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Assessing the Sustainability of Circular Economies

United Nations Economic and Social Committee (ECOSOC)

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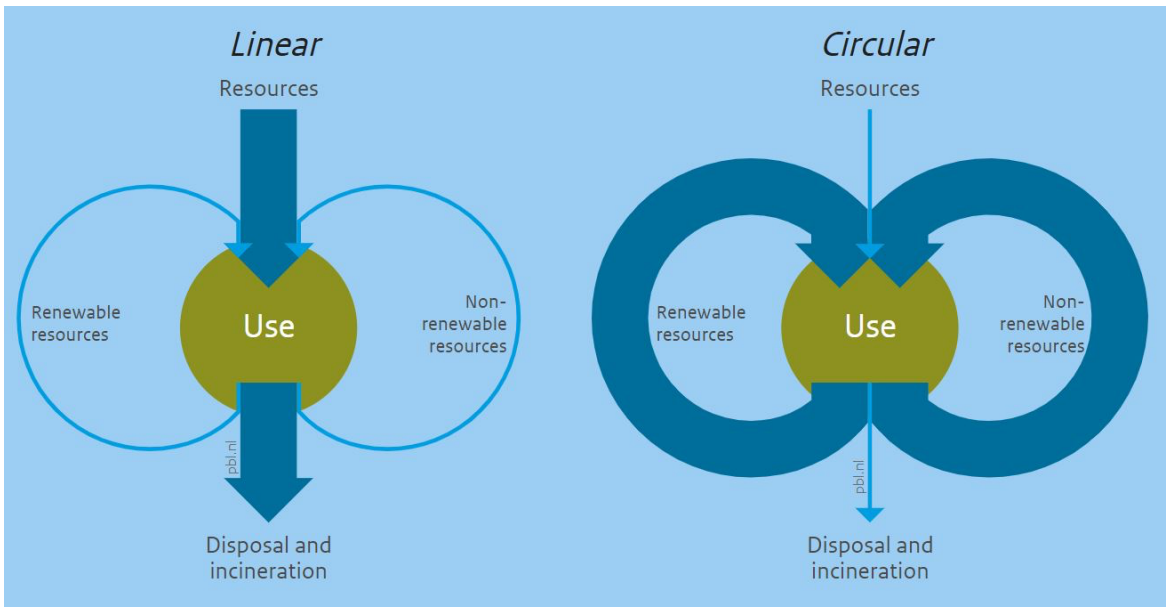
Introduction

The present economical model that we know today is the fruit of a process heavily dependable on a linear model of economy in which, simply put, raw materials are processed into a specific product that is then used until its utility life is over and then thrown away in the form of waste. Due to the wastefulness of this process not only in terms of materials itself but also in energetic, time-related and economical aspects, a search for a better way of production, consuming, and recycling has gained traction. With the mention of such a concept as early as 1966, a circular model of economy gained interest not only for its environmental benefits, but also financial and industrial optimization. (Ekins et. al, 2019)



"Scheme depicting a linear resource usage and a circular resource usage", found in: https://kenniskaarten.hetgroenebrein.nl/wp-content/uploads/2016/07/English-PBL-Linear-VS-Circular.jpg

One key difference between a linear and a circular system is found in the creation and maintenance of value, since the linear economy follows a take-make-dispose model, in which raw materials are collected, made into products and disposed of after use (Wautelet, 2018) . This means that, in this case, value is created by manufacturing and selling as many products as possible. In the circular model, value comes from optimizing every step, existing and the newly introduced, that also means preserving existing value. This can be achieved by using goods that are serving a purpose to more people, such as car-sharing, and also converting products into services, such as film streaming platforms, in which instead of selling physical movie tapes, a company sells watching licenses. (Nair, 2017)

A circular economy can be broken down into the so-called "3Rs": reduce, reuse and recycle. This means reducing the usage of resources with the goal of achieving the minimum viable amount, reusing products and parts as much as possible, and recycling used materials in order to not only avoid unnecessary waste but also bring down raw material exploration and usage.

Key terms & definitions

Circular economy (CE)

An alternative economic model that focuses on maximizing the value of the materials by maintaining them in the economy for as long as possible. According to the Ellen MacArthur Foundation, a circular economy has three main principles: designing out waste and pollution, keeping products and materials in use, and regenerating natural systems. The nature of a circular economy is expected to help countries tackle global issues such as climate change, pollution, depletion of natural resources, etc. (Ellen MacArthur Foundation, 2017)

Due to their close connection, one can easily mistake circular economy as recycling or reusing. In reality, those are separate concepts that require a different approach. While recycling and reusing often happen at the last stage of the material's life cycle, in a circular economy, the intention of making the most of the materials shaped the economic activities in every stage.

Linear economy

An economic model centered around "take, make, waste." As described in Wautelet, 2018, a linear economy involves only resources extraction, production, distribution, consumption and disposal. In contrast to circular economy, linear economy grew upon the idea of infinite resources, and thus, increasing the value of the materials is not considered in any aspect of the economic activities.

Sustainability

There has yet to be a unified definition for sustainability. Notwithstanding, according to the United Nations Brundtland Commission, it can be generally understood as "meeting the needs of the present without compromising the ability of future generations to meet their own needs." The concept of sustainability is often characterized by three pillars: environmental,

economic, and social. These pillars overlap and interact with each other in different ways. Therefore, it is important to build a comprehensive approach that takes into account all aspects of sustainability.

Reverse logistics

Reverse logistics is an essential component of a strategy toward a circular economy. Idowu & Louche (2010) defined reverse logistics as "the process of planning, implementing, and controlling the efficient, cost-effective flow of raw materials, in-process inventory, finished goods, and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal." Effective reverse logistics management can help companies reduce costs and increase profits. From another perspective, reverse logistics is beneficial for the environment as the proper implementation can result in a decreased amount of waste.

Urban metabolism

Kenndy et al. (2007) defined urban metabolism as "the sum total of the technical and socio-economic processes that occur in cities, resulting in growth, production of energy, and elimination of waste." According to Sanches (2020), urban metabolism is an essential tool to accelerate the transition toward a circular economy. It reflects the efficiency and sustainability of urban systems by giving us an understanding of the flows of materials when they enter, go around and leave the cities.

Virgin/non-virgin materials

By definition, virgin materials refer to materials that have not been used in the economy, which include both finite materials and renewable resources. (Ellen MacArthur Foundation, 2017) On the contrary, the definition of non-virgin materials covers the resources that have not been used, including but not limited to: materials in products that have been reused, refurbished or repaired; components that have been remanufactured; materials that have been recycled (secondary materials).

Transition management (Governance)

Kemp and Loorbach (2006) defined transition management as “forward-looking, adaptive, multi-actor governance aimed at long-term transformation processes that offer sustainability benefits.” Transition management involves the participation of various sectors to create effective and reflexive societal change. It is believed to be one of the keys to success in the transition to a circular economy.

Background Information

Brief History of the agenda and turning points

The concept of Circular Economy (CE) has been around longer than the term itself. Kenneth E. Boulding first addressed a "cyclical" system of production in 1966, while the term "circular economy" appeared for the first time in 1988 in "The Economics of Natural Resources" by Allen V. Kneese. Both documents address a certain type of economical model in which the use of resources is minimized by reutilizing already those in circulation, avoiding more waste and unnecessary usage by utilizing a more "circular flow" for materials and energy, focusing more on the longevity of materials. Soon after, the term was used by Pearce and Turner to describe an economic system where any misproduction and waste at parts of the process with a higher focus on the extraction, production, and consumption stages is turned into new resources, transforming old outputs into new inputs.

In the 90's some countries started looking deeper into resource usage to try and optimize their processes. Japan being a resource and space constrained country started mapping material flow, to try and figure out what was coming in and what was going out of its product life-cycle with the hopes of making better use of any material, labor, and energy. Since the transition of the millennial, China integrated the notion into its industrial and environmental policies, aiming to make them more focused on resource, waste, production, and use, creating a so called life-cycle-oriented economy. (Wang et. al 2012)

The original diffusion of the notion was firstly amplified by three major events: the explosion of raw material prices between 2000 and 2010, the Chinese control of rare earth materials, and the 2008 economic crisis, however one pivotal actor in the diffusion of the concept as we know it today, especially in Europe and the Americas, is The Ellen MacArthur Foundation. Due to them, for the first time the concept of the 3 main pillars of CE was used, them being:

1. Reduce and Eliminate waste and pollution
2. Circulate products and materials
3. Regenerate natural systems

Fast forward to the mid-2010s the whole concept of CE started to take of, giving space to new projects, agendas, and portfolios that include the EUs "The vision of the circular economy" (2010), the first circular economy action plan of the block, that lead to the EU Commission to adopts its first circular economy action plan in 2015. China's 2017 Circular Economy Policy Portfolio, focusing on eco-design and upstream, started being implemented. The 20th AECs Framework for Circular Economy for the ASEAN Economic Community (AEC), with the objective to guide ASEAN in achieving its long-term goals of a resilient economy, resource efficiency, and sustainable and inclusive growth and many others.

Due to the amount of environmental and economical issues we're experiencing today, such as the climate emergency and environmental challenges and especially after the COVID shortages that affected essentially any country, companies and individuals started rethinking their production and consumption patterns, looking for alternative methods and ways to get out of the linear model of production and into a circular one. This was lead to another amplification and solidification of new circular economy plans, such as The African Circular Economy Alliance, aimed to spur Africa’s transformation to a circular economy that delivers economic growth, jobs and positive environmental outcomes at the national, regional and continental levels, the Latin-American and the Caribbean Circular Economy Coalition, officially launched as a new initiative to promote circular economy with the aim of supporting the region to advance and invest in the circular economy transition as part of the COVID-19 recovery and EUs New Circular Economy Action Plan from 2020 created to show the way to a climate-neutral, competitive economy of empowered consumers.

Nowadays, corporate arguments supporting a transition and implementation of a circular economy are that it could make the supply of raw materials safer, help amortize the price volatility of inputs and control costs, reduce waste, extend the life cycle of products, serve new segments of customers, and generate long term shareholder value. (RHI Magnesita, 2021) A key idea behind the circular business models is to create loops throughout to recapture value that would otherwise be lost.

The development of circular economies in the context of Covid-19

Industrial perspective

When looking into the circular economy and its relation and application in regards to the industry itself, many challenges can arise but clever solutions and optimization paths are prone to yielding numerous advantages. Since different industries bring different problems and solutions, individual assessments and concepts are necessary instead of a single solution to CE across the whole manufacturing industry. To facilitate those specific points, it's easier to divide CE into the 3Rs and also give a look into a 4th one, the recovery of energy, as a separate process.

1st R: REDUCE: As mentioned before, often the first and one of the most simple steps towards a circularity is to reduce the amount of resources and raw materials that are being put into the manufacturing of a product. If the input amount is reduced, keeping the same level of product quality, upstream problems can be greatly reduced and avoided, such as refurbishing, reusing, recycling, recovering while also keeping lower costs and complexity, meaning that this is a decisive step towards CE in the industrial scope.

Since it's such a decisive and costly process while also being one of the most malleable ones, multiple examples arose in order to operate in a more sustainable manner. One of the industries that shows this the most is the packaging industry, in which companies develop ways to reduce the amount of the overall packaging material and also replace less sustainable materials with new more environmentally friendly solutions. One example is Körber, a strategic management holding company based in Hamburg, that reduces the plastic consumption of its customers by offering machinery which uses alternative materials such as wood, bamboo or even fungi.

2nd R: REUSE: Products that have already been used and would, in a linear economy model, be considered discartable often can be refurbished and reused, sometimes as a whole and others in parts to generate new products or support for reduction of raw material consumption, supporting and boosting sustainable manufacturing, vital for a CE. In contrast to the first R, however, refurbishing and reusing are some of the most complex aspects to put into practice considering all of the CE's industry-specific features, bringing a higher impact on existing manufacturing strategies and status-quo. Good examples for an implementation of second-hand/ refurbishment is IKEA's Circular Hub that refurbished furniture for a more affordable price, and Apple's Certified Refurbished program that follows a similar principle as IKEA but for Apple electronic devices. Besides B2C segments, refurbishment can also be leveraged in other industries as well as into B2B segments, for example by completely recovering defective parts, keeping it inside a closed cycle, directly shipping it back to the producer.

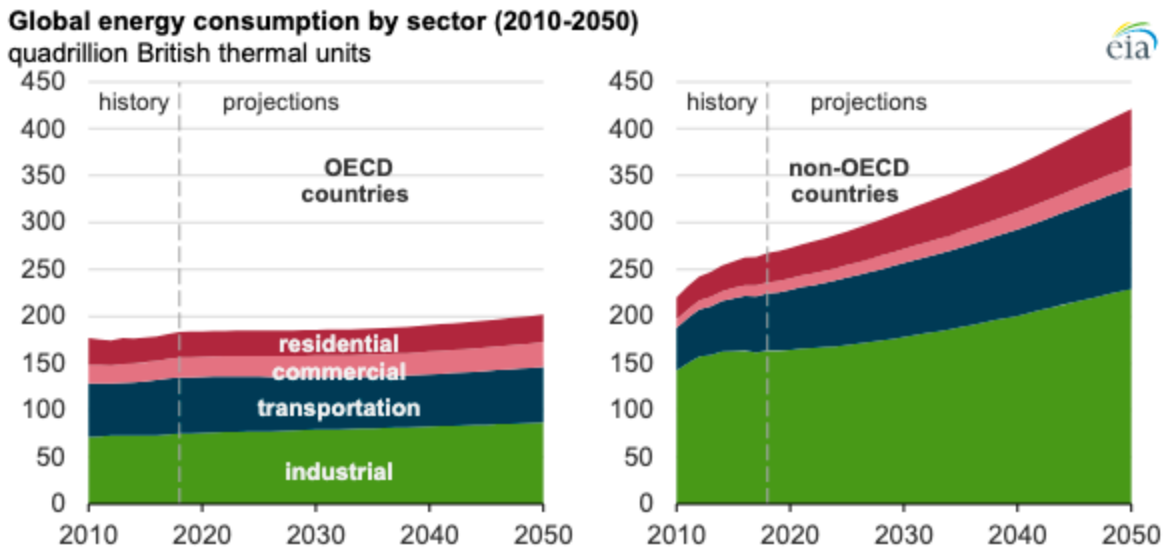
3rd R: RECYCLE: Converting whole or part of products at the end of their useful lives into new raw materials, feeding them back as input to the manufacturing chain of the original

product, also called recycling, not only reduces a considerable amount of waste, but also transforms it into additional valuable products. Less complex than the previous R, recycling is also vital to the transition to a CE, especially when the same manufacturing value chain is involved.

As mentioned before, industry-specific processes are required and an adaptation of manufacturing characteristics is imminent. Overall, companies can use waste materials, often byproducts of a broad production process, and transform it into start of the line material. Finished products can also be recycled later, this can be often seen in the production of rails, in which, at the end of useful product life, they comprise the highest-quality steel scrap. (DB Cargo, 2021 and Evolution SKF, 1998) The scrap is then melted to produce the same product, even when considering rigid alloy tolerances. Not only does this saves money and new input, but also helps reduce a waste problem and CO_2 emissions compared to steel production from primary resources (i.e., iron ore, coking coal, etc.). (Frauenhofer IMWS, 2019 and Recycling Magazine, 2020)

4th R: RECOVER: In some cases, reusing or recycling materials is not viable at all using present technology. However, it is essential to at least recover energy stored in those materials, introduced in the manufacturing process, e.g. by incinerating the products. A great example of recovery is production of biofuel using waste organic products. In France, McDonald's collects cooking oil and food waste from its establishments to transform into usable biofuel at a rate of two tons of biogas created from nine tons of waste, which is enough to power a vehicle over a distance of 7,500 km. (Veolia, 2018)

The industrial sector alone is responsible for more than 40% of total energy consumption globally, including a considerable portion that is wasted as heat. (IEA, 2020) While material waste is clearly visible and easy to grasp as a total, heat waste can be harder to identify and evaluate, qualitatively and quantitatively. This means that being able to evaluate the availability of waste heat and its recovery also means an opportunity to bring down industrial energy costs and its environmental impacts.



Global energy consumption by sector (2010 - 2050), found in: https://www.eia.gov/todayinenergy/detail.php?id=41433

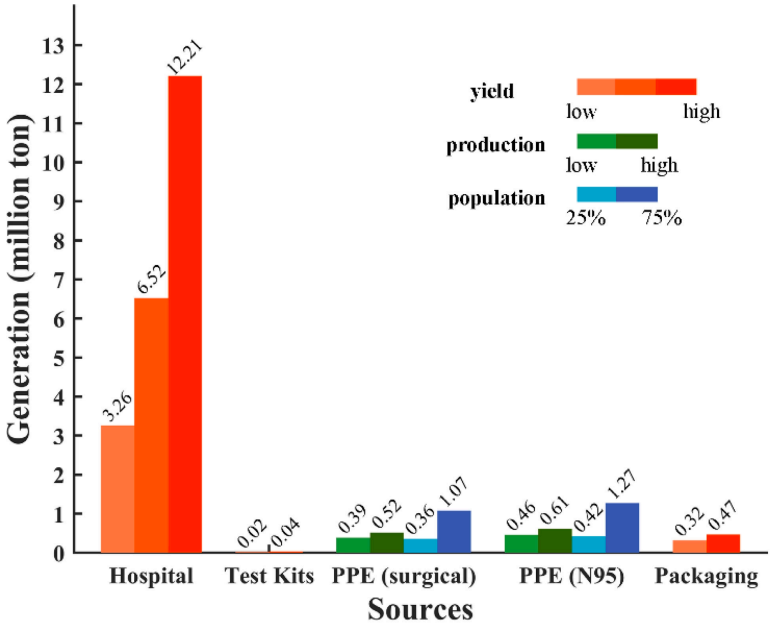
With the transition into the Industry 4.0, which focus on process efficiency and productivity, the implementation of a CE is becoming easier by the moment, but also more necessary. Due to applications of automatization machines and a numerous amount of computers, the waste of electronic parts and exploration of raw materials to produce them is higher than ever.

In 2020, after the pandemic started, slowly but surely many production chains started suffering from a lack of supplies and had to be shut down for long periods of time. (Hopkins, 2020 and Guan et al 2020) A good example was and still is the lack of microchips, especially in the automotive industry. Already in the early times of the pandemic, the automotive giant Hyundai had to suspend all operations at its manufacturing plant in South Korea due to a lack of parts coming from China. (Ewing et al, 2020)

Waste management

According to the WWF, 310 million tonnes of plastic waste are produced worldwide every year and put into landfills, incinerated and, in the best-case scenario, recycled, meaning that often it also ends up in the environment, polluting beaches, rivers and oceans causing harm to people and animals. Around and on the Mediterranean, for example, the plastic deluge increases by 30 per cent during the summer months due to tourism and seriously endangered flora and fauna.

Furthermore, less than a third of the plastic disposed of in the EU is currently recycled while The rest is incinerated or stored and most of improperly disposed plastic waste ends up in the sea. (WWF, 2019) This causes the amount of existing waste to grow every second that passes, especially when taking into consideration the ever-changing consumer habits, industrial development and cities growth. In many developing countries and emerging economies, waste is not being disposed of properly, harming people, the environment, the climate, and, as mentioned above, discards valuable material. Due to the pandemic, in addition the the already vicious routine of single-use products, specially plastic ones, came the gigantic spike in mask and gloves use, and covid testing, meaning an even bigger jump in the numbers of single-use plastic production. (EEA, 2021) One average corona self test was made almost entirely out of plastic and in all cases, used only once and masks also started being discarded more than the recommended since the pandemic panic was so high. Not only is the devastating nature of this process in terms of huge production numbers bad, but the biohazard nature of the product at the end of its life cycle creates an almost unfathomable recycling and reusing issue.



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Questions for further research

- How are we managing biodiversity?
- What is the current state and what are the next steps for the development of our waste management systems?
- How can international cooperation foster an inclusive circular economy?
- What are the prospects of 3R and circular economy in key development sectors (urban development such as buildings, infrastructure, construction, manufacturing and industries, transport, energy, etc.? To what extent the role of eco-towns is clearly understood in the context of advancing circular economies?
- What are the key enabling policy, institutional, financial and technological interventions that the governments should consider in greening the industries towards resource efficiency and circular economy?
- How can technology contribute to the promotion of circular economies?
- How has the pandemic affected the way food and transport systems are perceived and improved?
- What is the impact of a CE in the overall ecosystem, and how has the pandemic affected it?

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