-governmental organisations or governments. For example, the ISO 14000 environmental management system series, the European-level Eco-Management and Audit Scheme (EMAS) and the EU Taxonomy (Bauer, Busch and Tuncer, 2023).
2. Public voluntary challenges - programmes promoted or supported by public authorities which encourage firms, households or other institutional actors to improve environmental performance. For example, the London Food Purchasing Commitment developed by the NGOs ReLondon and Sustain alongside the London borough of Hackney.
3. Voluntary agreements - contractual or non-binding agreements with the aim of achieving certain objectives, developed through dialogue between public authorities or voluntary groups on one hand, and industry on the other (Defra, 2018b). Examples include the UK Plastics Pact and Textiles 2030 brokered by WRAP, as well as 'climate change agreements' made between industry and the Environment Agency to reduce energy use and CO2 emissions.

There are several examples of voluntary approaches achieving positive change in the UK in relation to CE objectives and those wider, suggesting these can be made to work when well-designed and targeted (OECD, 2000). The CE-Hub will further explore these pre-conditions, pros and cons of voluntary approaches as part of its policy tool profile series.

Information-based approaches

Moving towards a more circular economy in the UK presents new data and information needs, challenges and opportunities. These exist from micro-level interactions in purchasing and capital allocation decisions to the macro-level as an input into opportunity scanning and setting direction through policy. Across all scales and uses, high quality, reliable, relevant and timely data are frequently sought. Being in the centre of information and knowledge networks as well as having the ability to regulate hierarchically means central and local government actors can have a key role in filling many data gaps (Hood, 1983). Alongside longer-term education approaches, information-based approaches can include:

1. The provision of information such as to producers in the form of guidance/guidelines on resource efficiency;
2. Reducing transaction costs and other barriers to information flows such as through developing platforms, standardizing language or data sharing protocols;
3. The regulation of information flows between private actors e.g. the UK's Competition and Markets Authority (CMA) guidance on misleading green claims published in 2021; and
4. Mandated information disclosure, involving government mandating the reporting and public disclosure of information regarding the environmental performance of specific activities, products or an organisation (Blackman, Afsah and Ratunanda, 2004). Key routes for information to be made available include via labels, marking and information registers.

Procurement requirements

Approximately £400 billion is spent each year in the UK on public procurement suggesting that the UK government can exercise significant demand-side leverage through its purchasing decisions (HM Treasury, 2023b). Government consumption expenditure furthermore accounted for approximately 20% of England's material footprint (155 Mt) in 2020 (Defra, 2023b), and likely a similar percentage for the UK as a whole. 'Green public procurement' (GPP) is 'a process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life-cycle when compared to goods, services and works with the same primary function that would otherwise be procured' (EC, 2008, pg. 1). It is an economic-based consumption-side approach providing a direct but voluntary financial incentive to firms to develop products satisfying these requirements. GPP can work effectively as a demand-pull measure at the market formation and diffusion stages along the innovation lifecycle so as to increase the size of a market for a new technology (Nemet, 2009). There are a range of sustainable procurement applications already in use across government bodies in the UK, which include:

- The Public Services (Social Value) Act 2012 (the 'Social Value Act', or SVA) which requires consideration of how procurement might improve economic, social and environmental wellbeing;
- The 'Greening Government Commitments' to buy more sustainable and efficient products and services across the government estate; and
- The 'Procuring for Growth Balanced Scorecard' permitting non-financial considerations in major project procurements.

Nevertheless across the UK, procurement rules are largely fragmented at present. 'Circular procurement', as part of a wider GPP, involves public authorities intentionally procuring goods and services aligned with circular economy principles and with a reduced environmental impact relative to alternatives. Procurement changes to support the CE can be implemented in a variety of ways. Sweden, for instance, have put in place public procurement requirements for refurbished ICT equipment across its municipalities (Crafoord, Dalhammar and Milios, 2018).

Consumer rights

Consumer-rights approaches indirectly place a responsibility on firms, but which only comes into play if exercised by the consumer. Strengthening consumer rights and protection laws to support actions aligned with CE principles such as repair, may help consumers further wield a demand-side lever for driving change. As one example of a potential consumer-rights based approach, this could take the form of longer mandatory guarantees on product lifespans (Keirsbilck, Terryn and Alogna, 2020), the basis for which is already in place under the Consumer Rights Act 2015.

Responsibility-based approaches

Wider responsibility-based approaches include 'extended producer responsibility' (EPR) schemes - as well as the assignment of a 'duty of care' or liability such as on businesses or households for the correct treatment of waste and changes in the wider civil liability regime. EPR is a prominent environmental policy approach in which a producer's responsibility (whether physical or financial) for a product or asset/liability is extended to post-consumption stages of its lifecycle (OECD, 2001). This can reduce financial burdens on the public sector for waste management and potentially incentivize firms to innovate and pursue more sustainable design through mandating the internalisation of costs (OECD, 2020b). Several UK-wide producer responsibility schemes have already been introduced via:

- Producer Responsibility Obligations for packaging, which place requirements on eligible businesses to recover a portion of the packaging they placed on the market;
- The End-of-Life-Vehicles regulations, requiring producers introduce a take-back network for vehicles while meeting targets for reuse, recycling and recovery;
- The Waste Electrical and Electronic Equipment regulations, requiring producers of electronics and electrical equipment (EEE) register with an approved compliance scheme and pay for the costs associated with end-of-life treatment; and
- Regulations introducing producer responsibility requirements for batteries and accumulators.

Reforms to several these schemes are planned across the UK, while Defra have committed to consulting on the introduction of the EPR policy approach for five new additional product groups in England: textiles; bulky waste such as mattresses and furniture; vehicle tyres; fishing gear and certain materials used in the construction and demolition sector (Defra, 2018a).

Price & market-based instruments

In market economies such as the UK, prices parameterise activity. Prices for resources and waste management which do not reflect their associated negative externalities can incentivise the over-consumption of resources and over-production of waste (Bleischwitz, 2010). Price and market-based instruments seek to harness market dynamics to influence behaviour and can take the form of:

1. Administered prices - where a price is introduced in the absence of one or an existing price on goods or services is modified to better reflect otherwise externalised social costs in market prices (Pigou, 1920). Sub-types include:

   Taxes – a price per-unit levied on e.g. flows or stocks within the economy such as tonnes of packaging placed on the market with a less than 30% recycled content; as well as on the use of the environment as a source (such as a tax on primary material extraction); or a sink, whether for solid or gaseous wastes. Current applications in the UK include the:

   i. Aggregates Levy: Introduced in the UK in 2002, a tax levied on the commercial exploitation of rock, sand and gravel in the UK (Ettlinger, 2022). Current rates are £2.03 per tonne, with proposals for separate systems in some DAs e.g. the proposed Scottish Aggregates Levy

   ii. The Plastic Packaging Tax - Introduced in the UK in 2022, a tax on plastic packaging with less than 30% recycled content. Current rates are £210.82 per tonne; and

   iii. The Landfill Tax - Introduced in the UK in 1996, a two-tiered tax on the treatment of waste by landfill. Current rates are £102.10 per tonne for the 'standard rate' and £3.25 per tonne for the lower rate covering inert materials.

   b. Charges/fees - distinguished from taxes on the basis of being a 'requited' payment i.e. a good or service is received in exchange (ONS, 2019). Current applications in the UK include the:

i. Plastic Bag Charge - Introduced in the UK in October 2015, a charge levied on single-use carrier bags sold, priced at the level of 10p per bag since 2021 up from 5p when first introduced (2015);

ii. Congestion and emissions charges – e.g. Charges to enter 'clean air zones' with an emissions generating vehicle throughout cities in the UK; and

iii. A range of additional charges levied by the Environment Agency e.g. on International waste shipment transactions.

c. Charge-rebate systems - Front end fees added to a transaction, combined with a rebate conditional upon sought action being undertaken. Prospective applications in the UK include the:

i. Deposit-Return Schemes – Planned for introduction in Scotland, England, Wales & N. Ireland in 2025, a charge-rebate system consisting of front-end charges on single-use drinks containers combined with a rebate upon their disposal at collection points.

d. Subsidies – Subsidies can take indirect forms such as tax relief, which involves adjusting existing taxes to reduce disincentives/distortions to particular behaviours. An example of a historic application in the UK is the Enhanced Capital Allowances for water and energy-saving technologies. Subsidies can also take more direct forms of a payment to an actor, either to not undertake environmental 'bads' or to subsidize the provision of environmental 'goods'. Linked, grants are generally issued for specific purposes and offer a further potential means to support private demand/supply for e.g. new technologies. Applications in the UK have included the:

i. Boiler Scrappage Scheme - Introduced in 2010, the scheme aimed to encourage the replacement of old boilers with newer more energy efficient ones; and

ii. Feed-in tariff scheme for renewable energy sources - Introduced by Department of Energy and Climate Change and Ofgem from 2010 to stimulate the uptake of renewable energy sources in order to combat climate change and improve energy security.

2. Administered markets – work by assigning property rights over an allowable quantity of an environmental use or externality and creating (the mandate or conditions for) a market to trade in these (Coase, 1960). Sub-types include:

a. Cap and trade schemes - A maximum level of environmental use is set, split into individual units to be allocated by auction or grandfathering. Under these schemes, actors who reduce environmental use below the level of permits they hold can sell their surplus. Applications in the UK include the:

i. Landfill Allowance Trading Scheme (LATS) – Now defunct, introduced in 2005 with aim of reduce the amount of biodegradable waste going to landfill under the Landfill Directive;

ii. Traded fishery quotas- A trading and swap scheme ran by the Marine Management Organisation (MMO) to help maximise the use of fishing quotas; and

iii. EU and UK Emissions Trading Scheme - A trading scheme introduced from 2009 which applies a cap to total emissions (which decrease each year) and with eligible companies required to purchase an emissions allowance for every unit of CO2 emitted in one year.

b. Credit trading - Credits are assigned when an environmental good or service is produced, which can then be traded with those required to hold credits. While also incorporating trading, these do not necessarily set a cap. Applications in the UK to date includes the 'Packaging Waste Recovery Note System' developed as part of the UK implementation of the Packaging Directive.

3. Market-friction reductions and market ordering instruments – these include antitrust/competition enhancing laws and wider routes to reduce market transaction costs. An application in the UK is the Supply of Extended Warranties on Domestic Electrical Goods Order 2005, which sought to improve competition in the extended product warranty markets.

Trade policy and international governance

The potential role of trade policy in regulating global environmental problems has been a source of increasing focus. This can include through both tariff- and non-tariff measures (Yamaguchi, 2021; Santana, 2023).Tariff-based measures involve introducing custom duties on imports or exports. Non-tariff measures encompass 'policy measures other than tariffs that can potentially have an economic effect on international trade in goods' (UNCTAD, 2019). These can be broadly divided into 'technical measures', including regulations, standards, sanitary and phytosanitary (SPS) and Technical Barriers to Trade (TBT) measures on one hand, and 'non-technical measures' (NTMs) which include quantitative restrictions such as quotas, price measures or mandated distributional channels on the other. The compliance costs of NTMs are increasingly greater than customs duties (UNCTAD, 2023).

There are now more than 180 international environmental agreements (IEAs) covering a range of environmental issues and players. These broadly attempt to transform global public goods into common property resources and regulate the use of these resources in line with more sustainable levels. These can sometimes have cross-over with trade policy and of the IEAs in existence, approximately 10% incorporate trade provisions. These include the Cartagena Protocol, Kyoto Protocol, Montreal Protocol and Basel Convention, which either directly regulate trade of in-scope materials or products or indirectly influence trade through routes such as technology transfers. Most recently and in response to the global plastic pollution issue, over 175 nations have agreed to develop a legally binding agreement on plastic pollution by 2024.

Planning and permitting requirements

Procedural requirements relevant to the CE can be introduced in a variety of areas, including for planning policy, codes and audits, impact assessments and wider permitting processes. Environmental protection and sustainable development concerns have been given heightened primacy in planning in the UK through substantive and procedural changes in recent decades (Jones, 2012). Substantively, through broadening the range of material considerations that relevant decision makers must take into account at both the strategic plans and planning permission level and procedurally, through reducing the discretion of local decision makers. For example, heightened integration of environmental concerns in the planning system have resulted from the requirement of local plans to be aligned with sustainable development objectives such as is required under the National Planning Policy Framework (2012, updated 2021). The 2021 update – the National Model Design Code also provides tools and guidance for LAs to align local design codes with low carbon and circular economy principles.

Linked to the planning regime, the UK Integrated Pollution Prevention and Control regime was developed to regulate industrial installation in a cross-media pollution approach. Under the Environmental Protection Act 1990, since updated by the 2010 Environmental Permitting Regulations, permits are required for regulated activities which prescribe limit value and other conditions based on the application of Best Available Techniques (BATs) and Best Practical Environmental Options (BPEOs). Expanding these to further cover resource efficiency dimensions could support a more circular UK economy (Marshall, Velenturf and Jopson, 2018). Another example of relevant tools linked to permitting requirements is that requiring disclosure of convictions when applying for a permit for waste activities or installations (Environment Agency, 2023).

Direction setting

Defining and introducing plans, strategies and targets which effectively drive society towards a CE can help deliver 'strategic vision'. Key recent country-level plans and strategies across the four nations in the area of the CE include Scotland's Making Things Last (2016) and Circular Economy Bill (2023), England's Resources and Waste Strategy (2018), Wales' Beyond Recycling (2021) and the Draft Circular Economy Strategy for N. Ireland (2023). In addition, several plans targetting objectives associated with the CE predate the use of the term and which include the 2003 UK-level Sustainable Consumption and Production (SCP) framework 'Changing Patterns', its general action plan in the 2005 UK Sustainable Development Strategy and Waste Prevention Programmes since 2013 across the four nations intended to deliver preventive and integrated approaches to tackling waste.

In the UK, mandatory targets have been used to move waste from the lowest rungs of the waste hierarchy e.g. landfill diversion targets, household waste recycling targets and as part of EPR regulations on end-of-life-vehicles, packaging, batteries and WEEE, requiring producers to meet targets for reuse, recycling or recovery. Globally, attention has increasingly turned towards the importance of targets related to upstream resource use (WEF, 2019). The first wave of national-level targets across the EU and further afield relating to resource use largely targeted improvements in resource efficiency, however issues have been highlighted with these relative measures, including permitting absolute material demand to increase alongside (EEA, 2018). England considered a long-term target on resource productivity as part of the Environment Act. Across the UK, there has been a growth in applications and interest in targets (mandatory and non-) relating to resource use and set in absolute terms such as the Welsh Government's ambition to achieve 'one planet resource use' by 2050 (based on an ecological footprint calculation approach), the proposed target outlined in N. Irelands' Draft Circular Economy Strategy to reduce per capita material footprint to 8 tonnes per person and England's long-term target in law to reduce per-capita residual waste generation. Targets across the four nations in linked areas such as emissions are also drivers of change relevant to the CE.

Standards

Standards specify a particular process or condition to be attained and can include:

- Technology-or means-based standards, which mandate the use of specific technologies such as catalytic converters or activities and approaches such as waste segregation; and

- Performance-based standards, which prescribe a minimum quality or outcome to be met without requiring any specific way to achieve it. Outcomes can be set in relation to inputs] (such as fuel efficiency) or outputs (such as maximum emissions per unit of fuel used). Performance standards may also be specified in relation to ambient environmental quality, such as maximum NOx levels, which can be technology forcing and have implications for the CE.

Examples of relevant standards applied in the UK include:

1. Ecodesign standards, which work by limiting entry onto the market of the worst performing products for energy efficiency and now in some cases, covering resource efficiency dimensions;
2. The Restriction on Hazardous Substances Regulations which prohibited electrical and electronic equipment containing more than specified levels of lead, cadmium, mercury, hexavalent chromium, polybrominated biphenyl (PBB) and polybrominated diphenyl ether (PBDE) flame retardants from being placed on the market;
3. Performance standards levied on the government itself, such as targets introduced to reduce landfilling via the Landfill Directive; and
4. Technology standards such as incorporated in the UK Waste Regulation (2015), which require businesses and households to fully segregate their waste into general and recyclables. In addition, powers given under the Environment Act to mandate all LAs collect a consistent, minimum core set of dry recycling and organic recycling materials.

Bans

Bans are a strong prohibitory instrument used to restrict outright products, services or substances viewed to present an unacceptable risk to society or the environment. The use of bans is particularly relevant in cases where inaction creates a high level of risk and the desired outcome is for an activity to cease altogether (OBR, 2021). The scientific evidence for the impact of hazardous substances of concern on human health is a focal point for many such debates (e.g. Eales et al. 2022). Examples of bans applied or called for in the UK include the:

1. 2020 ban on single-use plastic straws, drinks stirrers and cotton buds in England and subsequent related bans and consultations;
2. The ban on biodegradable municipal waste going to landfill by 2025 in Scotland;
3. A UK-wide ban on the disposal of untreated industrial and automotive batteries to landfill under the Batteries and Accumulators and Waste Batteries and Accumulators Directive; and
4. The ban called for by the environment, food and rural affairs (EFRA) committee on the export of all plastic waste from the UK by 2027.

Bans are sometimes introduced alongside standards, which are increasingly ratcheted up in their stringency to provide a lead-in. **Project-level support**

Project- and programme-level support involves the government funding specific projects or programmes out of its budget. Project-level interventions can occur across technology-lifecycles from initial R&D to commercialization pilots and be introduced alongside other instruments to de-risk private investment (Schröder and Raes, 2021). The use of targeted public finance has been highlighted as a potentially critical way through which to attract private investment in infrastructure to support circular economy activities such as recycling and repair, for example (Aldersgate, 2021). Examples of this instrument applied in the UK to date include: a £4 million project funded by UKRI to develop an automated sorting and recycling demonstrator plant in textiles for the UK and the £20 million Plastics Innovation Fund.

Public sector delivery

Public sector delivery involves the Government financing and delivering on environmental protection directly e.g. HWRCs funded and ran by public authorities or via subcontracting arrangements. Governments across the UK no longer hold the same role in production via state enterprises as they did in the past. Nevertheless, the public sector retains an important indirect role in supporting the market and innovation (Castree, 2008), and continues to directly finance collective consumption in areas relevant to the use of resources such as waste management, public infrastructure and government operations. This is made possible through revenues generated by the government, which primarily comes from taxes paid in the UK alongside a small percentage (~10%) from non-tax sources[22] (IFS, 2023).

Wider forms of influence: Enabling, promoting and facilitating

The 'OECD Checklist for Action for the Circular Economy' extends the policy tools outlined to further detail some of the forms of 'soft' influence that governments can have, including through promotion and facilitation (Figure 12).

[22] Including income received from public corporations and interest payments on government assets.

Figure 12. The governance of the circular economy in cities and regions (OECD, 2020a)

For example, as promoters of the CE, cities, local authorities and other levels of government can define responsibilities in implementation processes, act as role models in their operational activity and support campaigns to promote reusable alternatives. As facilitators, those bodies can support system thinking to ensure coherence across sectors, enable collaboration and dialogue and work with industry and other actors to develop, for example, industry roadmaps. They can also provide enabling functions such as allocating financial stimulus to support the innovation process, capacity building across the public and private sector and introducing publicly accessible information, monitoring and evaluation systems based on robust data and incisive metrics (OECD, 2021b). These wider forms of influence can be seen at work in many cases in the UK. As one example, the Resources and Waste Provisional Common Framework Outline Agreement and Concordat (HM Government, 2022) sets out the UK-wide Resources and Waste Common Framework intended to facilitate multilateral policy development across the UK countries in coordination with one another.

Section 4. Policy tool selection

This section revisits the CE strategic outcomes and measures in Section 2 and looks at how these can be targeted by policy. It further outlines criteria that can be used when considering and comparing policy intervention options.

Linking policy interventions to CE strategic value drivers

Policy instruments can differ in their suitability and potential effectiveness depending on where change is sought to be driven across a value chain(s) and what type of change. Their suitability can also depend on whether change is sought to be driven in a singular area or across the economy.

Examples of policies potentially used at the production/product design stage include ecodesign requirements around design (for e.g. durability, repairability, recyclability) or embodied carbon content standards. Examples of policies at the consumption phase include purchasing requirements for public procurement related to resource efficiency criteria and labelling to support consumer choice. End of life instruments can include targets on reuse and recycling, EPR, project-level investment in recycling technologies and bans or restrictions on certain waste treatments (Milios, 2021).

Cross-cutting models of policy rationalisation should always be understood as simplifications. Nevertheless, they can help define where to focus policy instruments in an attempt to deliver strategic outcomes and to map input requirements for e.g. cost appraisal. Logic models (Figure 13) are often used to represent this theory (causal pathways and feedback loops) of how an intervention and its inputs can contribute to outcomes and yield benefits by addressing key drivers of performance (OHID, 2018) and can include the following components:

- Input: Something put into a process, project or change e.g. monetary or operational resources;
- Activity: What is done with the resources to produce the intended outputs e.g. introduction of policy or research as part of a programme like NICER;
- Outputs: Goods and services produced from inputs which result from the completion of activities;
- Intermediate outcomes: Changes resulting from outputs that have interacted with people and which might be the first outcomes that are observed (e.g. policy goals to support CE principles); and
- Strategic objectives/goals: The real-world (and generally, longer-term) impact the department is seeking to achieve e.g. social, economic or environmental change.

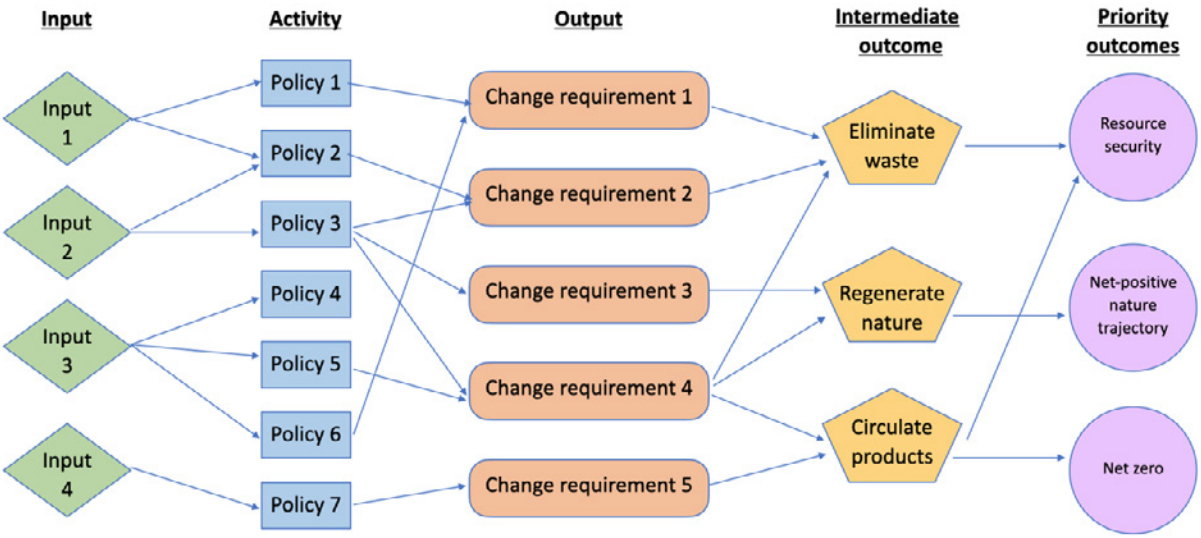


Figure 13. Illustrative logic model

To be robust, logic models need to have their assumptions grounded in evidence (HMT, 2023). 'Systems mapping' is an increasingly incorporated part of the option identification process, and can help identify dependencies between policies, barriers and contingencies on other actors and inputs at an early stage (Barbrook-Johnson and Penn, 2022).

Table 2. Public policy instruments classified by point of introduction along the value chain most commonly associated with

Instrument	Inflow	Use	Outflow
Voluntary instruments	X		X
Information-based	X	X	X
Procurement requirements	X		
Consumer rights		X	
Responsibility-based (EPR)			X
Price & market-based	X	X	X
Trade policy	X		X
Direction-setting			X
Standards	X		X
Bans	X		X
Project-level support	X	X	X
Public sector delivery			X

Instrument choice can be highly consequential for overall costs and benefits of pathways, risk management, positive spillovers and immediacy among other dimensions. In addition, how policy is designed and implemented is critical to reducing the economic burdens potentially posed by regulation such as increased barriers to market entry, reduced competition, transaction and administrative costs (Berestycki and Dechezleprêtre, 2020).

Domains of instrument focus

Policies of potential relevance to the CE can be further separated into their domain of focus and whether they are levied on:

1. Material flows and stocks in and at the interface of the economy. These consist of:

   a. policies levied on material flows and stocks (built capital) within the economy such as mandated recycling rates or secondary material requirements as well as more widely relating to the quality, quantity and location of materials, components or products; and

   b. policies applied at the technosphere-ecosphere boundary such as relating to the use of the environment as a material source or sink e.g. the UK Landfill Tax or UK Aggregates Levy.

2. Wider effluents

   a. As well as being relevant to CE objectives through contributing to the same long-term outcomes sought, instruments directly regulating emissions to the environment (atmosphere, land and water) can indirectly leverage CE value drivers. For instance, some evidence suggests fuel economy standards introduced primarily to reduce fuel use have been met partly through the lightweighting of vehicles (IRP, 2020). At the same time, other evidence points to fuel economy standards potentially encouraging a shift towards larger size vehicles in some markets (Whitefoot and Skerlos, 2011), while policies such as increasing the turnover of capital stocks via scrappage schemes to reduce the emissions intensity of the in-use stock, can appear to run directly

counter to CE value drivers in the immediate term and the impacts of these should be considered and managed as best as possible.

3. The natural capital stock

   a. Instruments regulating the condition and/or processes of the natural capital stock such as targets on tree cover or microplastic pollution levels, can also be relevant to the CE outcomes and principles outlined through routes such as increasing the supply of sustainable feedstocks or indirectly incentivizing reductions in the environmental intensity of economic activities through limits on the use of the environment as a source or sink.

4. Financial, human and social capital and transfers

   a. The Ellen MacArthur Foundation outline strategic-level policy goals 'to develop, deploy and scale circular economy solutions' (EMF, 2021) and which include: make the economics work; invest in innovation, infrastructure and skills e.g. investing in domestic reprocessing capacity (HM Government, 2023); and collaborate for systems change. Reflected here is the importance of investing in human capital and innovation for a CE transition – including education and specific knowledge, enabling development processes such as retraining as well as the availability and alignment of other inputs such as finance. Institutional and social capital, including networks, norms and trust can also help lower transaction costs in a CE transition and support the innovation process (alongside project-level support) across stages from invention to niche market creation, diffusion and saturation (Maskell, 2000). Macroeconomic policy can be highly relevant through its effect on the scale of economic activities and resultant material and energy throughput (Sterner and Corsia, 2013).

Other policy domains of relevance to CE objectives indirectly, include those relating to human health e.g. the UK ban on asbestos which can make reduce risks and barriers to construction waste recovery activities. Overall, while policies focusing directly on the flows and stocks of materials are often seen as most directly relevant to realizing the principles of a CE, policies in adjacent or supporting areas can also be as effective, or even critical as part of a policy mix. Determining where these can be extended to leverage CE value drivers may also be a pragmatic approach as in some cases, policy in linked areas such as covering emissions have greater political traction.

Policy mixes

In trying to leverage CE strategic value drivers and tackle barriers, policy issuing government bodies can have a choice between discrete instruments or an instrument 'mix'. In the UK, new policies are not introduced in a vacuum and will interact with existing legislative and regulatory requirements.

All policy instruments have strengths and weaknesses and differ in their suitability in relation to given policy objectives, while none have the ability to address every aspect of developing a more circular economy on their own. This is often the case even for individual product groups e.g. textiles (WRAP, 2023). This implies that policies to support a circular economy are likely to need to be introduced as a mix, levied also at different scales (del Rio and Howlett, 2013; Wilts and O'Brien, 2019).

Box 1: The COM-B framework - An example of the need for policy mix to affect desired behaviours, actions and practices

Pro-environmental behavior encompasses choices and actions that reduce environmental impact or improve the environment (West and Michie, 2020). The COM-B model, which consists of Capability, Opportunity, and Motivation, is one of several behavior models used to understand and influence behavior. Other models also exist, each offering unique insights and approaches. In the context of government tools for driving change, the COM-B model classifies these tools into three categories:

- Enhancing capability through knowledge and skill development
- Increasing opportunities for desired actions, such as infrastructure provision and financial support
- Boosting motivation for desired behaviors

The COM-B framework suggests that policies should combine these elements to create conditions for desired actions. For example, an effective recycling policy may require businesses to have the capability, opportunity, and motivation to recycle (Defra, 2018b).

When developing a policy response, diversity of instruments for diversity's sake should be avoided (Gunningham 2009). A 2007 OECD study found a mix of instruments were not always better than a single one for delivering environmental outcomes efficiently. Where there is a sound basis to introduce policies alongside one another, these need to be leveraged within a coherent framework across the lifecycle of materials, products and services to be efficient, in addition to the system in which those materials and products operate (Box 1). Certain instrument mixes such as EPR and taxes, which can be additive in nature or environmental tax and subsidy reform, may offer greater complementarity than others.

Coherence with the wider policy landscape is also key, particularly with policies for delivering 'net zero' and industrial strategy. Complementarities and conflicts between instruments and broader considerations such as performance against critical success factors and alignment with existing domestic cultural, legal, technological and policy arrangements can be considered to ensure policies do not combine to be less than the sum of their parts (Howlett, 2004).

Sequencing

The sequence in which instruments are introduced as part of a policy pathway can have implications for aggregate costs and benefits given the potential for interactions. For instance, while certain instruments such as taxes might help reach near-term objectives, technology-push policies might need to be introduced concurrently to bring new technologies to the shelf without which more ambitious long-term objectives may not easily be met (Sandén and Azar, 2005). Different schools of thought exist on best sequencing approaches. Bleischwitz (2010) calls for a step-by-step approach to policy introduction addressing market failures first.

'Smart regulation principles' recommend a responsive approach, whereby instrument choice is escalated from combinations including least interventionist approaches to those which involve a higher degree of coercion based on responsiveness of regulatees (Gunningham, 2009). Marginal abatement cost-curve (MACC) approaches propose starting with policies with least net cost and expanding out. Criticisms of MACC-based approaches relate primarily to overlooking temporal interdependence between policies, however. For instance, Grubb and Wieners (2020) illustrate a slow carbon price ramp approach is likely inefficient in the case when carbon abatement costs are shaped by innovation. In this case, higher cost options may be more effective to start with if they drive down innovation over time, and therefore reduce cumulative costs.

Barriers and enablers

Barriers are things that restrain change towards a particular outcome and can represent elements of the status quo which if not managed, can delay or limit change, in some cases indefinitely (OECD, 2009). Barriers to CE implementation can arise in many forms across economic, policy, technological, social and operational dimensions and which can differ by product or value chain stage. Introducing regulation without consideration of these can lead to deadweight loss.

As an example, barriers to the expansion of domestic recycling capacity have been noted to include relatively lower prices for exporting waste which is treated as equivalent to domestic reprocessing in current regulatory frameworks, the volatility of recycling note values in existing packaging recycling note markets and resultant uncertain returns on investments (Iacovidou et al. 2020 in OECD, 2022). Further examples of barriers along the value chain are outlined in Figure 14.

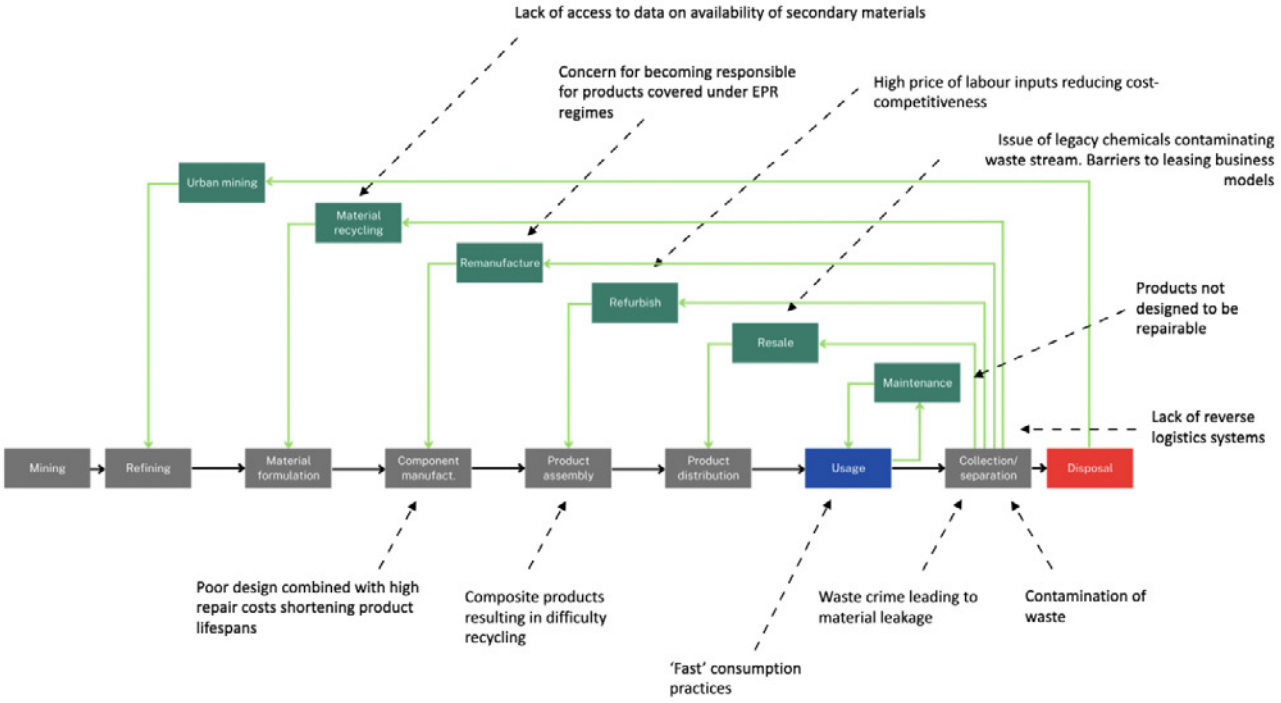


Figure 14. Examples of barriers along the value chain

In relation to economic barriers, the potential high upfront capital costs for introducing new products, processes, businesses or reverse logistics systems can act as a limit to change, including for new market entrants.[23] In addition, CE business models can be associated with higher operating expenditures such as for secondary versus virgin material inputs or for production models requiring higher labour inputs as is often the case at present for e.g. improved separation of waste or reverse logistics. For instance, where lime-based mortar is used, there is a very high technical potential for the reuse of bricks however this is often not exploited due to high costs (Hopkinson et al. 2018). In addition, potential differentiation advantages of new products may be undermined by a limited willingness of consumers to pay a premium or switch at all (Olander and Thøgersen, 2014). For instance, the inconvenience and cost of repairing electronics has been identified as a barrier to consumers for adopting these practices (Cole, Cooper and Gnanapragasam, 2017).

Technical and knowledge barriers are also major hindrances for enterprises. Technological barriers to circular economy objectives in the UK exist at the product and process level, and include poor product design for durability and disassembly, quality issues with secondary materials (Jaeger and Upadhyay, 2020), a lack of technical expertise, skills and training in relevant solutions, a lack of infrastructure such as for waste treatment and technical solutions to support CE such as recovery and sorting of complex materials and gaps in data systems. Other barriers are financial, including financial structures within enterprises and lack of external financial support from banks (Melati, Nikam and Nguyen, 2021).

Among businesses, hesitancy in adopting CE practices can result from firm core rigidities but also a short-term business culture. Behavioural barriers such as the 'status quo' bias can lead to companies underestimating the value of long-term benefits versus short-term costs and/or overestimate the risks associated with such investments (HM Government, 2013). A prominent cultural barrier to the CE among households is the lack of public awareness about what the circular economy is and its potential benefits, leading to a lack of demand for relevant products and practices - highlighted in Ireland's 'Whole of Government Circular Economy Strategy' 2022-23 (Department of the Environment, Climate and Communications, 2021).

Linked to barriers but in areas where the government might most readily have influence, the grounds for introducing policy is sometimes thought about in terms of responding to particular 'failures'. These are described below.

[23] These capital cost will also be associated with opportunity costs for alternative investments that may have greater payoff certainty (Flachenecker, Bleischwitz and Rentschler, 2018).

Market failures

Theoretically, a market failure is a problem that violates one of the assumptions of the first theorem of welfare economics (that a private market economy will achieve efficiency) and causes the market economy to deliver an outcome that does not maximize efficiency. The conditions required to maximize market efficiency include, among others, full information as well as the absence of externalities and split incentives (van Ewijk, 2018). At the level of the economy as a whole, 'market failures' that inhibit an increase in resource efficiency, resource productivity and a more circular economy include (van Ewijk, 2018):

1. Externalities - As well as eating into natural capital stocks when use rates exceed those of renewal, processes of extraction, production and disposal can often also negatively impact the environment via pollution and land use change. These impacts are frequently unmarketed, with externalities referring to uncompensated costs or benefits not accounted for in production/consumption functions. Correcting these frequently requires the involvement of government to reduce the oversupply of negative externalities or enhance the undersupply of positive externalities. Price and market-based instruments work by reflecting externalised environmental costs within market prices or by creating property rights over the environment and facilitating exchange of these;
2. Missing markets or excessive market frictions - An absence of markets can lead to missing economic incentives for activities that can reduce externalities such as using secondary materials. Regulation can encourage these markets to develop such as secondary material requirements or reduced market frictions through providing data platforms for industrial symbiosis e.g. N. Ireland's resource matchmaking scheme;
3. Split incentives - Split incentives refer to instances where an actor in the position of being able to make a decision which might improve the treatment of resources does not stand to gain even though others may, and thereby leading to limit incentives to make changes (Ekins et al. 2019),. Examples of this are manufacturers not being incentivised to design products for more circular end of life treatment as they do not shoulder the costs of waste disposal nor stand to gain from recovered resources under most management regimes. Policy levers which can help correct this include market-ordering instruments such as EPR, though design is an important consideration. Market-ordering instruments such as EPR work by aligning the incentives of actors to ensure they are responsible for and benefit from, environmentally-relevant decisions; and
4. Information failures - More circular systems frequently require new or improved information exchange between actors. A wide range of data-gaps nevertheless exist relevant to the circular economy and in particular, information asymmetries can exist between producers and consumers regarding product characteristics such as for durability or ease of repair. These can be viewed as a failure in information markets. Information-based instruments, including programmes of guidance for SMEs, developing data systems and disclosure requirements can be used to resolve information undersupply and asymmetries.

System failures

The UK is one of the most technologically innovative countries in the world, supported by conducive physical and technological infrastructure, scientific and technological capabilities and high levels of human capital alongside strong education and training, the availability of risk capital and wider social contextual factors (Storper, 1997). An 'innovation-systems' perspective emphasises the role of regulation in tackling factors inhibiting innovation and which can indirectly hinder CE outcomes (van Ewijk, 2018). These partly overlap with market failures (e.g., positive knowledge externalities), but also include an absence of relevant infrastructure and institutions (Maskell, 2000), low levels of human capital and limited access to required resource.

Government bodies can support innovation processes via laws and regulation. This includes through technology-push policies stimulating the supply of new technologies, demand-pull policies to increase the size of a market for new technologies and environmental policies, to support technologies the emergence or expansion of which may be undermined by market failures (Sandén and Azar, 2005). Government, and too other actors, can also support innovation through enabling interactions via the development of stakeholder discussion platforms to support constructive collaboration and competition. The use of waste as resources, for example, depends on mutual trust between entrepreneurs as well as effective standards. To tackle these failures, government can also build capabilities through the provision of education, funds and collaborative platforms to build knowledge and skills.

Transition failures

While addressing market failures is often a primary objective in UK regulation, even well-functioning markets in terms of being allocatively efficient can be blind to long-term societal goals (van Ewijk, 2018). To promote sustainable consumption, production and investment, some degree of institutional planning initiated by a community or government can also be necessary (van Ewijk, 2018; Weber and Rohracher, 2012). In many cases furthermore, major societal breakthroughs have been achieved through concerted government effort to drive long-term change, including dedicated research funding and infrastructural development (Mazzucato, 2015). The government plays an important role in driving the direction of long-term societal change that meets the needs of the whole populace as part of public interest regulation. Therefore, transitioning to more resource productive systems of production and consumption can be undermined by 'transition failures', such as insufficient guidance and coordination being in place for driving a system towards intended outcomes.

Policy instruments to resolve transition failures include target setting which can offer strategic direction to engender focused action. Another set of policy intervention relates to the coordination of sectors to ensure coherence in actions. Coordination and ensuring policy coherence across sectors and time can be done through aligning policies across sectors and materials, such as between requirements for recycled content and the sufficient provision of waste infrastructure to collect recyclables. Innovation policies can also be key to overcome existing technological equilibria where no individual actor has sufficiently strong incentive or capacity to make change.

Amending government failures

Government or regulatory failure can occur through two forms. Firstly, where state actors have failed to intervene where doing so could have otherwise realistically promoted greater efficiency. This can be understood as regulatory failure of the first type. Secondly, previous government intervention may have led to a less efficient situation than before or what might have otherwise realistically been due e.g. to poor policy design, the costs of interventions being higher than benefits or missing information. This can be thought of as government failure of the second type. The types of issues arising through government failure can span all other failures outlined here. For instance, predominant models of producer responsibility in the UK have been based on 'collective responsibility', with the costs for the collection and recycling shared among participating companies based on the amount of products put on the market. This approach lowers the ambition of individual companies to develop more circular products as a company would have to bear the costs of improved design and production changes while the benefits of the reduced end-of-life costs would be shared with all other companies in the market i.e. there is a split incentive as a result (van Rossem et al. 2006). Tackling historic government failures can therefore be an important part of a CE policy pathway.

Assessing policy options

Key questions that policy-generating government departments may have in the longlist process of policy options include what is the alignment of an option to strategic objectives of the department and what are the critical interventions needed to deliver required changes, their likely effectiveness, feasibility and affordability. Policy instruments can differ in their effectiveness and efficiency in achieving medium and long-term policy objectives, meaning the choice of instrument can be a key factor to consider additional to measures sought to be driven. At the longlist appraisal stage therefore, policy options (a combination of both a measure and policy instrument) can be assessed against a set of criteria or 'Critical Success Factors' (CSFs) i.e. 'attributes essential to the successful delivery of projects and programmes' (HM Treasury, 2023a). Multi-criteria decision analysis (MCDA) can be used to facilitate the consideration of multiple criteria in decision-making.[24] Examples of relevant CSFs re outlined below.

Effectiveness and efficiency

For CE-related policy and regulation, the potential effectiveness of an option can be assessed in relation to objectives such as reducing (primary) resource use, waste generation, reducing leakage and improving waste treatment. The immediacy (the indicative time required to implement) with which these effects might arise and certainty of meeting aims (predictability) are also key aspects of effectiveness over a given time frame.

Since 1999 in the UK (NAO, 2014), laws and policies expected to have a large welfare impact are subject to an extended shortlist appraisal process. Cost-benefit analysis (CBA) as part of an impact assessment is the default analytical framework when formulating government regulation with an anticipated impact over a certain threshold (British Ecological Society, 2017). At the longlist stage, policy options can therefore be considered in relation to how efficiently outcomes are

[24] The recommended method for longlist appraisal in the Green Book is a Multi-Criteria Decision Analysis (MCDA) approach using factors whose weights are defined through swing-weighting. Such an approach can be used to provide an overall score to policies based on how they score against individual CSF in combination with weights

delivered and whether these outcomes move the UK towards a more optimal distribution of goods, services and pollution (allocative efficiency).

Financial cost to the public sector

A key part of moving from theoretical to actual benefits is political and administrative feasibility (the ability to put a policy into effect in a given context). Government affordability is an important part of this. In addition to considering evidence on abatement and compliance costs from the perspective of potential regulatees, evidence on direct and indirect administrative costs to government (including at policy design and enforcement stages) of options, as well as any revenues generated which can offset these are important aspects to consider (HMT, 2022).

Long-run effects

Long-run effects include the ability of a policy instrument to meet regulatory aims persistently into the future (longevity) and to do so robustly in the context of external changes such as inflation. In addition, the ability of an instrument to be updated in response to new information and its capacity to harness technological change so as to lower the costs of achieving goals over time should be considered (Fiorino, 2004). Traditional CBA can struggle to capture dynamics effects resulting from the impacts on policies on processes of change in the economy, including innovation, diffusion, growth and structural change and other methodological approaches e.g. econometric models can be employed to explore these (Sharpe et al. 2021).

Distributional and equity effects

The state plays an important role in trying to ensure that the preferences of not only current citizens, but too future citizens and those who are less well heard (both today and tomorrow), are taken into account in decision-making. Considering the net-effects of instruments on different people and groups, and how these may exacerbate pre-existing inequities is an important consideration when selecting policy options therefore (Bryant and Bailey, 1997). While there have been some attempts to incorporate distributional concerns into CBA (OECD, 2018), its underpinning principles lack a distributional perspective, treating bearers of costs and benefits equally. Therefore, considering these separately is important as well as accordance with other ethical principles such as the 'polluter pays principle'. Evidence of regressive effects across income strata or geographies and particularly concerning any of the groups identified by the Equality Act 2010, as well as disproportionate burdens on small and micro businesses are furthermore required to be considered as part of the policy process in many cases (RPC, 2019).

Spillovers

Spillovers, both positive and negative can include: soft effects such as any impacts on attitudes, awareness and learning; wider economic impacts including on innovation and trade balance; and perverse incentives, as well as any contribution to potentially unintended consequences such as negatively impacting competition, giving rise to cross-media impacts or increasing waste crime. An example of a negative cross-media impact of a policy intervention was the IMO's 2018 Ship Emissions Regulation which led to the installation of equipment helping meet atmospheric emissions regulations but by routing discharge into the ocean. Another is possible increases in waste crime resulting from increased policy stringency via e.g. price increases in Landfill Tax. Another key 'spillover' of concern around CE regulation relates to possible 'rebound effects' eating into resource productivity gains, which can arise directly through lower prices, and indirectly through income effects. These are a particular risk under conditions of economic growth and stable or declining resource prices (Jevons, 1866; Alcott, 2005).

Strategic fit

The 'strategic fit' of a policy option reflects how policy interventions might support 'national, regional, local or organisational policies, initiatives and targets', align with other projects and programmes and fit with wider business strategy of UK public bodies (HM Treasury, 2023a). This is a further part of feasibility.

Section 5. A UK circular economy policy strategy

Building off the taxonomy outlined, this section summarises a series of potential policy pathways for CE change in the UK at a systems scale and across different time horizons.

Overview

Transforming the current predominately linear UK economy towards a circular economy is a long-term ambition and will require political and industrial leadership, policy mixes across multiple connected value chains and a comprehensive and systematic approach to measurement with evidence formation across agreed KPIs and appraisal frameworks. The good news is that it is happening already, often at different speeds and fragmented, but the pace and scale of change is increasing in certain sectors. At the same time some areas of the linear economy such as fashion or construction are deeply entrenched, and will require more than just a nudge.

To take a step back and look across the policy tools currently available to impact on value chain actors and activities, we created a simple roadmap as an example of what a future CE policy strategy through to 2050 might look like across three phases: inflow, use and outflow, initially across the technical sphere of the circular economy. Future papers will explore biological and natural capital sphere in greater details. Within the technosphere, it is not intended to address every economic sector, every environmental impact or social issue, but is broad brush to encompass practical, actionable steps that can be taken now or within current policy tools to drive technological, environmental and social innovations and scale up the core goals of CE highlighted at the start of this document.

The 2050 UK CE proposal outlined is driven by pragmatic strategies to increase CE value creation along core material and product value chains by leveraging CE value drivers which include a) maximising the value of end of life service resource and material flows, b) extending the life of stocks of existing infrastructure and products e.g. by upscaling servitisation and performance models, c) to reduce the material intake-demand by dematerialisation and improving the mix towards renewable feedstocks, and d) to power the transition increasingly with renewable energy, notably green hydrogen. Given the UK's high dependence on product imports, attention is also directed to circular-design and product liability strategies extending upstream to global supply chains.

Implementation of the proposal would span three phases. Phase 1 will identify robust, no-regret initiatives which will enable a rapid uptake, minimise transitional costs, have public and political acceptability and utilise known or near to market-ready technologies. Phase 2 will apply key system enablers to drive lasting change for the 'rules of the game', have longer lead times, require further evidence and research, be more costly and require greater levels of collaboration and agreements. Phase 3 will irreversibly embed and implement system level solutions at scale, requiring substantial reconfigurations of legislation, regulation, sectors, value chains, behaviours, innovations and involve more complex trade-offs across fully integrated and transparent value chains. Achieving this vision will require measurement and monitoring via the NICER CE-Observatory to identify, initiate and implement CE at scale to boost the UK's wealth creation and well-being while taking global leadership on a responsible resource stewardship for a net- zero pathway. A full policy appraisal has not been undertaken at this stage and any policy needs to be appraised and monitored carefully to evaluate achievement against desired outcomes and correct for any unintended consequences.

2022-25

Strategic value chain drivers	Policy enablers and actors (examples)	Intervention
Intercept and revalorise legacy resource flows	Materials and products Producers Retailers Standards Bodies Government	Establish a value chain governance and delivery framework for CE starting with: • Mandatory standards for reusability, repairability, recyclability and disassembly to be met through circular-design (this would provide a more stable footing for re-processing and the secondary materials market and would also allow supply chain auditing and monitoring); • EPR with fee modulation, Product Performance Standards and Product Liability obligations for priority products, resource stocks and flows; • Ban exports of UK waste starting with WEE and
	Technology Government Academia Startups/SMEs NGOs Trade assoc.	• Plan the next 5-year National CE infrastructure based on policy shifts above including banning new EfW, wood fired power stations and improved collection and sorting; • Enhanced CE funding for industry-research-societal partnering mechanisms
	Economic Government Extractive and processing industry	• Increase landfill and incineration gate fees; • full pricing of waste treatment.
	Social Local authority EA Manufacturers Retailers	• Support and finance local/regional clean-up/recovery and obsolete stock collections.and obsolete stock collections.
Max/intensify use	Materials and products Government NGOs Households	• Improve tax incentives for lifetime extension e.g. variable VAT for repair and maintenance.
	Technology Manufacturers Technology Co. SME/start ups	• Connect and monitor usage/condition of all major products and installations to enable predictive maintenance and enable value retention models. Prioritise technological developments e.g. IoT, AI, Digital Twins that support this vision
	Economic Local Authority Government Financial Services	• Incentives (tax breaks, soft loans) for enhanced public asset management (intensification, longevity, renovation, avoid demolition) and business support to enable CE innovation.

Strategic value chain drivers	Policy enablers and actors (examples)	Intervention
	Social Government & their agencies Local Authority Regulators Producers Retailers Consumers Households	• Integrate Natural Capital Accounting/Green Book into infrastructure and public procurement programmes; • Build evidence base for consumer 'nudge' and 'what works' to major sectors.
Optimise inputs	Materials and products Government	• Establish CE import certification to ensure imported products/ materials meet CE objectives.
	Technology Academia Research & Innovation Funding	• Long term injection of research/Innovation and funding CE industrial priorities geared towards longevity, revalorisation and optimising/reducing future inputs; Manufacturer guidance on reducing process losses.
	Economic Government Local Authority Primary industry Manufacturers SMEs Start Ups Standards Org.	• Circular economy criteria into all public procurement tenders to incentivise suppliers • Carbon tax (based on EUTS) doubling every 3 years; • Embodied carbon standards; • Shift tax burden from labour to resource consumption • non re-usable content; Revised Aggregates levy to address exemptions; • Long term mechanism and support for Global south to address CE -led resource shifts, losses and adjustments.
	Social Manufacturers Households Standards Org. Government	• Strengthen right to repair to make it cheaper to repair (WEEE) and other products than to buy new; • Product durability standards, products designed for repairability; affordable spare parts and repair services; access to the information to carry out repairs.
		• Construct a CE dashboard of metrics and indicators aligned to CE vision and goals (inc. broader KPIs for National 'Economic' Performance); • Create standardised and annual corporate CE accounting protocol, disclosure standards.
		• Long term Government led CE 'Mission' to set direction and vision including "Ministerial lead and responsibility for CE"; • Build a UK 2050 CE Routemap as an overall guide for policy development (to include common barriers, challenges, gaps and investment needs).

2025 +

Strategic value chain drivers	Policy enablers and actors (examples)	Intervention
Intercept and revalorise	Materials and products Government Local Authority Regulators	• Revised targets for resource and waste management to rebalance a perceived over-emphasis on recycling and encourage waste minimisation, reduction, re-use and repair; • Assessments of the economic viability of each new policy (e.g. potential secondary markets) and infrastructure requirements, recognising that incentives may initially be required to ensure successful policy uptake and implementation; • Enhanced monitoring programmes and stronger regulation to eliminate and avoid hazardous substances of concern and impacts of future meta and nano materials on value creation from post consumption life cycles.
	Technology Academia R&D	• Enhanced CE funding for industry-research-societal partnering mechanisms – innovation labs, partnership budgets, challenge mechanisms aligned to UKRI and IUK strategic technologies.
	Economic Finance sector	• Co-financing instruments (CE bonds) for demonstrator regional and local integrated resource hubs and higher risk, CE systems level projects.
	Social Education and skills bodies NGOs Local Authority	• Drive significant investments into information and educating consumer choices to shift demand towards circular configurations, incentivise active participation of communities to enable joint sharing of CE proceeds within their communities, boost local job creation and upskilling for revalorisation of assets.
Max and intensify use	Materials and products Government	• Review and evolve aspects of the Waste Framework Directive which deter circular approaches, specifically Definition of Waste, Definition of By-Products and End of Waste
	Technology Academia Manufacturers	• Innovate technology and mechanisms for intensification of use (esp. low productivity assets)
	Economic Households	• Incentivise multi-user shared economy services to intensity use and create higher returns from assets designed to last longer; intensify servitisation (e.g. MaaS, XaaS, BaaS)
	Social	• Comms and awareness campaigns targeting reducing resource consumption, reused, repurposed rather than recycling and efficiency.

Strategic value chain drivers	Policy enablers and actors (examples)	Intervention
Optimise inputs	Materials and products	• Restructure cross border movements of waste (e.g. international shipments, trade and use of recycled materials) to promote UK's domestic circular resource management prior
	Technology Academia R&D bodies Startups and SME	• Innovate dematerialisation or renewable alternatives for material goods across all sectors especially consumable. Design out disposable, non-regenerative products and items.
	Economic Government Finance sector	• Harmonise upstream and downstream primary resource, environmental and emission taxes, tariffs, fines, VAT and bans, remove perverse subsidies and reinvest in desired outcomes. • Funding streams/co- finance to support collaboration, incubators, investment programmes.
	Social Government Local authority NGOs SME and start ups Education and skills	• Policy and incentives to ensure: products designed for repairability; affordable spare parts and repair services; access to the information to carry out repairs; • Incentives and support for exchange marketplaces, community innovation and repair hubs; • Tailored CE capacity building and skills development for local groups/businesses
Measure, visualise, prioritise, steer	Government Regulators Data Technology companies	• Bridge the gap between government departments through CE 'value chain directors' responsible for specific and cross cutting strategic value chains/ sectors; • Build a National CE data strategy, • CE accounts that makes the quantity, quality, location, value and pathways of stocks and flows of natural capital, resources, products, components and materials visible and verifiable to identify CE opportunities
Governance	Government Producers Consumers Civic Society	• Improve inter-governmental coordination across ministries, national and regional entities to improve alignment of objectives and building consensus for interventions approaches (e.g. wider gap on tax incentives, regulate out non-CE and harmful practices.

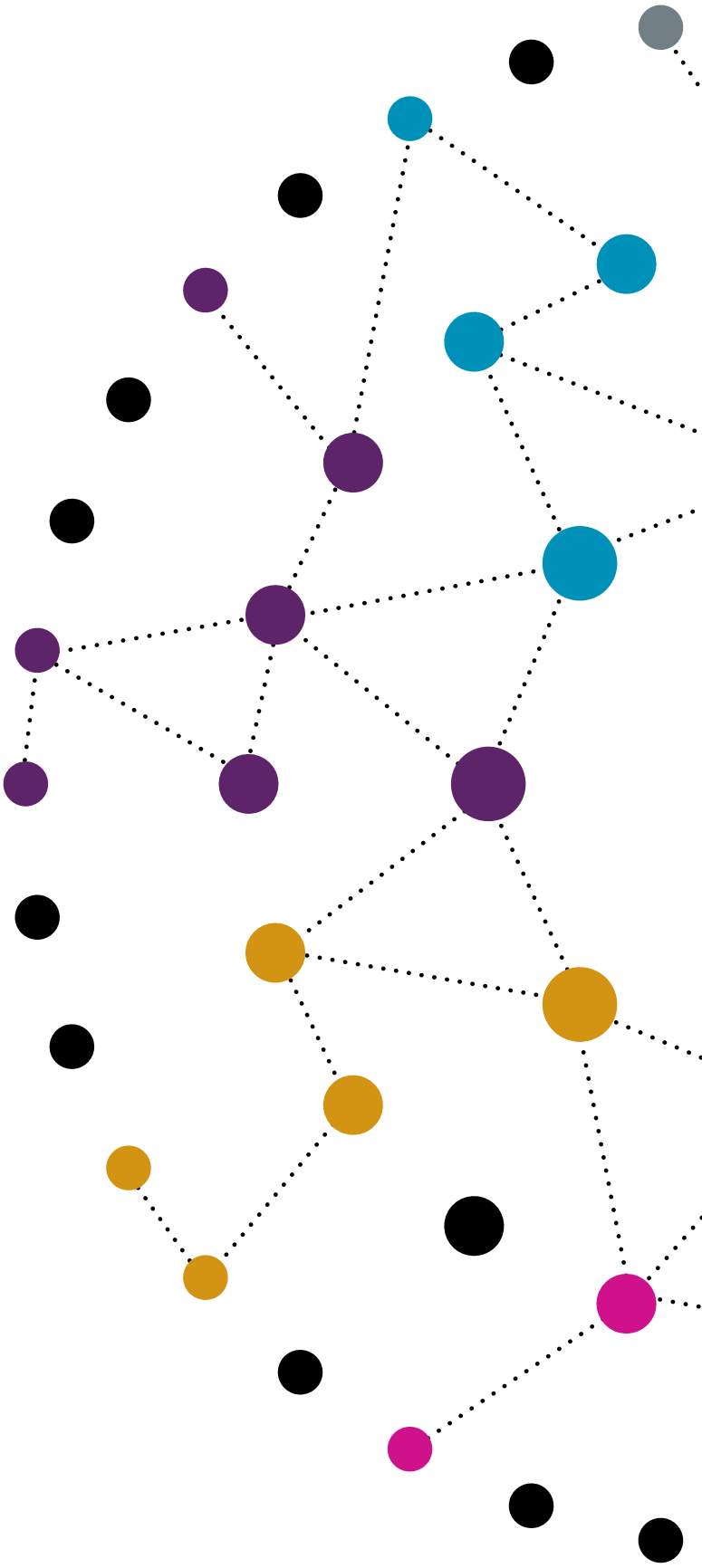
2040s

Strategic value chain drivers	Policy enablers and actors (examples)	Intervention
A fully circular UK economy	Materials and products Government Regulators Data Technology Producers	• Modulate, intensify and correct policies in light of evidence-monitoring and evaluation.
	Technology Government Regulators Data technology company	• Embedded technologies to ensure full transparency, trust and provenance of material/product flows across multiple life cycles and value chains.
	Economic Government Local Authority Producers	• All externalities fully priced, allocated; Revenues recirculated and distributed fairly towards key enablers, actors and outcomes; all citizens (esp. low income) rewarded for contributions towards 2050 vision.
	Social Households NGO Education and skills	• Mechanisms and incentives for an engaged citizenry aligned to circular products, services, system maintenance and enhancement.

Next steps

Anchored to the value chain taxonomy developed by the CE-Hub, this working paper has set out a classification of public policy tools that can be applied to leverage the potential benefits of CE strategic value drivers in the UK to achieve societal objectives. This provides a structure for building evidence on the UK regulatory landscape as it relates to the CE and offers a framework for making recommendations to move the UK towards a more circular, resource efficient and sustainable economy. It will be used as part of the NICER programme to continue to build evidence on the regulation landscape and shape any policy recommendations. It is a first pass and rather than remaining fixed, will continue to develop to meet requirements.

Planned applications of the taxonomy include a series of 'policy tool profiles'. These will provide more detailed case studies of how policy tools are currently being used in the UK and further afield in support of CE and linked objectives, assess policy tools against the CSFs outlined, define in which contexts and under which conditions tools are likely to be most effective (including accounting for policy interactions), set out how instruments can be modelled across core appraisal methodologies and make recommendations for policy design and implementation. In addition, and applying the taxonomy as a diagnostic tool, a series of policy briefs are planned, looking at barriers and enablers to circular value creation in specific areas in greater depth and providing recommendations for the adjustment, extension, introduction or reconfiguration of policy instruments to enable the changes/measures identified as necessary by NICER programme centres to realise the benefits of greater circularity across the UK.



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