

CircularMetal: A Proposed RCUK Interdisciplinary Circular Economy Centre

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Summary

In the 4.5 billion-year history of the Earth, humankind arrived late to a planet already functioning in a fully circular manner, and lived in harmony within the infinite cycles of the natural ecosystem until the intervention of the Industrial Revolution 200 years ago. Empowered by advancing science and technology, humankind exploited nature for more and more resources (biomass, fossil fuels, metal ores and non-metallic minerals) to meet the growing needs for housing and infrastructure, nutrition, mobility, communications, consumables, services and healthcare. Since 1970, the global population has doubled (7.2bn) and global economic activity (GDP) has grown fourfold (US\$60.4Tn). Such rapid population expansion and economic growth were fuelled by a fast-growing extraction of natural resources from 26.7Gt in 1970 to 92.1Gt in 2017, which accounts for 50% of the global GHG emission and more than 90% of water stress and biodiversity loss due to land use. The International Resource Panel (2019) has forecast that by 2050, global resource extraction will increase to 177Gt/year, global population to 10.2bn and GHG emission to 60Gt/year. This is leading to a head-on collision between the shrinking global ecosystem (the parent system) and the expanding human economy (a subsystem). Urgent actions are required to mitigate this catastrophic collision. Circular economy approaches provide effective mechanisms to decouple economic growth and rising living standards from resource consumption and environmental damage.

Metallic materials are the backbone of manufacturing and the fuel for economic growth. The UK metals industry comprises 11,100 companies, employs 230,000 people, directly contributes £10.7bn to the UK GDP, indirectly supports a further 750,000 employees and some £200bn UK GDP. As a foundation industry, it underpins the competitive positions of every industrial sector, including aerospace, automotive, construction, electronics, defence and general engineering. Transformation of the metals industry from the current largely linear economy to a circular economy plays a critical role in delivering the government's industrial strategy for clean growth, doubling of resource productivity and reaching net zero carbon emissions in 2050.

We propose to establish an Interdisciplinary Circular Economy Centre, *CircularMetal*, to accelerate this transformation. We have assembled a truly interdisciplinary academic team with a wide range of academic expertise (such as macroeconomics, industrial sustainability, business management, artificial intelligence, product design, metallurgical science and materials engineering) and a strong industrial consortium involving the full range of the metals supply chain.

As an integral part of the national circular economy community, our ambition is to make the UK the first country in the world to realise full metal circulation. We will conduct macroeconomic analysis of metal flow to identify circularity gaps and to develop pathways/policies/regulations to bridge them; we will develop circular business models, circular design principles and enabling technologies to underpin this transition; and we will also work closely with the wider academic and industrial communities, policy makers and the general public to deliver the widest possible impact of circular economy. The *CircularMetal* programme will provide the capability and pathways to eliminate the need for metal extraction, resulting in an estimated £100bn addition to the UK economy over the next 10 years.

Our objectives include:

1. To be a national leader of circular metal research and innovation in the area of metallic materials.
2. To understand metal flow in the global economy to develop actionable solutions and practical policies.
3. To develop circular business models by optimising the metallic material supply chain in the context of full metal circulation to maximise resource productivity.

4. To develop circular design principles to realise the potential of full metal circulation.
5. To develop circular technologies to enable full metal circulation.
6. To deliver the widest impact of full metal circulation by engaging users and wider stakeholders.

We aim to achieve our objectives through a truly interdisciplinary approach to circular economy pertinent to metals, including:

- Closing the loop: reducing or eliminating extraction of primary metals; meeting the societal need by an increasing proportion of secondary metals.
- Slowing down the flow rate: designing products for durability; prolonging product life; reuse, remanufacture (including repair, refurbishment and approaches to deliver it
- Narrowing the flow volume: by increasing resource productivity; increasing product use and repair; using higher performance metals; reducing over-specification; modifying consumer behaviour.

Research on metal flow in the global economy in the context of CE is complex by nature and covers a wide range of research subjects, such as macroeconomics, industrial sustainability, business management, artificial intelligence, product design, metallurgical science and engineering. Even just in the area of metallurgy, a logical question is how many metals can we explore in the CircularMetal research programme? CircularMetal will establish an effective platform for hosting CE research in metallic materials flow. The CircularMetal team will focus its research on the two most widely used metals (steel and aluminium) to demonstrate approaches and solutions for the transition to CE, which will then be expanded to other metals through linking with other UK research activities and developing new research activities in the future.