8 Circular Economy

From panacea for sustainability to conceptual and resource realities

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The appeal of Circular Economy

Humans exert an immense pressure on the natural environment by extracting materials and generating waste. Thanks to our better comprehension of this, compared to a few decades ago, there have been attempts to improve the situation. One of these attempts is the emergence of the Circular Economy (CE) concept, as a solution to better utilise resources and improve environmental pressure. CE is a technology-focused concept, which can also generate economic gains. Due to this, it has gained a perception of great appeal from academia, public, and private sectors (Velenturf and Purnell, 2021). The development of CE has been strongly practitioner-led (e.g., Ellen MacArthur Foundation), and it is positioned squarely within the Green Growth discourse, meaning that primary resource consumption and emissions can be decoupled from Gross Domestic Product (GDP) to legitimise continued economic growth (Parrique et al., 2019).

It is understandable where the appeal of CE is steaming from, since Lacy and Rutqvist (2016) forecasted $4.5 trillion in global economic benefits by 2030, and $25 trillion by 2050, when the global economy was $80 trillion in 2017 (World Bank, 2019). However, the appeal is not just financial, since circular business models create more value from each unit of natural resource compared to traditional linear models (Di Maio et al., 2017; Robaina et al., 2020). Additionally, recycling is a big part of CE, and it is not just about keeping waste out of landfills, but it is also about energy conservation. All products contain embodied energy, which is the total amount of energy required to produce a product (mining, transportation, manufacturing, and distribution). The recycling process also consumes energy, added to the transportation of waste; however, even taking this into account, there is a difference of three orders of magnitude between the amount of energy needed to produce products from raw materials and the amount of energy needed to recycle them from the old ones (Johnson, 2015).

Due to these, and other, very positive aspects, the Circular Economy Action Plan (EC, 2015), and later the second Circular Economy Package (EC, 2019), introduced measures to stimulate Europe's transition into a CE, "closing the loop" of product lifecycles through greater recycling and reuse, benefitting both the environment and the economy (Robaina et al., 2020).

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Definition and indicator issues

At first glance, CE is appealing, and it is worth striving for, but based on current understanding and practice, there are a lot of things to consider, before we get invested in it too deeply. It is logical to try and minimise resource exploitation, while decreasing waste, but CE has received as many definitions as there are CE researchers and practitioners (Kirchherr et al., 2017). A common motto is to strive to make better use of resources, but what constitutes "better" remains debatable. CE has undoubted sustainability potential documented in literature, but its limited conceptual grounding and weak connection to sustainable development can prove to be detrimental (Velenturf and Purnell, 2021).

Furthermore, indicators can be useful in assessing CE, and although the European Commission has been developing a wide variety of quantitative indicators (Huysveld et al., 2019), there is still a scarcity of adequate metrics for performance measurements. The trouble is that what should be measured to assess compliance with CE principles is debatable, since CE definition is rather qualitative and ambiguous, and different indicators can lead to different conclusions. Some authors have reviewed tools and methodologies already in use and argued that most of them are not capable of measuring all CE characteristics (Moraga et al., 2019).

Additionally, as mentioned earlier, CE is positioned within the Green Growth discourse and the decoupling from GDP discussion. However, decoupling itself is also vague as a term. Frequently, there is no distinction between "relative" and "absolute", but even if "absolute decoupling" is achieved, this doesn't mean we have solved our problems. A rise in GDP with a drop (no matter the percentage) in emissions is considered "absolute decoupling", but sustainability-wise this is somewhat parodical, because it does not solve the issue, nor does it make growth sustainable (Parrique, 2021).

Conventionally, an economy's resource use is measured through Domestic Material Consumption (DMC), which is the total weight of raw materials extracted from the domestic territory, plus physical imports, minus physical exports. Many governments have adopted the division of GDP by DMC to assess the "resource efficiency" of their economy. If the GDP grows faster than DMC, then we have "relative decoupling" and a more resource-efficient economy. GDP/DMC is also used by the European Union and the OECD to monitor progress towards Green Growth. However, and without opening a discussion about the suitability of GDP as an indicator, DMC is problematic itself, since it does not include material impact involved in the production and transport of imported goods (Wiedman et al., 2015). If we alternatively look at the total resource impact of consumption by any given nation (referred to as "material footprint" by Wiedmann et al.), the perception changes. Wiedmann et al. (2015) show that although the EU-27, USA, UK, Japan, and the OECD have achieved "relative decoupling", their material footprint has been rising at a rate equal or greater than GDP. This shows that perhaps decoupling is not actually occurring, depending on the chosen definition (Hickel and Kallis, 2020).

The Jevons Paradox also has a place in this discussion, since according to it, in the long-term, an increase in efficiency in resource use will generate an increase in resource consumption rather than a decrease. It is important to understand the nature of the Jevons Paradox when it comes to our attempt to achieve a CE (Hickel and Kallis, 2020). Additionally, societal success evaluated through indicators of growth assumes that affluence correlates with well-being (Cobb et al., 1995; Robra and Heikkurinen, 2019). The problem though is that economic growth is very closely correlated with environmental damage (IPCC, 2014). Despite efforts to develop technology and increase efficiency of production, economic growth has not achieved decoupling from global resource and energy use, nor from the rise of emissions and waste (Robra and Heikkurinen, 2019).

Different resource aspects and shifting of problems

Aside from the actual definition of CE, which is vital to exist and be accepted widely, and the ongoing issue with indicators, there are also more practical issues to consider. It needs to be noted here that CE is not a new concept, it has been implemented for economic purposes for hundreds of years, and there are examples of "industrial symbiosis" where the by-products of one industry are used as inputs for another (Desrochers and Leppala, 2010). Although industrial symbioses can be sustainable, they can also lock in unsustainable material systems like the petrochemical industry infrastructure, perpetuating a dependency on fossil fuel extraction (Velenturf and Purnell, 2021).

There is an ongoing concern about evidence of the feasibility and environmental benefits of circularity in general, and specifically recycling. Waste recycling does not and cannot create a perfect circle due to the growing demand for materials, which exceeds the waste available from past consumption, while materials are lost and degraded during processing (entropy), and the energy required for processing rises with higher collection rates (van Ewijk, et al., 2021). Resource efficiency cannot improve forever, as eventually it approaches physical limits (Ward et al., 2016). In general, indefinite growth of any material category is not compatible with ecological principles.

An interesting example is recycled concrete (RC-concrete). Mostert et al. (2021) assessed RC-concrete regarding its potential in CE. They found that it can decrease the material footprint by up to 50%, but the reduction potential for the climate footprint is limited, while the water footprint can be up to ten times higher with the wet processing of concrete waste. Although RC-concrete can save natural aggregates, the deconstruction and treatment process of concrete waste is energy-intensive and could require a great quantity of water, depending on the treatment technology used. In the case where additional amounts of cement are needed, the overall Green House Gas (GHG) emissions can surpass that of Business As Usual concrete (Mostert et al., 2021). CE has decarbonisation potential, but it is important to avoid shifting emissions from one part of the system to another. If for example biological materials are used in place of mineral

resources, it is possible to require water resources well beyond sustainable levels of supply (Giampietro and Funtowicz, 2020).

In another example, van Ewijk et al. (2021), in their analysis of recycling pulp and paper, found that landfill practices mattered more than material flows, and energy use mattered the most, showing that greater circularity through recycling and recovery is not a straightforward recipe for reducing GHG emissions and that circular use of materials cannot remove the requirement for clean energy (van Ewijk, et al., 2021). These two different examples show that there are other resources that need to be considered in the whole CE discussion and that the outcomes of engaging in CE are anything but clear-cut.

Another very important issue to consider is the shifting of problems from one place to another. For example, the reuse and recycling rate of plastics in Europe is still very low, especially in relation to paper, glass, and metals. In particular, Europe produces 25.8 million tonnes (Mt) of plastic waste annually, with <30% of this being collected for recycling (EC, 2018). A significant part of this quantity, however, is exported to third countries, which sometimes apply different and less friendly environmental standards (Robaina et al., 2020). In another more specific example, 46% of separated Polyethylene (one of the most common types of plastic) waste is exported outside of the source country, and although the fate of this export is not well-known, a study by Bishop et al. (2020) estimated that 83,187 tonnes, or 3% of exported European Polyethylene, in 2017, ended up in the ocean. Also, the European Environment Agency reports that 250,000 tonnes to 1.3 Mt of cast-off electrical products are exported annually from Europe, and the most frequent destinations are West Africa and Asia (Sahajwalla and Gaikwad, 2018).

All these examples, among many others, significantly affect CE studies. In general, 92% of all decoupling studies only use production-based measures, instead of consumption-based indicators (Wiedenhofer et al., 2020), which create an illusion of absolute decoupling when the environmental pressures are just shifted elsewhere (Parrique, 2021). Since this shift is also usually happening from the Global North to the Global South, it creates a sort of discrimination and an unjust burden on the Global South.

Since a relationship between the Global North and South is already established, it is important to notice that waste, for example, differs from country to country, geographical region, population, social conditions, economic situation, local habits, climate, and so on. High-income countries generate less organic waste (32% of total) than low- and middle-income countries (56% and 53% of the total, respectively), while high-income countries generate a high percentage of plastic, paper, metal, glass, and so on as waste (51% of the total) (Kaza et al., 2018). This makes it clear that depending on the case study, different waste and potentially materials are more critical and should receive priority. Not all case studies are the same, and they need to be treated as such.

Moreover, despite the fact that CE is frequently associated with sustainability, it is still unclear if it actually contributes towards the achievement of the Sustainable Development Goals (SDGs), particularly regarding their social

aspects. This is an aspect that is true in general, but even more so for the future of the Global South. Although scholars have started to explore the assessment of social sustainability within CE practices, Walker et al. (2021) in their assessment of CE's social sustainability practices in industry in Italy and the Netherlands concluded that the majority of firms do not conduct any type of social assessment. Even the companies that did implement some sort of assessment did so in a qualitative manner or used industry-based sustainability indicator frameworks. Frequently, the only indicator mentioned in CE literature, regarding the social aspect, is "job creation" (Kravchenko et al., 2019), discounting other important aspects, from health to corruption (Walker et al., 2021).

Ways forward?

Some of EC's issues have been identified above, but is there a way they can be alleviated? The first step is to start with the concept itself. Which alternatives exist, and are there any possible inputs from elsewhere? From the multitude of conceptual approaches to sustainable development, three stand out since they discuss the relationship between environment, society, and development (Belmonte-Ureña, et al., 2021) and these are CE, Degrowth, and Green Growth. However, it is not that clear which of these embraces the breadth of topics found in the SDGs. CE advocates for an economic system dissociating environmental pressure from economic growth by replacing linear production for a circular one, with waste as a resource (Sanguino et al., 2020). Green Growth focuses on economic growth through investments in activities that protect or restore the natural environment (Vazquez-Brust et al., 2014), while Degrowth assumes resource limitations and advocates for smaller growth rates (even negative as the name suggests) to balance the natural and economic systems (Sandberg et al., 2019).

The CE and Green Growth concepts are increasingly taken into account in policies, while Degrowth is seen as too controversial by decision makers (Sandberg et al., 2019). Additionally, CE theory of addressing the challenge is weak, as was discussed earlier, since it doesn't accept boundaries, and it is ambiguous about how to deal with industries that cannot be made circular (Belmonte-Ureña et al., 2021). Giampietro and Funtowicz (2020) go a step further and argue that "the belief in the ability of technology and markets to achieve a decoupling from economic growth through a CE is essentially a 'folk tale' ". This has in part to do with Degrowth scholars and activists being sceptical of growth itself (Kallis, 2019). This is not to say that a Degrowth perspective is necessarily a legitimate alternative, since, according to critics, it has not engaged with real-world dynamics of class politics, and it has simply chosen to highlight the problem of growth and proposed to abandon it altogether (Arsel, 2020).

Nevertheless, there are lessons learned from Degrowth, since the concept claims that growth is not possible on a finite planet, while at the same time economic growth is not a prerequisite for human well-being (Demaria et al., 2013; Robra and Heikkurinen, 2019). The main aim of Degrowth is to reduce economic activity to a point where it can be considered ecologically sustainable (Demaria

et al., 2013). Practically, what this ecological sustainability would mean for a society is to "keep [its] wastes within assimilative capacities; harvest within re-generative capacities of renewable resources; deplete non-renewables at the rate at which renewable substitutes are developed" (Goodland and Daly, 1996, p. 1002). It is more important to meet human needs than to meet ever-increasing human wants (Bonnedahl and Heikkurinen, 2019).

Additionally, and perhaps on a more practical note, it is important for CE to take the Resource Nexus into account. For example, Nerini et al. (2017) identified 113 SDG targets requiring actions to change energy systems, finding evidence of relationships between 143 targets (synergies and trade-offs); this being for SDG7 (Affordable and Clean Energy) alone. Trying to take more Goals into account, the synergies and trade-offs would rise significantly. This is not something trivial, and it signifies that there is still a lot of work to be done, but also shows that there are a lot of opportunities for research and action. These relationships strongly indicate that substantial changes are in order, to be able to deliver the SDGs. CE would have a lot to gain from embracing a Resource Nexus perspective in its modelling.

Conclusions

The CE concept has been proposed as a solution to better utilise resources and improve environmental pressure, but its definition is weak and not consistent. Consequently, its metrics are lacking when it comes to performance measurements because it is debatable what actually needs to be measured. CE is in line with Green Growth discourse and the decoupling from GDP, but decoupling is also vague, and even "absolute decoupling" does by no means suggest that we have achieved sustainability. In addition to conceptual and definition aspects, it is important to account for physical/natural limitations to recycling and reusing of materials. Waste recycling cannot create a perfect circle, since firstly the materials degrade with time (due to processing), and secondly, the demand for materials is constantly increasing.

Furthermore, sustainability is not just GHG emissions; water, food, land, materials, pollution, waste, biodiversity loss, they all need to be considered. "Which other resources do we need to use in order to recycle/reuse a specific material?" is a question that needs to constantly be asked. It has been shown that it is possible, for example, to use significant energy and water in order to reutilise certain materials. This connection between resources (the Resource Nexus) is vital when it comes to CE. The impact of greater circularity needs to be assessed for individual materials and products, and each product, different aspect, and so on deserves its own research.

Another important aspect is that of shifting some of the burden (waste, processing, etc.) elsewhere, and this usually happens from the Global North to the Global South. This is something that needs to be considered in all forms of modelling of the CE. Imports and particularly exports need to be taken into account, therefore consumption-based indicators might be more useful. Additionally, the

social aspect of the CE literature is weak, and so are its social metrics, since apart from "job creation", nothing else stands out.

Additionally, Degrowth, which is considered to be a lot more controversial than CE, does take into account the simple fact that growth is not possible on a finite planet and that economic growth is not necessarily a prerequisite for human well-being. Therefore, Degrowth should not be dismissed, since sufficiency-oriented strategies can be valuable for developed countries, but also developing ones to some extent. At the end of the day, the three Rs of CE are Reduce/Reuse/Recycle, and the first part goes very well with Degrowth thinking.

Despite the issues mentioned above, CE and Green Growth are both increasingly used in policies, and this is the reason why we have a responsibility of pointing out their defects and suggesting how they can be improved. There are a lot of aspects that need to be considered simultaneously to aim towards true sustainability. CE has potential, but if one thinks that it can help towards true sustainability, it is wishful thinking at best. Concepts like the Resource Nexus and Degrowth can greatly assist in improving CE in many ways, by firstly achieving a worthwhile definition of the concept, and secondly by improving on its metrics. Lastly, it is important to understand that a "perfect solution" is not possible, CE does have limitations, some of which cannot be improved by much, and we need to accept this.

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