CHAPTER 3

The Anatomy of the Circular Economy: Goals, Strategies, Values and Scales

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Despite its political and public importance, there is no a single definition of the circular economy (Kirchherr et al., 2017; Rizos et al., 2017). The purpose of this chapter is to undertake a critical investigation of the concept of circular economy as a "boundary object" (Star & Griesemer, 1989), analytically opaque with performative valences. This configures the circular economy as a stake-in-game whose meaning is subject to negotiations among actors, at cognitive, normative and practical levels (Barbera, 2020).

Two emphases follow from this. First, the scientific reflection around the concept of circular economy should be studied in relation to how it creates interests, projects, meaning and social reality (Haraway, 2007). In fact, any attempt to define a concept is a political act that sets boundaries and a specific focus through which the reality is framed. From what

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point of view do we choose to look at the world, at living and nonliving beings, and at their interrelationships? What is chosen to be kept in, what is left out, what is made central, what peripheral, large or small, significant or not? Kirchherr et al. (2017), in this regard, point out that most of the definitions they analyzed consider the circular economy merely as a strategy to continue ensuring economic growth, without reference to interests and projects related to the social dimension. Only 20% explicitly consider the social equity dimension within the definition, and only one definition makes a reference to future generations (Geng et al., 2013).

Second, scientific thinking around the concept of circular economy should also be studied in relation to how the plasticity of the concept is able to connect different organizational fields and otherwise unconnected social worlds, generating new value metrics and quality conventions. In this regard, we will see how the concept of the circular economy, read through the lens of socio-ecological (Young et al., 2006) and socio-technical (Callon & Latour, 1981) studies, allows economic issues to be connected with environmental issues and again with issues related to justice and social equity, so that a specific goal can be achieved, namely the generation of value in its multiple dimensions: "environmental quality, economic prosperity and social equity, for the sake of present and future generations" (Kirchherr et al., 2017, p. 229).

For the purposes of the analysis we intend to conduct, therefore, we start from the definition given by Kirchherr et al., (2017, p. 229): "*an economic system that replaces the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes. It operates at the micro level (products, companies, consumers), meso level (eco-industrial parks) and macro level (city, region, nation and beyond), with the aim to accomplish sustainable development, thus simultaneously creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations.*"

Based on this definition, we highlight three distinctive points:

1. Need to redesign production and consumption processes (from linear to circular) by looking at natural cycles (paragraphs 1 and 2);
2. Need to redesign space (from aseptic to reticular) that affects a plurality of actors (human and non-human) and can be acted upon at different scales (paragraph 3);

3. Need to redesign the hierarchy between means and ends and the worldview: from dichotomous to systemic (paragraph 4).

1 Learning from Nature to Close Circles

The adjective "circular," next to the word "economy," is evocative: it indicates the way of closing the circle (Commoner, 1972) of production and consumption processes, just as circular are the biological cycles occurring in nature (Fog, 2002), in contrast to the linear dynamics of the current economic model, characterized by the triad take-make-dispose (EMAF, 2013). One of the reasons that has favored the consolidation of the linear model is to be found in the abundance of material and energy resources that industrialized nations have experienced to date. Considering inexhaustible and especially costless natural resources has led to an increase in negative externalities related to the consumption a styles nd production patterns (Hardin, 1968, Perman et al., 1999, WWF, 2016). It has been clear for several decades that the linear model is unsustainable (Frosch & Gallopoulos, 1989).

The explanation for this untenability is the failure to consider the three laws of thermodynamics. The first law says: the total energy of the universe, which is an isolated system,[1] while changing from one form to another, remains unchanged.[2] However, energy cannot freely change from one form to another: thermal energy (heat) can freely change from a hot source to a colder one, but not in the opposite direction (second law). The physicist Clausius in 1865 introduced the concept of entropy to denote the spontaneous tendency of energy to transform into heat. Energy in the form of heat is said to be degraded in that not all of the heat produced can be transformed back into work, but remains lost to the environment. Read together, the two laws provide an additional insight:

[1] Thermodynamic systems can be: isolated when they exchange neither energy nor matter with the outside world, closed when they exchange energy but not matter and open when they exchange both.

[2] The law of conservation of energy stems from the ancient Greek insight: "nothing is created, nothing is destroyed, everything is transformed." The so-called pluralist philosophers, such as Empedocles, Anaxagoras and Democritus held, in fact, that the things of the world were made up of plural and eternal elements: the atoms, which by joining together give rise to the new and by disuniting cause the end of things. Heraclitus (500 B.C.) condensed this knowledge into the famous maxim "panta rei" (everything flows).

for any isolated physical system, energy transformations can only occur spontaneously in one direction, and therefore entropy, like time that only progresses from the past to the future, proceeds only from lower entropy (order) to higher entropy (disorder) (third principle). Maximum entropy is a state in which energy is completely degraded and is no longer capable of providing work, i.e., the equilibrium state of a system.

Applying the concept of entropy to biology results in an apparent contradiction. Indeed, biological systems tend to evolve in the direction of higher order, that is, lower entropy. However, such order in biological organisms is only possible because of the increase in entropy that is generated in the environment. In fact, the extraordinary order and complexity of all life forms are largely balanced by the disorder that is generated by the progressive consumption of the sun (Tonelli, 2020). Thus, the global entropic balance tends to degrade. The thermodynamic reading of nature's processes leads to the identification of the existence of entropic time: the faster the resources and energy of the Earth's ecosystem are consumed, the shorter the time of its survival. Thus, it is possible to identify a connection between the concept of entropy and the environmental economic problems underlying the linear economic model.

A model criticized by Pearce and Turner (1990), who in their work "Economics of Natural Resources and the Environment" propose a new economic paradigm they call the "circular economy," which can dialogue with the principles of thermodynamics. Their thinking was inspired by the works of Kenneth Boulding (1966) and Barbara Ward (1966) who both use the metaphor of the spaceship[3] to describe planet Earth as a closed system in which natural resources are finite and waste production cannot be sent outside. These works discussed, precisely, the biophysical limits of the current economic system built on overconsumption and a growing ecological deficit. Georgescu-Roegen (1971) fits into this line of thought and suggests a move toward a "bioeconomy," capable of mimicking biological cycles by designing goods and services, under the constraints imposed by nature, at a lower environmental cost. Redefining the economy as an open subset of the system-closed Earth is, therefore, the most important conceptual shift introduced in the 1970s by ecological

[3] The evocative image of the Earth as a spacecraft was presented by Adlai Stevenson in his speech to the United Nations Economic and Social Council in Geneva on July 9, 1965, and taken up shortly thereafter by Ward and Boulding.

economists (Costanza et al., 1997), who took the concept of a stationary economy from classical economists and modified it (Daly, 1977).

2 From Linear to Circular: Redesigning Production and Consumption Processes

The circular economy, according to the definition proposed by Kirchherr et al. (2017), is to be understood as a new economic paradigm that takes shape through different business models, capable of redesigning production and consumption processes (Sustainable Development Goal #12).[4] In fact, business model innovation, by defining the way a company operates (value creation, delivery and capture), can be the basis for changing the very way business is done (Bocken et al., 2014).

Circular business models are referred to in the literature (Bompan & Brambilla, 2016; Lacy et al., 2016; Rizos et al., 2017) by the following names: recovery and recycling, upcycling, circular inputs, product life extension, sharing platforms, product as a service, to which are added all those business models that aim to reduce impacts and waste through efficient use of resources.

However, these business models, although complementary, do not all have the same impact in reducing natural resource and material consumption and minimizing waste generation. Potting et al. (2017) identify 10 strategies (the 10 R)[5] sorted according to a hierarchy, developed on the basis of the Ladder van Lansink[6] which establishes an order of priority for waste treatment methods. In light of this scale, European Directive 2008/98/EC, known as the Waste Framework Directive, is issued in 2008, within which the concept of the "waste hierarchy" is formalized.[7]

Taking inspiration from Potting et al. (2017) and Rizos et al. (2017), we developed a new categorization that can hold together circular

[4] https://sdgs.un.org/goals/goal12.

[5] We generally refer to the 3R framework known as Reduce, Reuse, Recycle. In fact, several R models have been presented over the decades, used both in academia and by practitioners, and no specific article can be traced as a starting point for these frameworks (Sihvonen and Ritola, 2015).

[6] This name comes from a Dutch government resolution adopted in 1979 (Rli, 2015).

[7] *"The following waste hierarchy shall applies as apriority order in waste prevention and management legislation and policy: a) prevention; b) preparation for reuse; c) recycling; d) other recovery, e.g., energy recovery; and e) disposal"* (Article 4).

economy goals, business models and strategies (Fig. 1). First, we identified in the three categories proposed Rizos et al. (2017) the goals that the new economic paradigm aims at: (I) using fewer virgin resources; (II) maintaining the highest value of matter within production cycles; (III) changing consumption and production patterns. To which we added a fourth: (IV) generate value from waste.

In the respective business models, we identified the means by which to achieve the goals. And to each business model then, we matched one of the 10 R's proposed by Potting et al. (2017), again, introducing a modification. Instead of considering the strategies Refurbish and Regenerate separately, we chose to merge them into a single strategy and propose a new one: Refill.

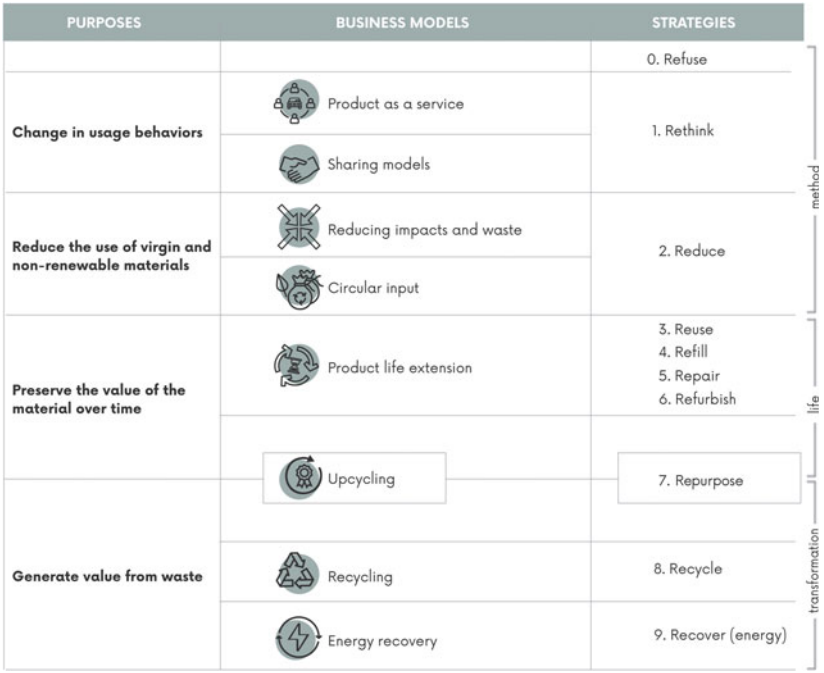

Fig. 1 Goals, business models and strategies of the circular economy (source: our elaboration from Rizos et al., 2017 and Potting et al., 2017)

We found it interesting to divide the 10 R's into three families: the "Method R's" (Refuse, Rethink and Reduce) are those that enable an effective cultural and economic paradigm shift. This is followed by the "Life R's" (Reuse, Refill, Repair, Refurbish, Repurpose), all of which are strategies for extending the life of a good before it becomes waste. All "Life R's" presuppose "Method R's," that is, they are strategies that incorporate the choice to have rejected linear model, to have thought differently to how it has always been done, result in a reduction of impact. Finally, the "Transformation R's" (Recycling and Energy Recovery) are strategies of valuing waste and no longer goods.

Let will start by examining "Transformation R's" starting with **Recover (R9).** Directive 2008/98/EC, later amended by Directive 2018/851/EU, specifies in Article 3 point (15) that the word "recovery" should mean: *"any operation the principal result of which is waste serving a useful purpose by replacing other materials which would otherwise have been used to fulfil a particular function, or waste being prepared to fulfil that function, in the plant or in the wider economy."*

And adds point (15bis) in which specifies the difference between "material recovery" and "energy recovery." "Material recovery" is understood to be any recovery operation other than energy recovery and reprocessing to obtain materials for use as fuels or other means to produce energy. It includes, among other things, the preparation for reuse, recycling and backfilling.

It is appropriate, therefore, to distinguish between Recycling and Energy Recovery considering the latter subsidiary and residual to material recovery. The same EU legislation mentioned above (Directive 2018/251) specifies that the share of waste to energy material no longer contributes to the calculation of recycling targets.

The **Recycling (R8)** strategy is defined in Article 3, point (17) of Directive 2008/98/EC as "*recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes. It includes the reprocessing of organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations.*"

Two variants of this business model can be identified (Lacy et al., 2016). The first refers to products that have reached the end of their useful life (post-consumer recycling), which in turn can be managed through closed loops (by the manufacturing company itself) or through open loops (separate collection system, which is the clear majority). The

second model refers to the recovery of waste (scrap) from the production process (per-consumer recycling).

Recycling and Energy Recovery, therefore, are the functional strategies to generate new value (in the form of matter or energy) from waste. Important to try to close the circle, but absolutely not sufficient and especially not a priority, being precisely at the last place in the hierarchy.

Wedged between strategies that aim to generate value from waste and those that aim to extend the life of products is a specific strategy that is so particular that we agree with those (Bompan & Brambilla, 2016) who consider it necessary to include it for all intents and purposes among the new business models specific to the circular economy. This is *upcycling*, which can be defined as an ideational and transformative process aimed at creating a new material or product from a material or product that no longer functions or serves the purpose for which it was made.

The term *upcycle* first appeared in an interview (Kay, 1994) with Reiner Pilz,[8] who used this expression to contrast it with the practice of recycling called "downcycling" instead. The term is taken up and systematized by architect McDonough and chemist Braungart (2003). In the text "The Upcycle: Beyond Sustainability. Designing for Abundance," the authors criticize the traditional recycling system: products, not being designed from the start to be recycled, once recycled generate a less durable and lower value material.

The characteristic of an upcycling process, therefore, is the transformation (**Repurpose, R7)** of the original use of a good or material so that it gains more value. This can be done without changing the material, as in the case of an old tire becoming a swing in a playground. People often refer to this practice as creative reuse.[9] Or it can occur by working on the material for example when rubber from an old inner tube becomes a wallet, or citrus waste becomes input for making a new type of yarn, instead of simply being composted. When waste from one production process becomes input for a different production process, it is called cross-fertilization (Bompan & Brambilla, 2016). The principles of upcycling find application in industrial symbiosis, which through the exchange of resources and by-products aims to develop synergistic and profitable

[8] Director from Pliz GmbH & Co. KG, a German automation company.

[9] The word reuse in this case is not to be confused with the R3 strategy REUSE, referring, instead, to the reuse of the same object, with the same function, by a different party, who has become the new owner of the good.

collaborations between companies (Chertow, 2000; Garner & Keoleian, 1995). Contrary to Bompan and Brambilla (2016), on the other hand, we do not consider it appropriate to include in this category upcycling processes, which are high-quality recycling, such as the one pioneered and patented by the company Aquafil[10] relating to fibers of polyamide 6, commonly known as nylon.

As shown in Fig. 1, the "lives R's" are the most numerous. We really have so many options available to us before turning a good into waste, through the business model life extension of products. First, there are the strategies that aim to **Reuse** (R3)[11] goods. Art. 3(13) 2008/98/EC defines reuse *"any operation by which products or components that are not waste are used again for the same purpose for which they were conceived*." Typically included in this strategy are the second-hand and vintage markets. As mentioned, we felt it was strategic and crucial to add a different R to Potting et al.'s (2017) model by identifying a particular form of reuse and naming it, **Refill** (R4). To provide a name and a place for such a strategy within the R hierarchy means to offer an operational direction to companies and a political priority to policymakers to fight the disposable imperative, that is so dominant in the packaging industry. Hence, it involves designing containers or items to be used multiple times over time, not just once. This category includes bulk logistics (the customers get the packaging to transport the products they buy) and reverse logistics, where the packaging, once used, is picked up, washed and reused again as packaging, on an industrial scale. Or again it can be intended as a strategy to replace typically disposable products such as sanitary napkins, diapers with washable diapers or menstrual cups, or even disposable crockery with reusable crockery. Let us emphasize how this strategy, as new as it may appear, was in fact a habit from the years before the economic boom (returnable milk bottle empties).

A further strategy for extending the life of goods, also not new, is **Repair** (R5) and building for durability referring to those production processes characterized by the quality of materials chosen and attention to customer service (Bocken & Short, 2016), such as repair precisely, often linked to artisan processes as opposed to the model of fast fashion or

[10] https://www.aquafil.com/it/

[11] Art. 3(13) 2008/98/EC means any operation by which products or components that are not waste are used again for the same purpose for which they were intended.

planned obsolescence[12] (Longmuss & Poppe, 2017), typical of electronic or household appliances, but not only. In this regard, the importance of restoring occupations and skills, often linked to the world of craftsmanship, that are in danger of disappearing (tailoring repairs, shoemakers) is emphasized, as well as the need to support new skills (such as those related to the repair of computers and cell phones). Great impetus for Europe to take on the task of facilitating and incentivizing the repair of electrical and electronic equipment (EEE) is the global Right to Repair movement.[13]

One strategy that has taken ground lately in reaction to the development of electronic tools and that goes beyond selling second-hand and repairing is **Refurbishing** (R6). This involves restoring used products through a modernization process that involves replacing old and/or worn parts as new parts (Van Weelden et al., 2016). In order for refurbishment (as well as repair) to achieve maximum success with minimum effort, it becomes important that products are designed on a modular basis whereby individual components can be easily removed, repaired and replaced. An example that has now become iconic is the Fairphone, the smartphone made by a Dutch social enterprise that has embraced the principle of modularity, as well as that of traceability of the materials used (Kannengießer, 2020).

Finally, the "method R's," which, as mentioned, are already part of the "life R's," however, have a specification of their own. To **Reduce** (R2) means first of all to reduce upstream of production cycles, the use of matter and energy in general and virgin matter and nonrenewable energy in particular. There are two types of business models of interest. The first concerns those models inherent in reducing impacts and waste that aim to achieve greater process efficiency by optimizing material and energy demands. Examples are energy efficiency, precision interventions (such as 3D printing, the use of drones in agriculture), and reducing the volume and weight of packaging.

[12] The term planned obsolescence first appeared in 1931 by real estate broker Bernard London (1932), who proposed that it be imposed on businesses by law so that it could lift consumption in the United States during the Great Depression. In the 1950s U.S. designer Brooks Stevens reinterpreted the concept of planned obsolescence by giving it a new definition: the instilling in the buyer the desire to buy something just a little bit newer and a little bit sooner than it is needed (Glenn, 2005).

[13] https://repair.eu/it/

The second type concerns the adoption of circular inputs (for both material and energy production), as strategic business drivers. Circular means, on the one hand, renewable and/or biodegradable inputs (materials derived from renewable biomass that can replace toxic and/or nonrenewable inputs and after use can be safely degraded; energy derived from renewable and sustainable sources) and, on the other hand, second raw material, i.e., inputs made from recovered material, by-products or recycled material.

Rethinking (R1) invites us to look otherwise at the way we use (produce and consume) things, and not just at the amount of resources used or the amount of waste produced (Bocken & Short, 2016). In 1988, Swiss architect Walter Stahel coined the expression product as a service, proposing a new business model based on the use of goods and not on possession. According to this model, the company retains ownership of the product in question and offers the customer the use of it. By applying this business model, the company is better able to maintain control over the resources at its disposal. This practice should motivate the company to repair and keep the product in use for a longer period of time, allowing for an environmental benefit (Stahel, 1988; Tukker & Tischner, 2006). Some strategies for implementing product as a service are the practice of leasing, renting, pay-per-use or performance-based business model.

Alongside the product as a service, with the same rationale of promoting use and not ownership, sharing models and platform have emerged. As with the previous business model, again rental, sharing, exchange and lending, in this case among peers, are facilitated. Such models, often supported by technology platforms, facilitate the sharing of underutilized products (such as RVs, snowshoes, drills) by reducing the demand for new products and also fostering the creation of social capital (JRC, 2016).

In closing, it is worth noting how the concept of circular economy has a mostly metaphorical value, in the sense of indicating a tension, a direction, a new posture in imitation of nature in a double sense. For while it is true that closing the circle refers to the idea of closing biological cycles, nature itself teaches us that it is impossible to perfectly close the circle due to the laws of thermodynamics (entropy). We therefore disagree with those who argue for decoupling natural resource use and economic growth (Yu et al., 2013; Accenture, 2014, EMFA, 2015). In fact, since the last two centuries of extraordinary economic growth in high-income countries are largely due to the availability of cheap fossil fuels, and not

already from technological progress (Ayres & Ayres, 2010), this means that in a future post fossil fuels that need to be built, economic growth must slow down (Ayres & Warr, 2009) and assume a steady state (Daly, 1977) and sufficiency (Dyllick & Hockerts, 2002).

Taking up, then, the hierarchy of R's proposed by Potting et al. (2017) we like to emphasize that the original R, the one that precedes all the others, is **Refuse (R0)** which has 0 as its number and not 1, to emphasize the generative character, from which the other strategies descend. Rather than understanding this strategy in a technical way, we like to interpret it primarily in a political way. The ability to say "No!" What becomes necessary to reject is the myth of endless growth, assuming instead to the fullest the concept of limit. For only by rejecting and placing under critique the logics of the current economic model, it is possible to open up new and different economic, cultural and social models, as the chemist and commodity scientist Giorgio Nebbia (2002, p. 36) suggests: *"no one will save us but our hands, our courage to say No!, our sense of responsibility to future generations, to the "near future" whose face we will never know, but whose lives, happiness, depend on what we will and will not do, on what we will buy and reject, tomorrow and in future decades."*

3 Space Becomes Reticular: Redrawing Boundaries, Relationships and Actors

The second distinctive point to keep in mind when discussing the circular economy is that it can be declined at different scales: micro (product level, individual company), meso (level of interaction between companies, industrial parks) and macro (city level and beyond) (Kirchherr et al., 2017).

Depending on the scale chosen for analysis, different are the interactions that take place between the subjects of the system. And, yet, each scale level, however much it may be read independently, is not independent of the levels that precede or follow it. These considerations lead us to think in terms of boundaries, relationships, actors, nodes, networks and thus, from a systemic perspective. Since we are dealing with products, firms, machinery, entrepreneurs, administrations, laws and citizens, all embedded in natural and built environments, we suggest that reasoning around the circular economy should develop from the concepts of socio-ecological system (Young et al., 2006) and socio-technical system (Callon & Latour, 1981). Both perspectives, in

fact, are based on the concept of system. The former investigates the possible boundaries between natural and social systems and the relationships between the two. Indeed, integrated studies of human and natural systems reveal patterns of interrelationship that are not evident when studied separately by social or natural scientists (Liu et al., 2007).

The second perspective places more emphasis on the issue of the relationships at work between different actors and the capacity of each to act, regardless of whether those actors are human or non-human, animate or inanimate: people, technology and natural phenomena can all be components of heterogeneous networks and assume the role of actor, or rather "actant" (Callon, 1986). People are not always subjects and things are not always objects. Categories such as subjects, objects and actors must be understood as outcomes, as effects. They cannot or should not be defined a priori. The term "actant" denotes, in fact, a thing endowed with "agency," where agency means the capacity to act and produce effects, and not already the will to act intentionally.

It becomes interesting to follow the actants and study how they create reality through the diversity of their practices and material resources (Latour, 1987). Apart from size, there is no difference in the nature of macro-actants and micro-actants (Callon & Latour, 1981): all that changes is their composition and the way their constituent elements are arranged, aggregated or deployed. A company, as well as a city, properly organized, can act as a single entity: it is neither simpler nor more complicated than a single human being, or a product.

Both the socio-ecological and socio-technical perspectives, therefore, recognize and assume to the fullest extent the realization that everything is connected, that actions take place in a space that is no longer hierarchical a priori, because it is a reticular space, a space that is all on the surface, where there are no depths and levels. Systems are an infinite chain of these levels. And yet, hierarchies and boundaries (starting with what is to be studied and how, who is the object of study, who it is that acts the analysis) are observable realities, not already as facts, but as the outcome of continuous mediations between the actants, as constructed facts (Latour & Woolgar, 1986).

In this regard, it is necessary to ask how to set up observation to define the framework of focus, and thus to understand, in light of the gaze adopted, what has been made central and peripheral, large and small, significant and not. The question of which "enactments" (enactments) prevail and become more real is thus an empirical question of

the nature and character of the connections—and boundaries—between different places and acted practices (Asdal et al., 2007).

4 A Systemic Look: Redesigning the Hierarchy Between Means and Goals

The last part of the definition of circular economy proposed by Kirchherr et al., (2017, p. 229) states: "……*with the aim to accomplish sustainable development, thus simultaneously creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations.*"

This phrase highlights how the circular economy is to be understood, as a means and not an end, as an economic strategy functional to achieve a specific goal, namely the generation of value in its multiple dimensions: environmental quality, economic prosperity and social equity, for the sake of present and future generations[14]. Yet, most of the 114 definitions analyzed in the study by Kirchherr et al. (2017) consider the circular economy as a way to ensure economic growth without referring to the three dimensions of sustainable development in an integrated way: 88% of the definitions do not include the concept of sustainable development within them, and only 20% explicitly consider the dimension of social equity within the definition. Why should the circular economy have to deal not only with economic and environmental issues, but also with issues of justice and equity, worrying about today and tomorrow?

In the first two paragraphs, we tried to explore the implications and motivations behind the adjective circular, in the expression "circular economy." In this last paragraph, we focus on the word "economy." Kate Raworth (2017), a British woman and economist, makes an interesting reading of economic thought by denouncing how economics has defined itself as the science of human behavior, eliminating the human factor in its models altogether over time.

The word economy was coined by the Athenian philosopher Xenophon (fourth century BC) who described it as an art aimed at the good governance of the household. Aristotle later, in the 1st Book of Politics

[14] There is a clear echo of the concept of sustainable development as elaborated by the 1987 Brundtland Report understood as "development that meets the needs of the present generation without compromising those of future generations" (World Commission on Environment and Development, 1987).

(fourth century BC), distinguished between *oikonomia* and *chrematistics*, whose aim was no longer good household management but the art of acquiring wealth. With the establishment of political economy in the eighteenth century, economics acquires the status of a science: the science of domestic policies in free nations, the main purpose of which is to secure subsistence and provide employment for citizens so that they can create relations of exchange and mutual interest (Steuart, 1767). Even as defined by Adam Smith, political economy remains a purpose-oriented science with two distinct objects: to enable citizens to procure their livelihoods and to provide the state with revenue to secure public services (Smith, 1776). With Stuart Mill (1844), the focus is no longer on the purposes of economic science, but on the discovery of its laws. In 1932 came the famous definition of economics according to neoclassical thought, with which many textbooks still open today: a science that studies human behavior as a relationship between ends and scarce means that have alternative uses (Robbins, 1932). While citing the study of human behavior and the ends/means relationship, in fact, neoclassical economics refrains from any judgment of ends and value. Finally, the word purpose/goal disappears entirely in the definition given by economist Gregory Mankiw (1998), according to whom economics is simply the study of how society manages its scarce resources. No longer considering the question of aims and objectives makes it possible to enshrine the independence of economic science from the sphere of the politics of ethics, ultimately from value judgment, thus removing itself from any normative statement (what it ought to be) to establish itself as a positive science, aimed at the simple description of what is.

However, although it claims to be unrelated to the concept of value, neoclassical economic theory has in fact placed this dimension at the center of its scaffolding, since it is grounded in the concept of utility, defined as the satisfaction or happiness obtained by a person for consuming a given good or service (Begg et al., 1987). While considering it a completely subjective quantity, and therefore not commensurable, much less comparable, neoclassical theory holds that the price people are willing to pay to obtain a good or service is a good enough indicator to calculate the utility they derive from it. It is the concept of opportunity cost: the value assigned to a given good is a function only of the foregone cost of obtaining this good relative to obtaining another possible good. In addition, assuming as a given that consumers prefer more to

less, neoclassical economic doctrine identifies output growth as a consistent indicator for calculating human welfare. And so, by the late 1950s, GDP growth had become the overriding policy objective of industrialized countries, transforming from an option of policies to a necessity of economic policies.

To the growth curve stretching to infinity graph, Raworth (2017), instead, proposes a different image as a new cognitive and operational tool for orienting the twenty-first century. The image is a doughnut[15], capable of opening onto a future scenario in which it is possible to meet the needs of each person while simultaneously safeguarding the living world which we depend on. The inner circle of the doughnut represents the social bases, below which we find ourselves in the hole of deprivation, experienced by those unable to meet basic needs. These needs are: food sufficiently; clean water and decent sanitation; access to electricity and clean cooking equipment; access to education and health care; decent housing; a minimum income and decent work; access to communication and social support networks; gender equity; social equity; political expression; peace; and justice.

The outside circle of the doughnut, on the other hand, represents the ecological ceiling, or nine critical natural processes necessary for the regulation of Earth system functioning (Rockstrom & Steffen, 2009), expressed as indicators: ozone depletion; climate change; ocean acidification; chemical pollution; nitrogen and phosphorus cycling; freshwater consumption; land use change; biodiversity loss; and atmospheric aerosol loading.

Within the two boundaries, lower and upper, an ecologically safe and socially equitable space is generated, where the two boundaries, inner and outer, are closely interconnected. In other words, "*the pendular representation of the economic process, […] according to which demand stimulates production, and the latter provides the income necessary to feed new demand, in a reversible process seemingly able to reproduce itself indefinitely, will have to be replaced by a circular and evolutionary representation,*

[15] In fact, Raworth recognizes herself as part of a collectivity of scholars who over time, even before her, laid the groundwork for arriving at the conception of the doughnut image, in particular she feels grateful to Barbara Ward, a pioneer of sustainable development who called governments to action to come within both internal (human rights) and external (environmental limits) boundaries, outlining with words rather than images of the boundaries of the doughnut (Ward and Dubos, 1973).

in which the economic process turns out to be rooted in the biophysical environment that sustains it" (Bonaiuti, 2003, p. 9).

The doughnut economy, then, re-proposes what has already been suggested by the concept of the stationary economy (Daly, 1977) and the sufficiency economy, defined both as corporate sustainability tactics and consumption priorities (Dyllick & Hockerts, 2002), and as a national strategy that can ensure that the community maintains an adequate population and preserves ecosystem wealth.

The circular economy, in conclusion, with the combination of the word economy and the adjective circular, is both a matter of laws, the biophysical ones of thermodynamics, and a matter of vision: the one that assumes human beings to be part of a complex system of relationships on which they depend. According to this point of view, which assumes the interdependence between the environmental, social and economic spheres as a paradigm, the interests, the projects and meanings that the concept of circular economy mobilizes concern the well-being and happiness of each living being of today and tomorrow. This means taking an interdisciplinary approach that can link otherwise disconnected disciplines and different organizational fields: economics, sociology, biology, physics, as well as engineering, design, law and urban planning and philosophy. Thus, in the face of the overall picture that is foreshadowed, we are all called to "work to become responsible for what we learn to see" (Haraway, 2007).

Bibliography

Accenture. (2014). *Circular Advantage: Innovative Business Models and Technologies to Create Value in a World without Limits to Growth*, at https://sharingcitiesalliance.knowledgeowl.com/help/circular-advantage-innovative-business-models-and-technologies-to-create-value-in-a-world-without-limits-to-growth (accessed 12.01.24)

Asdal, K., Brenna, B., & Moser, I. (Eds.). (2007). *The politics of interventions. A History of STS*. Technoscience. The Politics of Interventions, Unipub.

Ayres, R. U., & Ayres, E. H. (2010). *Crossing the energy divide: Moving from fossil fuel dependence to a clean-energy future*. Wharton School Publishing.

Ayres, R. U., & Warr, B. (2009). *The economic growth engine: How energy and work drive material prosperity, Cheltenham*. Massachusetts, Edward Elgar Publishing.

Barbera, F. (2020). *L'innovazione sociale: aspetti concettuali, problematiche metodologiche e implicazioni per l'agenda della ricerca*, Polis (ISSN 1120–9488) Fascicolo 1, aprile 2020.

Begg, D. K. H., Dornbusch, R., & Fischer, S. (1987). *Economics*. McGraw-Hill.
Bocken, N. M. P., & Short, S. W. (2016). Towards a sufficiency-driven business model: Experiences and opportunities. *Environmental Innovation and Societal Transitions, 18*, 41–61.
Bocken, N. M. P., Short, S. W., Rana, P., & Evans, S. (2014). A literature and practice review to develop sustainable business model archetypes. *Journal Clean Production, 65*(2014), 42–56.
Bompan E., & Brambilla I. N. (2016). *Che cosa è l'economia circolare*. Edizioni Ambiente.
Bonaiuti, M., (a cura di). (2003). *Introduzione*, in Georgescu- Roegen N., *Bioeconomia. Verso un'altra economia ecologicamente e socialmente sostenibile*. Bollati Boringhieri.
Boulding, K. (1966). *The economics of the coming spaceship earth*, in H. Jarrett (Ed.), *Environmental quality in a growing economy*. Johns Hopkins University.
Callon, M., & Latour, B. (1981). *Unscrewing the big Leviathan: How actors macrostructure reality and how sociologists help them to do so*, in K. Knorr Cetina, & A. V. Cicourel (Eds.) *Advances in social theory and methodology: Toward an integration of micro and macro sociologies* (pp. 277–303). Routledge and Kegan Paul.
Callon, M. (1986). *The Sociology of an Actor-Network*, in Callon M., Law J., Rip A., *Mapping the Dynamics of Science and Technology*. Macmillan.
Chertow, M. R. (2000). Industrial symbiosis: Literature and taxonomy. *Annual Review of Energy and the Environment, 25*, 313–337.
Commoner, B. (1972). *Il cerchio da chiudere. La natura, l'uomo e la tecnologia*. Garzanti Editore.
Costanza, R., Cumberland, J. H., Daly, H., Goodland, R., & Norgaard, R. B. (1997). *An introduction to ecological economics*. CRC Press.
Daly, H. (1977). *Steady state economics*. Freeman.
Dyllick, T., & Hockerts, K. (2002). *Beyond the business case for corporate sustainability,* in Business Strategy and the Environment (Vol. 11(2), pp. 130–141) Special Issue: Sustainability at the Millennium: Globalization, Competitiveness and Public Trust.
EMAF, Ellen MacArthur Foundation. (2013). *Towards a Circular Economy: Business Rationale for an Accelerated Transition*, https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Ellen-MacArthur-Foundation-Towards-the-Circular-Economy-vol.1.pdf
Frosch, R. A., & Gallopoulos, N. E. (1989). Strategies for manufacturing. *Scientific American, 261*, 144–152.
Garner, A., & Keoleian, G. A. (1995). *Industrial ecology: An introduction*. National Pollution Prevention Center for Higher Education.
Geng, Y., et al. (2013). Measuring China's circular economy. *Science 339* (6127).

Georgescu-Roegen, N. (1971). *The entropy law and the economic process*. Harvard University Press.

Glenn, A. (2005). Industrial strength design: How brooks Stevens shaped your world. *Cambridge University Press, Enterprise and Society, 6*(3), 548–550.

Haraway, D. (2007). *Situated knowledges*. The Science Question in Feminism and The Privilege of Partial Perspective, in K. Asdal et al., & Technoscience the Politics of Interventions, (Eds.) Unipub.

Hardin, G. J. (1968). The tragedy of the commons. *Science, 162*(3859), 1243–1248.

JRC, Joint Research Centre. (2016). *Scoping the sharing economy: Origins, definitions, impact and regulatory issues,* https://ec.europa.eu/jrc/sites/jrcsh/files/JRC100369.pdf

Kannengießer, S. (2020). *Engaging with and reflecting on the materiality of digital media technologies: Repair and fair production. New Media and Society*, *22*(1), 123–139.

Kay, T. (1994). *Reiner Pilz*. Salvo Monthly in Germany. No. 23 October 94, pp. 11–14.

Kirchherr, J., Reike, D., & Hekkert, M. (2017). *Conceptualizing the circular economy: An analysis of 114 definitions,* Resources, Conservation and Recycling.

Lacy, P., Rubqvist, J., & Lamonica, B. (2016 ed. orig. 2015). *Circular economy. Dallo spreco al valore*. Egea.

Liu et al. (2007). Coupled human and natural systems. *Science*, *317*(5844), 1513–1516.

Latour, B. (1987). *Science in action how to follow scientists and engineers through society*. Harvard University Press.

Latour, B., & Woolgar, S. (1986). *Laboratory life: The construction of scientific facts* (2nd ed.). Princeton.

London, B. (1932). Ending the depression through planned obsolescence. https://en.wikipedia.org/w/index.php?title=File:London_(1932)_Ending_the_depression_through_planned_obsolescence.pdf&page=7 (accessed 12.01.24)

Longmuss, J., & Poppe, E. (2017). *Planned obsolescence: Who are those planners?* Product Lifetimes and the Environment 2017—Conference Proceedings, in C. Bakker, & R. Mugge (Eds.), Delft University of Technology and IOS Press.

Mankiw, G. (1998). *Principles of Economics.*

McDonough, W., & Braugart, M., (2003, ed. Orig. 2002), *Dalla Culla alla Culla: come conciliare tutela dell'ambiente, equità sociale e sviluppo*, Blue Edizioni.

Mill, J. S. (1844). *On the definition of political economy*.

Pearce, D. W., & Turner, R. K. (1990). *Economics of natural resources and the environment*. Johns Hopkins University Press.
Perman, R., Ma, Y., McGilvary, J., & Common, M. (1999). *Natural resources and environmental economics*, 2 ed., Edinburgh, Pearson Education Limited.
Potting, J., Hekkert, M., Worrell, E., & Hanemaaijer, A. (2017). *Circular economy: Measuring innovation in product chains* (p. 2544). PBL publication number.
Raworth, K., (2017) *L'economia della ciambella. Sette mosse per pensare come a un economista del XXI secolo.* Edizioni Ambiente.
Rizos, V., Tuokko, K., & Behrens, A. (2017). T*he circular economy: A review of definitions, processes and impacts,* CEPS Research Report, No. 2017/08/April 2017. https://www.ceps.eu/ceps-publications/circular-economy-review-definitions-processes-and-impacts/
Rli. (2015). *Circular economy. From intention to implementation* (in Dutch; Rli 2015/03, NUR-740, ISBN 978–90–77323–00–7), *Council for the Environment and Infrastructure* (Rli), The Hague.
Robbins, L. (1932). *Essay on the Nature and Significance of Economics Science.*
Rockstrom, J., & Steffen, W. (2009). *A safe operating space for humanity,* in Nature Vol 461|24 September 2009.
Sihvonen, S., & Ritola, T. (2015). Conceptualizing ReX for aggregating end-of-life strategies in product development. *Procedia CIRP, 29*(2015), 639–644.
Smith, A. (1776). *An Inquiry into the wealth of Nations.*
Stahel, R. W. (1988). *From Products to Services: Selling performance instead of goods*, in The IPTS Report n° 27, September 1998, IPTS, JRC.
Star, S. L., Griesemer, J. R. (1989). *Institutional ecology, «Translations» and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology*, in Social Studies of Science, 3, 387–420.
Steuart, J. (1767). A*n inquiry into the principles of political economy.*
Tonelli, G. (2020). *Genesi. Il grande racconto delle origini.* Feltrinelli.
Tukker, A., & Tischner, U. (2006). Product-services as a research field: Past, present and future: Reflections from a decade of research. *Journal of Cleaner Production, 14*, 1552–1556.
Van Weelden, E., Mugge, R., & Bakker, C. (2016). Paving the way towards circular consumption: Exploring consumer acceptance of refurbished mobile phones in the Dutch market. *Journal of Cleaner Production, 113*, 743–754.
Ward, B. (1966). *Spaceship Earth.* Columbia University Press.
Ward, B., & Dubos, R. (1973). *Only one Earth.* Penguin Books.
World Commission on Environment and Development. (1987). *Our Common Future*, Ginevra, 27 aprile 1987, London Oxford University Press.
WWF, World Wildlife Fund. (2016). *Living Planet Report*, https://www.worldwildlife.org/pages/living-planet-report-2016 (accessed 12.01.24).

Young, O. R., Berkhout, F., Gallopín, G. C., Janssen, M. A., Ostrom, E., & van der Leeuw, S. (2006). *The globalization of socio-ecological systems: An agenda for scientific research. Global Environmental Change*, *16*, 304–316.

Yu, Y., Chen, D., Zhu, B., & Hu, S. (2013). Eco-efficiency trends in China, 1978–2010: Decoupling environmental pressure from economic growth. *Ecological Indicators, N., 24*, 177–184.