Circular Economy and Carbon Targets

Professor Peter Hopkinson and Professor Fiona Charnley

Co-Directors of the Exeter Centre for the Circular Economy and UKRI National Interdisciplinary Circular Economy Hub (CE-Hub), University of Exeter

Introduction

Each year, the UK requires 1.2Bn tonnes of materials to sustain the current economy. This figure includes domestic consumption, but also technical and biological materials associated with global supply chains including fossil fuel consumption. This equates to around 17 tonnes per capita p.a. All industrialised Nations share this material intensity characteristic and emerging economies are rapidly following a similar trajectory[1] .

These material throughputs create large amounts of waste and emissions at every stage of the supply chain. For example, around 35% of all food produced is never consumed, generating 6.6 million tonnes of waste in the UK (1.3 Bn tonnes globally) and adds increasing pressure to soil systems and biodiversity[2]. Materials such as sand, which we might believe to be abundant and non-controversial, are being used at a rate far greater than they are being replenished with adverse consequences that affects livelihoods and exacerbate climate change stresses. A Recent UN report has highlighted how the 50Bn tonnes of sand used in the world economy each year impacts on rivers leading to pollution, flooding and drought[3].

Many of the products, services and infrastructure that constitute final UK demand are disposed of well-before the end of their economic or technical life cycle. For example 35% of all materials in the apparel supply chain ending up as waste even before a garment reaches the consumer, £30 billion worth of clothes remain unworn and 350,000 tonnes / £140 million worth of clothing goes to landfill each year. Not only does 'Fast Fashion' generate an exceptional amount of material and economic waste but the embodied carbon and greenhouse gases that were used to create the items in the first life cycle. A recent report highlighted that 45% of all carbon emissions are associated with the production and consumption of buildings, vehicles, electronics, clothes, food and packaging[4]. This pattern of linear, single life throughput of materials is a hall mark of an unsustainable and inefficient linear economic model, sometimes referred to as a take-make-dispose model.

Renewable Technology

It is widely agreed that the shift to renewable energy and decarbonisation of energy grids is an essential part of meeting carbon targets notably scope 1 and 2 emissions. However, many of the technologies associated with the solutions proposed for this shift are materially intensive involving a plethora of critical resources (Figure 1).

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[1] Haas et al (2016) How circular is the world economy. https://www.researchgate.net/publication/304816391_How_Circular_Is_the_Global_Economy_A_Sociometabolic_Analysis

[2] FAO (2020): Available at http://www.fao.org/food-loss-and-food-waste/flw-data)

[3] UNEP (2019) Sand and sustainability Available at https://www.unep.org/news-and-stories/press-release/rising-demand-sand-calls-resource-governance

[4] Ellen MacArthur Foundation (2020) Completing the circle. How the circular economy tackles climate change. Available at https://www.ellenmacarthurfoundation.org/assets/downloads/Completing_The_Picture_How_The_Circular_Economy-_Tackles_Climate_Change_V3_26_September.pdf

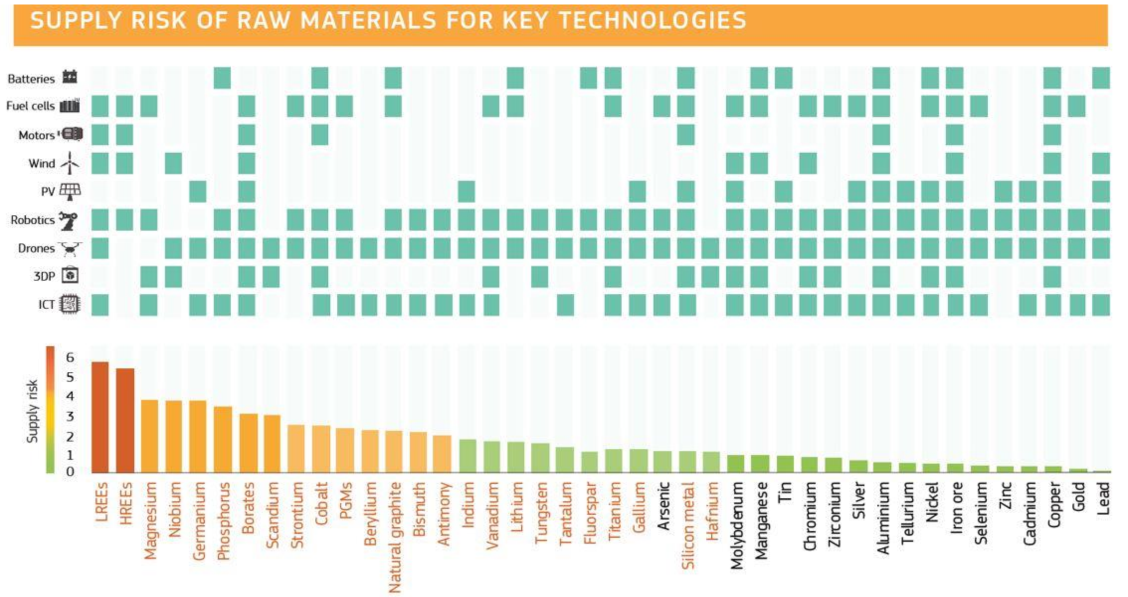

Figure 1: Raw materials used in renewable technologies and 'green infrastructure and their supply risk[5]

[Case Study: UK Critical Raw Materials]() Collectively, *metals* feed into UK manufacturing and related sectors and have an annual gross value added of around £85Bn. Technology metals (techmetals) are an essential, distinct, subset of specialist, often 'critical', metals each with its own specific properties; they are fundamental enablers throughout all industry and especially in clean energy and digital technologies. Techmetals are crucial to delivering the UK's ambition for net zero greenhouse gas emission by 2050 and demand for many techmetals is increasing rapidly. Not only do we need to use *more* metals than ever before to decarbonise, we need a *wider range* of metals. An increase in offshore wind turbines from 8 GW today to 30 GW by 2030 and 75 GW by 2050, for example, requires 10 years' worth of global Nd and Dy production. Just to replace all UK-based ICE vehicles today with electric vehicles would take 207,900t cobalt, 264,600t of lithium carbonate and at least 7200t of Nd and Dy - just under two times the total annual world Co production, nearly the entire world production of Nd and 75% of the world's Li production. Despite these figures, the amounts mined per year will still be orders of magnitude less than major industry metals such as aluminium, iron and copper. Only 4 of the 27 raw materials considered critical by the EU in 2017 have an end-of-life recycling input rate (EU EOL-RIR) of 10% or higher. Currently, the UK remains **close to 100% import reliant** for these metals, most of which arrive already in components or products. REE imports were estimated to cost (just) £28.5 million in 2017 but are essential components of all cars (EV and ICE), large wind turbines, and practically all digital technologies.

To date, efforts to tackle the climate crisis have focused on a transition to renewable energy complemented by energy efficiency. However, as demonstrated in the case study above, we argue that although crucial and wholly consistent with the circular economy, these measures alone are not enough and can only address 55% of emissions. The remaining 45%

[5] (EU JCR available at https://rmis.jrc.ec.europa.eu/uploads/CRMs_for_Strategic_Technologies_and_Sectors_in_the_EU_2020.pdf

comes from producing the cars, clothes, food and other products we use everyday (Figure 2). The circular economy can contribute to completing the picture of emissions reduction by transforming the way we make and use products.

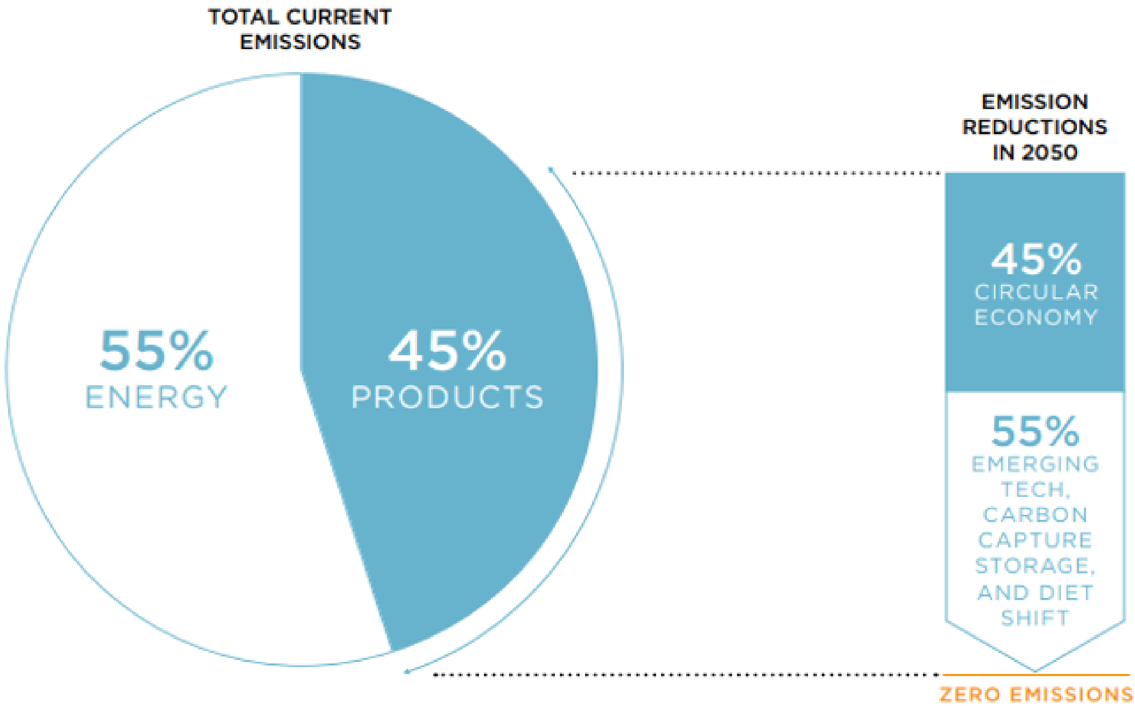

Figure 2: Completing the Picture: Tackling the Overlooked Emissions (The Ellen MacArthur Foundation, 2020)

The Circular Economy: A New Economic Model

The circular economy is a systems-level approach to economic development that aims to decouple economic growth from the consumption of finite resources and build economic, natural and social capital. It is underpinned by a transition towards renewable energy sources and increasing use of renewable materials. In doing so it aims to radically improve resource productivity and overall resource demand and significantly reduce carbon footprints associated with production and consumption. As a system level framework, it recognises the importance of collaboration and connectivity between all key stakeholders at a variety of scales and a fair distribution of wealth creation and benefits.

The key principles of a circular economy are:

- Design out waste and pollution at the outset – and in doing so avoid or minimise GHG emissions,
- Keep products and materials in use at their highest value for the longest period – and in doing so retain embodied energy, carbon and materials,

- Regenerate natural systems and in doing so retain and sequester carbon in soils and biological systems.

An important feature of a circular economy is to distinguish between the biological and technical sphere of an economy (Figure 3). Failure to do so is the cause of many of today's environmental problems. Global ocean plastic pollution is an example of a highly durable technical material leaking into the biosphere with consequent unintended but catastrophic impacts. The two spheres have implications for the way we design products, services and infrastructure and sources of future circular value creation and capture.

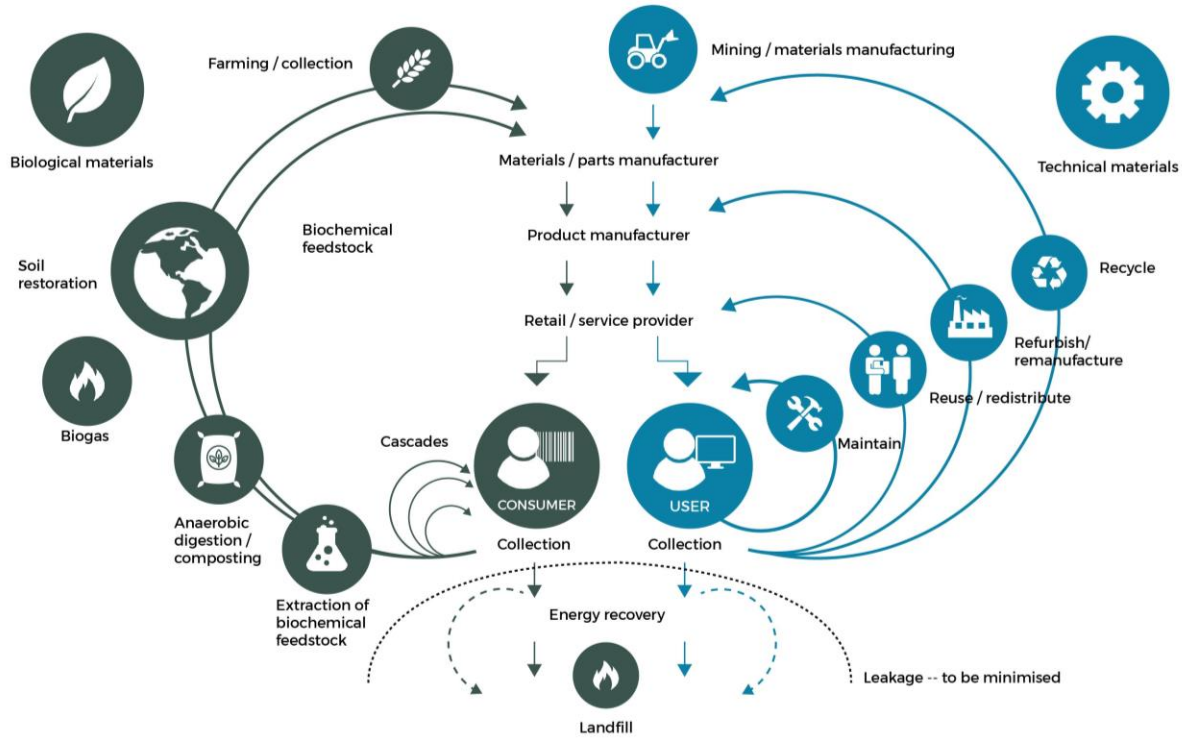

Figure 3: The Circular Economy

Products, components and materials designed for the biosphere should be able to be cascaded, composted or able to biodegrade safely to regenerate natural systems. Man made products, components and materials should be designed to be durable and circulate through multiple life cycles including collection, upgrade, remanufacture, repair and as a last resort recycling.

There are many ways that Circular Economy can be used to reduce GHG emissions and sequester carbon and these are being demonstrated by multiple organisations across industrial sectors.

Design Out Waste: Eliminating waste from building design could save up to 1.0Gt CO_2 per year for example, it is often possible to achieve the same structural strength using 50-60% of the amount of cement[6].

[6] Material Economics, Industrial transformation 2050: pathways to net-zero emissions from EU heavy industry (2019)

Keep Products in Circulation: Designing automotive components to be remanufactured could save up to 38Mt CO_2 per year. For example, Renault have managed to reuse and remanufacture 43% of its vehicle carcasses[7].

Regenerate Natural Systems: Regenerative agriculture approaches such as managed grazing could save up to 1.4Gt CO_2e per year[8].

UKRI National Circular Economy Research Programme (NICER)

The UKRI NICER Programme is a £30M investment to accelerate interdisciplinary research, innovation and impact to scale-up and accelerate a UK circular economy. Five National Centres in Textiles, Construction Materials, Chemicals, Technology Metals and Metals and a coordinating Circular Economy Hub were launched in January 2021 and will collaborate across academia, government and industry to provide national leadership and catalyse innovative new approaches and technologies that will boost the UK economy and benefit the environment.

[7] Ellen MacArthur Foundation, The Circular Economy Applied to the Automotive Industry (2012)
[8] Project Drawdown, Food – managed grazing (2019)