Smart remanufacturing as an enabler for a net-zero manufacturing future

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Executive Summary

- It has been hard to set achievable goals for manufacturing emissions, but policy makers are faced with needing to do this.
- Manufacturing emissions are 45% of global greenhouse gas emissions and the UK will not reach the target of net zero by 2050 without addressing them.
- While energy services emissions are relatively straightforward to decarbonise by electrification and the use of renewable energy sources, manufacturing emissions are more complex to manage.
- A regenerative approach needs to replace linear take-make-waste, but to do this requires a programme to digitally visualise and map the complex processes so that research and policy questions can be tested.
- When enabled with digital technologies, computer simulation results show that remanufacturing circular approach display higher remanufacturing efficiency, better forecast of remanufacturing and production processes leading to reduced remanufacturing costs

Background

To solve the Climate Change challenge, the UK government recently pledged to cut greenhouse gases (GHG) emissions to almost zero by 2050. GHGs can be categorised into two distinct categories: these are energy services emissions, which constitute about 55% of global GHGs emissions, and manufacturing emissions, which account for 45% of total emissions. Manufacturing emissions are much more difficult to tackle largely due to the complexity of manufacturing supply chains. There is evidence to show that **digitisation and application of circular economy approaches can improve product trackability, traceability and help reduce manufacturing emissions.**

What is Circular Economy?

From the risks on the environment to human health and crop growth risks, the urgency of the climate challenge cannot be overemphasised. **The greenhouse gas emissions triggering climate change are a product of our linear "take-make-waste" extractive manufacturing system.** This type of economic system relies on fossil fuels and does not sustainably manage resources. A study puts the cost to the global economy relating to climate change at USD 54 trillion by 2100, even if the 1.5°C target set by the Paris agreement is reached. Thus, a step-change that requires we rethink our linear economy model to a circular model where value is retained as long as possible, is needed.

According to the Ellen McArthur Foundation, 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 three principles: (1) designing out waste and pollution, (2) keeping material in use for as long as possible and (3) building regenerative natural systems. **Remanufacturing,** a circular strategy that aims to bring used products (called "cores") to their original manufactured state, **is a key part of the process focussed on**

recovering and restoring products, components and materials. Other strategies include reuse, comprehensive refurbishment, repair or, as a last resort, recycling. The application of digital technologies has the ability to support the transition to a circular economy (and remanufacturing). These include improving virtualisation, dematerialisation, transparency and enabling feedback driven intelligence.

How can Circular Economy help us tackle achieve Net Zero?

The global COVID-19 crisis presents an unparalleled opportunity to rethink economic activity, including energy use and carbon emissions. For example, a more transformational alternative is to address our consumption emissions by addressing the embodied carbon in primary materials processing through circular supply chains and create economic opportunity and jobs in the UK. **Circular Economy offers the manufacturing sector a compelling alternative to a linear make-use-dispose economy**. Studies show that application of Circular Economy strategies, such as remanufacturing, can potentially eliminate almost half of the remaining emissions from the production of goods. Remanufacturing, however, suffers from several limitation. These include the lack of cores, and the mismatch between fluctuating demand, supply and value of use components, causing uncertainty with costs and return on investment. Also, the lack of clear information concerning the condition, availability and location of manufacturing assets in use, remains a challenge for circular economy implementation.

Digital technologies (such as tracing technologies) **have been developed to overcome some of these barriers to implementing circular economy principles in the manufacturing sector.** Due to the complexity of manufacturing products and supply chains, a deeper knowledge and understanding is required on how data acquired from digital technologies can fully unlock the potential of a circular economy. Our research is a contribution towards answering this question.

Policy Implications & Proposals

- The adoption of remanufacturing as the end of life option for private and government sectors should be identified and pursued as a policy plan.
- A policy steering group for remanufacturing adoption across key public procurement offices should be established
- The policy steering group should also focus on specifying and clarifying the definition of remanufacturing, ensuring it is separate from refurbishment.
- The adoption of digitalisation in the remanufacturing process should be scaled up (research funding, for instance, should focus on this)
- Remanufacturing should feature within Climate Change reduction conversations (e.g.: 2050 Net-Zero GHGs target, DEFRA Resources and Waste Strategy and draft Waste Prevention Programme, among others)

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