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Circular Economy, sustainable capitalism

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Introduction

Circularity is the principle that has always governed the nature. It has allowed primitive people to overcome the problem of scarcity of resources, and is the basis of circular societies. Circularity has allowed primitive societies to overcome the shortages of skills, resources and people by making the best possible use of the avaliable natural sources. Sharing and reuse in primitive communities were a necessity and the norm. It's quite obvious that in a context like that, human capital is one of the founding elements, it is placed at the basis of it. The care and sharing of stocks have been the engine of the circular society of the past and will be the basis of our sustainable future. Industrial Revolution allowed mankind to overcome the problems arising from scarcity, but at the same time, this epochal event, distanced people from nature. As said before, Industrial Revolution cut the link between man and nature and placed efficiency first, at the expense of sufficiency. From here on, the global economy's evolution has been dominated by a linear model of production and consumption, in which goods are manufactured from raw materials, sold, used and then discarded as waste. The success of the linear industrial economy, LIE, has led to abundance for what concerns the production of objects and materials, but has also led to an unsustainable consumption of resources and to an ever-increasing volume of waste. Actually, we are exploiting so much, and so quickly the natural enviroment, that we are already living far beyond Earth's capability to sustain us, consequently provoking the ineluctable deterioration of ecosystems. Looking for efficiency as a solution, thus looking for a reduction of resources and fossil energy consumed per unit of economic output, unfortunately will not change the finite nature of material stocks, it can only delay the unavoidable. The current economic system is incredibly wasteful in its model of value creation, this does nothing but create economic losses and structural waste. The pressure exerted on the environment, in fact, is so high that it risks to compromise its ability of providing goods and resources also in the future. In Europe, for example, material recycling and waste-based energy recovery catch only 5% of the original raw material value. Recently, lot of companies have begun to recognize that the linear system increases their exposure to risks, with particular reference to volatile resource's prices and supply disruptions. Higher resource price volatility may reduce economic growth by increasing uncertainty, discouraging businesses from investing and increasing the cost of hedging against the risk associated to resources. Many areas of the world possess few natural deposits of non-renewable materials. The European Union, in particular, imports six times as much materials and natural resources as it exports. The threat to supply security and safety associated with long, elaborately optimised global supply chains appears to be increasing. There are a lot of negative

environmental repercussions related to the linear model. The elements that are contributing the most to these environmental pressures include: climate change, loss of biodiversity and natural capital, land degradation, and ocean pollution. Degradation of natural capital is especially affecting the productivity of economies. What is needed is a more forward-looking vision that starts from the assumption and perception that every kind of human activity is made possible and supported by the ecosystem within which it operates. The circular industrial economy, CIE, although it is not the only existing smart and green strategy, is probably the most sustainable business model, because able of simultaneously improving multiple ecological, social and economic factors. The circular model of growth, decoupled from the consumption of finite resources and capable of delivering resilient economic systems, is proposing itself as the new/next way of development. As a matter of fact, technological advances, guided by circular economy's principles could create more and more opportunities in a context like this one. These improvements would allow more efficient collaboration and knowledge sharing, better tracking of materials, improved forward and reverse logistics set-ups, and increased use of renewable energy. A new model of transaction is catching on, in which individuals welcome business models that enable them to access services rather than owning the products, thus becoming users. The ratio for transitioning to a circular model is very well documented, and also the magnitude of the economic opportunity is gradually rising from an analytical perspective and also from the case studies provided by early adopters. The philosophy depicted by the circular approach would allow mankind to insert itself into the environment that surrounds it, guided by a greater sense of responsibility and respect for natural processes and cycles. The objective of this work is to highlight what are the main characteristics of the circular model, in contrast to those of the linear one and to, through an analysis of a business case, highlight which are the real applications of this model emphasizing the improvements and the advanges compared to the classic system.

Chapter 1. The concept of circular economy

The notion of circular economy basically relates to a systemic approach towards economic development, created to benefit businesses, society and the enviroment. This model draws inspiration from nature, since nature is governed by a self-organized system of virtuous cycles of materials in which someone's waste is food and benefit for someone else. Natural processes are not subject to time and monetary constraints. The linear approach, is no longer working for businesses, people or the environment. Shifting the system involves everyone and everything: businesses, governments, and individuals. By designing out waste and pollution, keeping products and materials in use, and regenerating natural systems, everything can be reinvented. In contrast to the "take,make,waste" linear model, the circular one is conceived as a continous cycle of positive development, that preserves and enhanches natural capital, optimises resources exploitation/use and minimise system risks by better managing the finite resources and the renewable flows. Circular economy is restorative and regenerative by design and aims to keep products, components, and materials at their highest utility and value at all times. It rests on three principles: designing out waste and pollution, keeping products and materials in use, and regenerating natural systems. It works at any scale, for big and small businesses, for organisations and individuals, globally and locally. The aim of that approach is to, little by little, decouple growth from the consumption of finite resources and to re-build capital, whether this is financial, human, social or natural. This ensures enhanced flows of goods and services. The circular system, to be implemented, needs changes not only from the technological angle, but also from a social, cultural and civil point of view. It has the sustainability as founding element of its business model. The concept of Extended producer responsibility, in particular, underlines how the circular model is an industrial system capable of using for an extended period of time the same materials in order to contrast the lack of abondance of raw material on our planet. It is critical that manufacturers and importers take care of their products once their useful life has ended so that they are recovered and returned to the production cycle. The necessary condition for this model to develop, in accordance with the market rules themselves, is the existence of a national network of recycling companies competing with each other, this consequently increases the demand for recycled material and improves the offer from a qualitative and performance point of view. The linear economy has to change. All the elements of the take-make-waste system should be reconsidered: how resources are managed, how products are made and used, and what we do with the materials afterwards. Only after taking in

consideration all these factors an economy that can benefit everyone respecting planetary boundaries can be created.

I. Circular economy' founding principles

1. Design out waste and pollution;
2. Keep products and material in use;
3. Regenerate natural system.

Image 1. Circular Economy's founding principles

Source: ellenmacarthurfoundation.org

1. **Preserve and enhance natural capital by controlling finite stocks and balancing renewable resource flows.**

   Everythink starts by dematerialising utility. A circular economy reveals and designs out the negative effects of the economic activity which is causing harm to human health and to the natural systems. This includes the release of greenhouse gases and hazardous substances, the pollution of air, land, and water, as well as structural waste such as traffic congestion. A circular economy also improves natural capital by encouraging nutrient flows within the system and by creating conditions for regeneration.

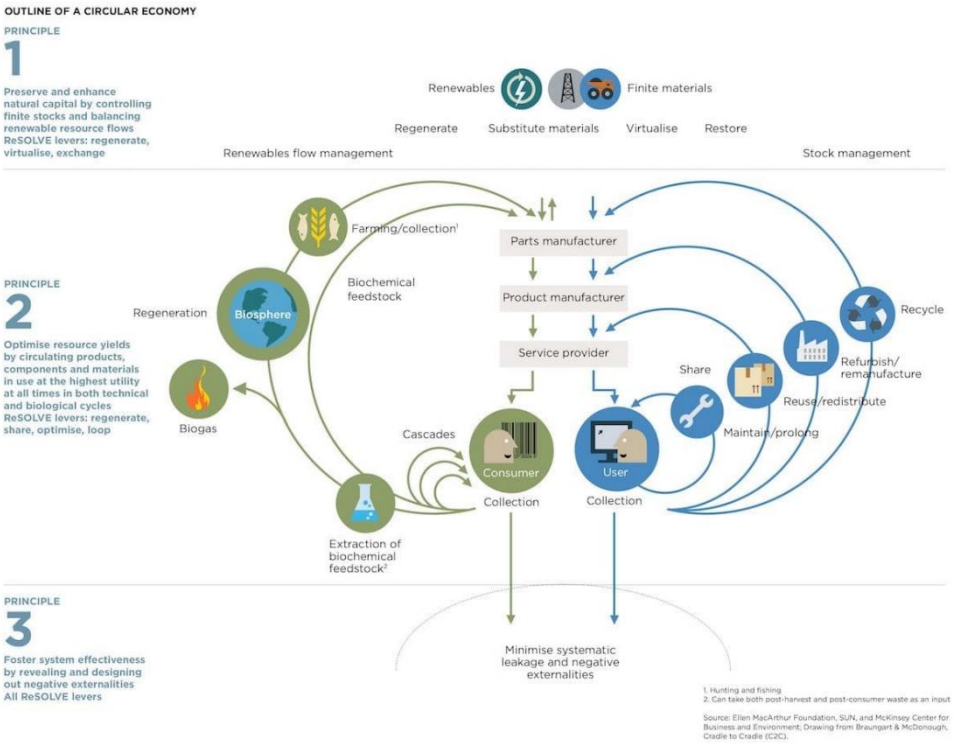
2. **Optimize resource yields by circulating products, components and materials with maximum utility at all times, both in technical and biological cycles.**

   It means designing for regeneration, restoration and recycling in order to keep technical and material components in circulation, as long as possible, and make them contribute to the economy. Circular systems employ tighter, inner loops. These systems maximise the number of consecutive cycles and the time spent in each cycle by extending product life, optimising reuse and by making effective use of bio-based materials, encouraging many different uses for them as they circle within the economy and natural systems. Circular economy supports activities that preserve value in the form of energy, labour, and materials. In biological cycles, products are designed with the intention of being consumed or metabolised by the economy and regenerate new resource value. For biological materials, the core of value creation lies in the opportunity of extracting additional value from products and materials by cascading them through other applications.

3. **Foster system effectiveness by disclosing and designing out negative externalities.**

   By definition, circular economy avoids the use of non-renewable resources and conserve or enhances renewable ones, this means reducing damage to systems and areas such as food, mobility, education, health, entertainment, and managing externalities, such as land use, air, water and noise pollution, and the release of toxic substances. For example by returning valuable nutrients to the soil to support regeneration or using renewable energy instead of relying on fossil fuels.

Image 2. Outline of a Circular Economy



Source: ellenmacarthurfoundation.org

II. The conceptualization of circular economy

In a circular economy, the economic activity builds and rebuilds the health of the system. It is perceived the need for the economy to work effectively at all scales. Moving towards a circular economy does not just deal with adjustments aimed at reducing the negative impacts of the linear one. Rather, it represents a systemic shift that builds long-term resilience, generates business and economic opportunities, and provides benefits at the environmental and societal level. The approach distinguishes between technical and biological cycles. Biological cycles encompass the flows of renewable materials. Consumption happens only in biological cycles where biologically-based materials (such as cotton or wood) are designed to fuel the system through processes such as composting and anaerobic digestion. These cycles restore living systems and provide renewable resources for the economy. On the other hand, technical cycles entail the management of stocks of finite materials and the refurbishment of products, components, and materials through strategies like reuse, repair, remanufacture or recycling. From a linear development, focused on mineral substances, we move on to a circular vision based on exchange, recycling and recovery as founding system elements. Circular economy is preferable because it utilizes resources more efficiently than the linear pattern.

I. Fundamental characteristics

- **Waste is designed out**. What has so far been understood as waste, now must be understood as a set of biological, chemical and technical components that can be disassembled into simpler units with the intention of being reused or destined for new purposes. Technical materials, polymers, alloys, and other man-made materials, are designed to be recovered. We move from the concept of recycling of matter to the concept of renewable matter and this means that the life of renewable matterial is extended as much as possible. This imply that waste doesn't exist, biological materials, by definition, are non-toxic and can easily be returned to the soil;
- **Renewable energy sources power the economy.** The energy required to stimulate the circular economy should be renewable by nature, in order to increase systems resilience. According to Rockstrom, there are nine planetary boundaries that must not be overcome if we want to continue to live on a stable and prosperous planet. These nine boundaries comprise: **1** The carbon dioxide concentration below 350 ppm (parts per million); **2** The

maintenance of biodiversity at 90%, (in Africa it is below 84%), **3** The use of nitrogen and phosphorus which must remain below the thresholds of 11 Tg (teragrams) and 62 Tg respectively, today twice as many are used; **4** The maintenance of 75% of primary forests (currently under 62%); **5** Aerosol emissions below the threshold of 0.25 AOD (today we exceed 0.30 AOD); **6** The reduction of stratospheric ozone (margin not exceeded); **7** Ocean acidification (threshold not exceeded but severely at risk); **8** The use of fresh water under 4000 km3 (we are at 2600 km3 only thanks to the large basins); **9** The discharge of polluting substances (impossible to quantify with today's methodologies);

- **Systemic thinking.** Different parts are strongly linked to each other. Circular economy requires complex scenario analysis to perceive the infinite branches of renewable matter and to guarantee its founding principles. Linear industrial production is determinist, structuralist, it goes from A to B, from matter to waste, whereas systemic thinking is possibilist, quantum, global and holistic and this means that it takes into consideration every element. In systemic thinking it is fundamental to look for all the possible uses to recreate a circular flux of matter, in particular stocks and flows. Stocks of matter must always be filled in order to keep the system in balance and make it resilient to shocks. Flows are the dynamic variable, it means that everything is potentially interconnected and influences each other through a series of variable fluxes.

  Systemic thinking must always consider the interconnection between elements, its goal is to transform complex analyzes into efficient strategies;
- **Prices or other feedback mechanisms should reflect real costs.** Lack of transparency acts as a barrier for the transition to a circular economy, consequently prices need to reflect full costs in order to be effective;
- **Cascade actions and restricted cycles.** Using the available resources in a cascade way means that the waste of a product can be used as a new input to create income and productivity. Cascade processes are therefore a fundamental step for allowing the transfer of value from one product to another. They have the very important role of dynamization activator. Cascade effects, not only avoid waste but can transform elements into something of equal or greater value than the initial value of the product that has become waste. As far as closed loops are concerned, they are the context where economic and financial benefits can be maximized, where the lowest price can be offered to the consumer and where environmental benefits can be optimized. Furthermore, narrow cascade loops are optimal

from the point of view of social advantages, since they are absolutely labor-intensive and therefore create employment;

- **Crossfertilization.** It is inevitable to understand how to intersect cycles and supply chains of matterial in a system, without interruptions. Creating/enabling systems for inter-cycle and intersectoral improvement is essential to minimize negative outputs. Without intersections between cycles and between various sectors, it is not possible to use all the viable potentialities of renewable matter;
- **Resilience.** Resilience becomes an inclusive concept that favors the removal of barriers that too often have limited innovation and sustainability processes. The goal is to generate a positive global impact on the social sphere, culture, economy and climatic and environmental sustainability. This goal is consolidated in the theories of resilience that recognize how human activities have a significant influence on the biosphere from the local to global, becoming at the same time crucial for its survival.

  Policies based on resilience have the ability of: **1** Understanding the elements of complex economic interaction and of ecological and social systems; **2** Recognizing how they organize themselves and change over time; **3** Perceiving how they can be influenced through multiple interventions to maintain, adapt or transform them into desirable balances. Resilience thus, becomes a fundamental element both for the transition from linear to circular but also an implicit characteristic of circular models, without resilience in fact, the circular system becomes weaker and risks to break its circularity. A resilience-based approach, provides a set of tools to improve the management of innovation policies and to ensure that governance and regulatory systems become more sustainable.
- **Temporality.** The linear economy is based on short-term strategies, focused on the maximization of the profits, whereas, a company that wants to operate according to a circular model must look for a long-term industrial strategy.

  Western economies guarantee obsolescence through three procedures: **1** Fashions; **2** Continuous incremental innovation; **3** Planned obsolescence. In the linear model, when goods leave the warehouse, in some cases (high consumption products) companies cease to be interested, while in others they hold a legal liability connected to the guarantee time offered. In the circular economy, where products are designed to have end-of-life management or are sold as a service, companies have an interest in maintaining maximum control over products when they are about to become truly obsolete, to optimize the

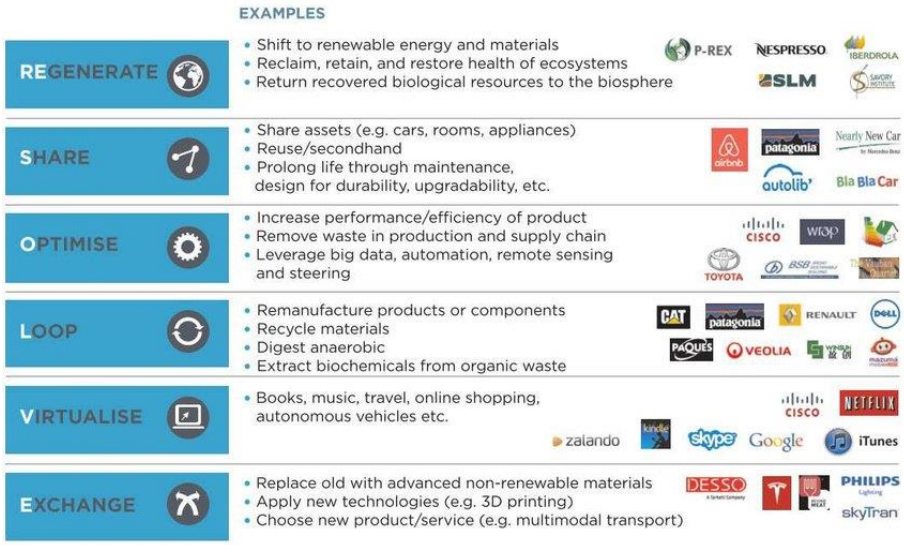
withdrawal and to be able to reintroduce them in the restricted cycles of renewable matter. Consequently the relationships with customers extend well beyond the guarantee times, and therefore, trust must be maintained over time because customers are in all respects suppliers.

This fidelity can potentially generate closed loops, hence becoming a strategy for increasing customers loyalty, making them part of a revolution, educating them in the civic duty of renewing materials;

- **Scale.** Geography in the circular economy plays a fundamental role. The good design of a product must satisfy the following elements: **1** Understand the efficiency of the supply scale, thus understanding how to define the territory where to collect secondary raw materials; **2** What is the size of a business closed circle of matter? Does it make sense to have a centralized regeneration or is it better to have many small decentralized remanufacturing centers or third-party companies that work the matter for me? Evaluating how to decentralize the processing is critical to minimize energy consumption and optimize management costs; **3** In the world of retail it is essential to implement geographical proximity strategies, in particular for the services and products that are withdrawn by customers at the end of their life, consequently territoriality is fundamental to manage a central element of the circular economy;
- **People.** The circular economy must be a harbinger of jobs, with shorter hours and widespread employment. The optimization of costs related to the management of resources and consumption, derived from circular models, should naturally increase the economic availability to cover the cost of labor (tax permitting). The circular economy's worker presents himself as a qualified, active and creative worker. For its part, the company must act to minimize the corporate social footprint, improving working conditions and maximizing welfare. Human resources cannot be left out of production cycles, reverse, they must be improved.

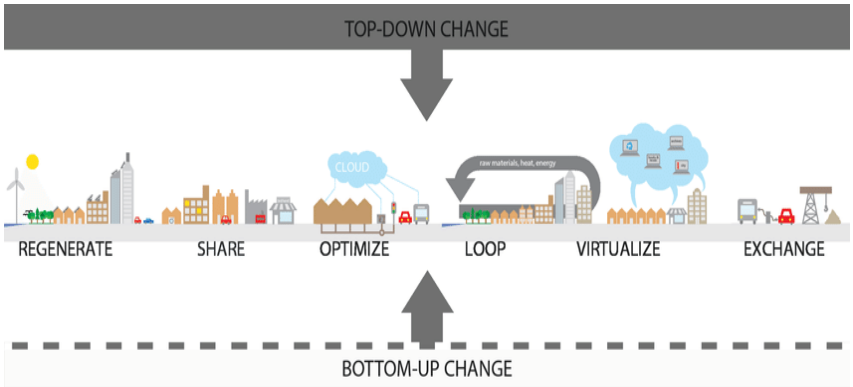
III. Resolve Framework

Image 3. Resolve Framework



Source: ellenmacarthurfoundation.org

Image 4. Resolve Framework



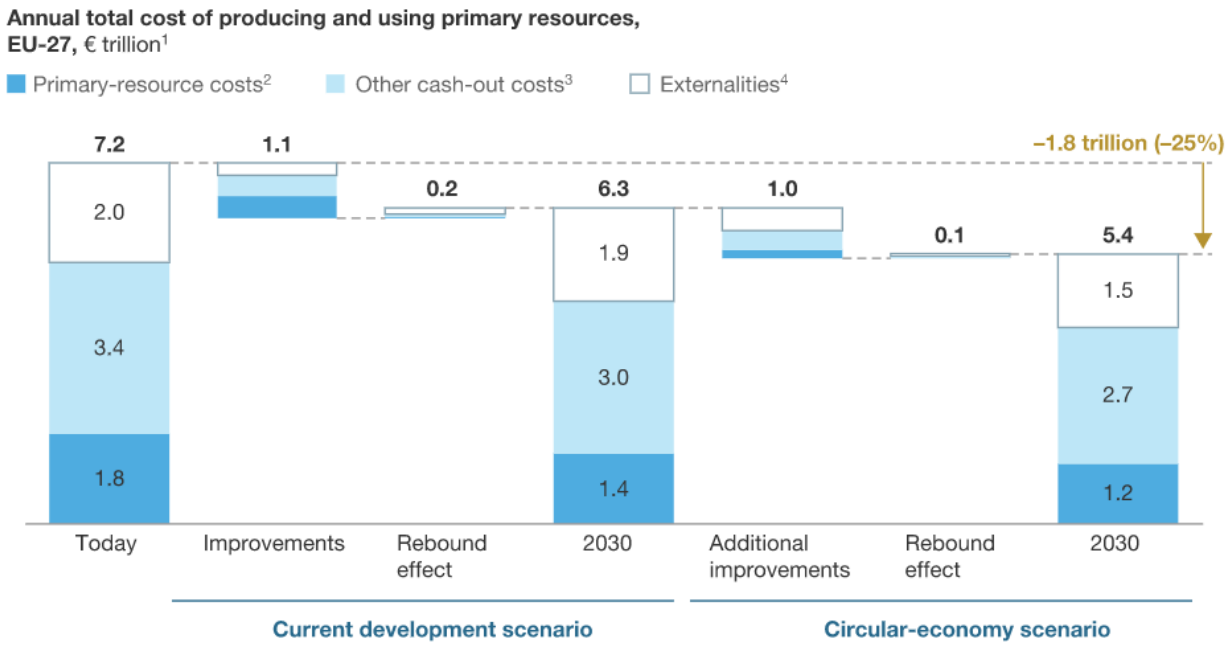
Source: ellenmacarthurfoundation.org

The Resolve framework involve six actions that businesses and governments could implement in order to promote the shift from a linear to a circular economy, these are: Regenerate, Share, Optimise, Loop, Virtualise, and Exchange. The aforementioned framework, is a tool for businesses and governments for implementing and generating circular strategies and growth initiatives. All these actions are closely related to each other and contribute to increase the exploitation of physical assets, extend their life, and shift the use of resources from limited sources to renewable ones. Each action consolidates and accelerates the functioning of the others.

IV. Circular Economy' opportunities

The opportunities, as shown in Graph 1, consists on the improving of economic growth, on the substantial net material cost savings, on the creation of employment, and on the increasing of innovation.

Graph 1. Annual total cost of producing and using primary resources



Source Mckinsey.com

The Ellen MacArthur Foundation, SUN, and McKinsey suggested that by adopting circular economy principles, Europe can take advantage of the imminent technology revolution in order to create a net benefit of €1.8 trillion by 2030, or €0.9 trillion more than in the current linear development path. Circular economy could create tremendous opportunities for industrial renewal, regeneration, and innovation. Economic growth would be achieved mainly thanks to an increasing amount of revenues coming from circular activities, and at the same time, thanks to lower cost of production achieved by a more efficient utilisation of inputs. European GDP could raise as much as 11% by 2030 and 27% by 2050, compared with 4% and 15% of the current linear development scenario. The Ellen MacArthur Foundation has also estimated that, in the sectors of complex medium-lived products in the EU, the annual saving opportunity on net material costs amounts to USD 630 billion in an advanced circular economy scenario. As said before, there is a positive relation between circular economy and employment, this positive relation is largely attributable to the increased spending fuelled by the lower prices expected across sectors and to the labour-intensity of high quality recycling activities and higher skilled jobs in remanufacturing. Jobs will be created across industrial

sectors thanks to the development of local reverse logistics. Within small and medium enterprises, through increased innovation and entrepreneurship, and a new service-based economy. In this system, human capital is a very important element, because it is unique, renewable and the only factor with a qualitative margin. Its quality can be improved through training and practice but will deteriorate rapidly if not used. The aspiration to replace unidirectional products with "circular by design" goods and to create reverse logistics networks and other systems to support the circular economy is a powerful stimulus for new ideas thus, as said before, innovation is a fundamental driver.

Image 5. Competitiveness of the EU eco-industry

Source: Eurostat 2014

V. Environmental opportunities

The environmental benefits that could be provided by the adoption of the circular economy path relate to the reduction of emissions and primary material consumption, to the preservetion and improvement of land productivity, and to the minimization of negative externalities. For what concerns Europe, the Ellen MacArthur Foundation has found that a circular economic development pattern could cut in half carbon dioxide emissions by 2030, relative to today's levels. Moreover a circular economic development pattern could result in a reduction of primary material consumption, by 32% by 2030 and 53% by 2050, compared with today. Soil degradation costs are estimated at arround USD 40 billion annually worldwide, without taking in consideration the hidden costs of increased fertiliser use, loss of biodiversity and loss of unique landscapes. Higher land productivity, less waste in the food value chain, and the return of nutrients to the soil will enhance the value of land and soil as assets. By moving much more biological material through anaerobic digestion or through the composting process and back into the soil, will reduce the need to replenish with additional nutrients. Systematic use of organic waste could help regenerate land and replace chemical fertilisers 2.7 times over. If Europe would decide to take a circular approach towards food systems, synthetic fertiliser consumption could fall by as much as 80% by 2050. Positive results could also be achieved in terms of reduction of negative externalities, such as land use, air, water and noise pollution, release of toxic substances, and climate change. For example by reducing the cost of time lost to congestion by 16% by 2030, and close to 60% by 2050.

VI. Companies' opportunities

New and bigger profit pools, greater security in supply, new demand for business services, and as a consequence greater resilience could be achieved. Concerning profit opportunities, individual businesses could obtain lower input costs and in some cases could create completely new profit streams. Examples of improvements that can be achieved:

- The cost of remanufacturing mobile phones could be reduced by 50% per device, if the industry would made phones easier to disassemble, improve the reverse cycle, and offer incentives to return phones;
- High-end washing machines would be accessible for most households if they were leased instead of sold, thus customers could save roughly a third per wash cycle, and the manufacturer could earn a third more in profits;
- A profit of USD 1.90 per hectolitre of beer produced can be captured by selling brewer's spent grains. Costs of packaging, processing and distribution of beer could be reduced by 20% by shifting to reusable glass bottles.

The transition to a more circular type of economy means using less virgin material and more recycled inputs with a higher share of labour costs, reducing companies' exposure to ever more volatile raw materials prices thus, increasing resilience. The threat of disruption of supply chains following natural disasters or geopolitical imbalances is reduced because alternative materials sources are provided by operators. Circular economy would create demand for new business services, such as:

• Collection and reverse logistics companies which support the reintroduction of the end of life products into the system;

• Product remarketers and sales platforms that facilitate longer lives or higher utilisation of products;

• Specialised knowledge about parts and components remanufacturing and products refurbishment could be offered.

Circular solutions provide new ways to engage customers and to increase their loyalty. New business models such as rentals or leasing contracts can help companies to establish a longer-

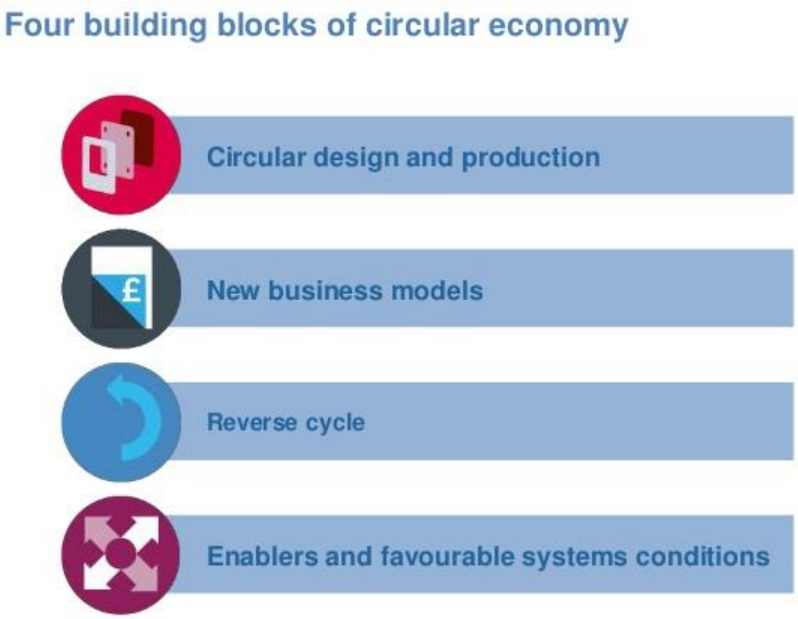
term relationship with customers, as the number of interactions increase over the lifetime of a product.

VII. Opportunities for citizens

Basically the benefits for customers deal with lower prices, and lower total cost of ownership. The implementation of the circular approach could increase the disposable income of an average household due to the reduction cost of products and services and due to the conversion of unproductive to productive time. The average disposable income for EU households would increase by €3,000, or 11% higher than the current development scenario by 2030. The usefulness or advantage perceived by customers can be improved by the additional quality provided by the circular models. Customer choice increases as manufacturers supply systems better meet customer needs. Furthermore, also the problem of obsolescence can be mitigated. For customers, overcoming the problem of premature obsolescence will notably bring down total ownership costs and deliver higher convenience, thanks to the avoidance of difficulties associated with repairs and returns. In the process of switching from a linear to a circular model, cities will also play a fondamental role, infact, they will act as engine of the global economy. With 54% of the world's population living in urban areas, proportion that is expected to increase to 66% by 2050, they will be the heart of creativity, innovation and growth. Urban environments will become hotbeds of circular economic activity, enabling closed loops of biological nutrients and the recirculation of durable materials.

VIII. Circular economy' building blocks

Image 6. Circular Economy's building blocks



Source: ellenmacarthurfoundation.org

I. *Circular product design and production.*

Companies will need to build core competencies in circular design to facilitate product reuse, recycling and the cascading process. Materials selection will play a critical role in product design. Other important areas for the successful of circular design are: the standardisation of components, the design of durable products intended for easy sorting at the end of life, the separation or reuse of products and materials, and the development of design criteria for production, that take into account possible useful applications of by-products and waste.

II. *New business models.*

Business models that move from ownership to performance based payment patterns are fundamental in translating products designed for reuse into attractive value propositions. By giving priority to access over ownership, these models will guide the passage from consumers to users.

III. *Reverse cycle.*

To create value from materials and products after their use, they need to be collected and brought back. Reverse logistics and treatment methods allow those materials to get back

into the market. It is therefore critical to build up the necessary capabilities and infrastructures to move towards circularity. Collection systems must be user-friendly, located in areas that are accessible to customers and capable of maintaining the quality of the materials so they can cascade through diverse applications.

IV. *Enablers and favourable system conditions.*

Education. Education plays a critical role in building up the needed skill base to drive towards circular innovation and in preparing future professionals for a new economic pattern. **Financing**. All players across value chains will need access to financing and risk management tools to encourage capital investment and R&D. A stable regulatory environment is the focal point for investors. Governments can create further funding incentives by underwriting some of the risks associated with innovative business models. **Collaborative Platforms.** Effective cross-chain and cross-sector collaboration are imperative for the large-scale establishment of a circular system. **A New Economic Framework.** Moving fiscal incentives from resources towards labour, enhancing today's flow-based metrics, such as GDP, with measures of a country's stock of assets, and developing a long-term plan to rebalance factor costs and adequately price key externalities, are all instruments that policymakers have at their disposal to develop a new economic framework that would support the transition to a circular economy.

IX. Role of politics, institutions and governments in deep

Institutions, Governments and politicians play a critical role in creating and enabling the conditions for a circular economy to emerge and prosper. They set direction but more importantly, they are drivers for innovation and investment. Shifting from a linear to circular system require systemic solutions. From a circular perspective, business models, product and service design, legislation, accounting practices, urban planning, farming practices, materials extraction, manufacturing, currently have undesirable qualities. Building a sustainable society in industrialized countries, requires first of all to create a desire for circularity by motivating people to become dependent on the reuse and repair for the goods they own and good administrators of objects that they rent or share with others. Being more specific, the efficiency and sustainability of the CIE can be significantly improved by closing the invisible circles of legal liability for both objects and materials. Extended Producer Legal Liability (EPL) creates an invisible circle of responsibility. Goods and materials which are worthless at the end of their life cycle are returned to the manufacturer who thus, becomes the last legally responsible owner. The manufacturer knows how the objects were made and what materials were used. Consequently, they know how to revalue components and materials in new goods or pure molecules. The EPL encourages manufacturers to prevent future legal liabilities by designing goods that still have an high value at the end of their life cycle and involve minimal legal liability. Actually, the problem is that the common end of pipe recycling activities aim is only to minimize costs for companies, not to maintain the highest value of materials for society. This conflict leads to considerable macroeconomic losses. The promotion policies of the CIE could contribute to solve many of these problems in a holistic way, and this thanks above all, to the intrinsic characteristics of the CIE: high labor input in contrast with low carbon and energy input, and partial reliance on decentralized small and medium-sized enterprises. An example is the sustainable taxation, which is based on the relevance of work and resources as production factors. In many states, labor is heavily taxed, while the production and consumption of fossil fuels and other non-renewable resources are subsidized. Consequently, keeping in mind that CIE is labor intensive, reshaping the taxes on these two production factors, favoring renewable resources and promoting a shift of the tax burden away from labour/income and towards non-renewable resources would encourage economic actors to move towards CIE and sustainability. Human work is a renewable resource. Not taxing it, but instead taxing non-renewable resources, could accelerate the shift from the LIE to the CIE, expand the application of the circular economy to new economic players and new sectors and strengthen the competitiveness of the CIE's existing economic actors. In the least

intrusive way, government and public entities can help foster cross collaboration chains by setting standards and guidelines. Also product labeling is an important lever to ensure adequate treatment in reverse loops for what concerns non-toxicity, purity or handling problems. Government and institution may also have the role of intermediaries, in the U.K. for instance, ther is an organisation called the Waste & Resources Action Programme, or WRAP, whose aim is to bring community leaders and government leaders together to improve resource efficiency across the country. There are also many opportunities for administrations to use their own procurement and material handling to accelerate the spread of circular setups. Additionally, by lending the full weight of their collective purchasing power, they can support circularity initiatives and reduce the risk connected with the critical initial phase for the innovators of the circular arena.

Chapter 2. Historical and literary references

I. Historical background

Everything started with the Industrial Symbiosis model. It basically consists on companies that cooperate one with the other, that cooperation encompasses the exchanging of materials, water, energy or the sharing of components in their business. The concept was first introduced in Denmark in 1961. Symbiosis makes it possible to integrate industrial activities in order to transform the waste of the former supply chain into a resource for the others. Moreover, the exchange of secondary materials increased the efficiency of the individual production processes and greatly reduced their environmental impact. The following step was the foundation of Club Roma, it was founded in April 1968 by the italian entrepreneur Aurelio Peccei and the scottish scientist Alexander King. It is composed by economists and scientist. In 1972 Club Roma published a report "I limiti dello sviluppo", the text brings together researches and writings of some MIT's scholars on the implications that a continuous growth would have had on the planet. After that there was the energy crisis. In 1973 Middle Eastern oil producing countries raise prices and reduce exports by 25%, the result was the adoption in USA and in EU of the economic austerity, and the conseguent spread of fears about the scarcity of resources and of the concept of energy saving. Next in 1976, Walter R. Stahel and Geneviève Reday-Mulvey in their report "Potential for Substition Manpower for Energy" introduced a new model of economy, the so called Cyclical Economy. They were inspired by natural systems and in particular by the self-healing ability of natural processes. In their report they underlined that this kind of economy could be encouraged by an adequate strategy characterized by a regionalization of jobs and skills supported by a centralized structure of research and management planning. A cyclical economy would consume less resources and more efficiently, in particular, production would be characterized by smaller decentralized units with higher and more qualified work inputs. The output would be an economic system that offers a service instead of a product. Later in 1982, there was the foundation of the Product-Life institute. Founded by Stahel and Giarini with the aim of developing strategies to increase the productivity of materials by pursuing the objective of quality of performance of services to the end user.

Strategies:

- Product is considered as a service, it means that manufacturers are interested in producing long-lasting goods;
- Extension, to the manufacturers, of the responsibility of goods in the period of use and after use, this imply that manufactures fabricate products that are less polluting and easily recyclable / disposable;
- Property sharing, same quality of service with fewer goods;
- Regeneration, do not modify the casing / frame of goods, instead, replaces only the obsolete or faulty components;
- Product design oriented to longer life, regeneration and recycling.

For Stahel and Gerini “Product life” means extending the lifespan of a product, optimizing the resources used to produce it and reducing the amount of sources and energy needed, consequently, welfare and greater wealth are generated and the transition towards a sustainable society is contributed. Any disincentives can be eliminated with education, appropriate taxes and policy measures. 1987 was the year where the concept of sustainable development was first heard. The core assumption of that notion was that development, to be sustainable, should not affect the environment to the point of compromising its use by future generations. Afterwords in 1988, was introduced the concept of Industrial metabolism or Industrial Ecology. The idea was conceived by Robert U. Ayres, according to the author Industrial Ecology is a strategy for reducing the impact of anthropogenic flows on natural resources, this approach has the aim of creating closed circular processes where waste is seen as new material that falls within the productive-economic circle. To better understand the connections between man and nature Ayres took inspiration from the reflections on the thermodynamics of Georgescu-Roegen. The term “Industrial metabolism” refers to the processes of taking energy and matter from natural sources and then discharges the altered residues in the receptors of the environment, this means that what enters the sphere of human activities after being transformed is then returned to nature. According to the first principle of thermodynamics "In a closed system the sum of all forms of energy remains constant", in the same way the principle of conservation of matter shows that, the quantity of matter imported from the environment is exactly equal to the quantity that is returned with the exception of the materials that temporarily accumulate in goods, hence towards matter, the Earth is a closed system. A growing amount of matter flows through our society but while the size of this subsystem continues

to grow, the global ecosystem is limited, consequently the anthroposphere exceeds the limits of the ecosystem. The second principle of thermodynamics the “Entropy law” clarifies the directional aspect of any interference with nature. Over time the entropy increases and in a closed system it cannot decrease but only increase, thus not only every return of material from the human sphere to the natural environment is ecologically relevant but any intervention on the environment affects the ecological balance. Ayres concluded saying that if we combine the effects of both principles we can understand that in the production of goods, not only the mass is conserved and returns to the natural environment but that, this return occurs with much greater entropy in the form of dispersed and non-recoverable matter or under unusable form of thermal radiation, thus society, economy and environment are interdependent and the environmental alterations determined by industrialized countries is reaching levels that cannot be sustainable. “Nature will always find a new balance, the question is whether this process will allow humanity to survive”. The following step was the book “The Limits of Certainty”, it was written by stahel and Giarini in 1989, the book underscores how the limits generally recognized for growth, scarcity of certain raw materials, actually represent the limits of the linear economic model. According to the authors, these limits can be overcome through a regenerative model, the circular one. Subsequently, another important event took place and it was the foundation of the Wuppertal Institute for Climate, Energy and Enviroment. Founded in 1991 by Ernst Ulrich von Weizsacker, the institute considers that any business initiative must necessarily be supported by economic and social policies that allow it to structure and evolve. It also promotes the idea that sustainability can only take place by launching policies that aspire, simultaneously, to achieve greater efficiency in the use of energy and natural resources for the production of goods and services, as well as policies that aim for sufficiency, for changing consumer lifestyles, promoting the virtues of sobriety and moderation. In 1992 the Wuppertal Institute for Climate, Energy and Enviroment, introduced two curious tools, MIPS (material input per unit of service), MAIA (material intensity analisys). MIPS assesses the environmental impact of goods and services throughout all stages of their life. MAIA highlights the differences with respect to the specific result. Although interesting, these tools did not take flight. The following important step was the constitution of the United Nations Sustainable Development Commission. In 1992, in Rio de Janeiro, United Nations Sustainable Development Commission was born, to oversee the implementation of the agreements. The plan called for a change in the society's behavioral models by promoting the participation of all sectors, by expanding the devices for the implementation of the program, such as economic and financial legislative instruments. The

Commission developed political guidelines for future activities, promoted partnerships between governments, supervised the implementation of the Rio Action Plan “Agenda 21”. Moreover the EU approved, in the same year, the Fifth Environmental Action Plan to make the agreements signed in Rio operative. In the same year, 1992, was also created the Ecolabel UE. It is a European trademark used to certify (according to EC regulation No. 66/2010) the reduced environmental impact of the products or services offered by companies that have obtained their use. Eco-label is a voluntary community tool that certifies environmentally compatible products, allowing the consumer to recognize, through a brand, the respect of the environment by a product (or service) throughout its lifecycle. That feature can thus, diversify the product from competitors’s one present on the market, maintaining high environmental performance standards. In 1995, on the occasion of the meeting between, Club Roma and Wuppertal Institute, the report “Taking Nature into Account” was born. The aforementioned report, stresses the importance of ensuring that the economic accounts of all countries are reviewed, modified and integrated with ecological accounting. In 1996 Friedrich Hinterberger, sociologist and political scientist, published "Economics, political ecology". Starting from the works of the Wuppertal Institute, Hinterberger proposed his theories about the concept of dematerialisation of economic flows as a solution to contrast, reduce and limit the damage caused by human activities on the environment**.** Dematerialisation means to drastically reduce the flows of materials used by men, hence interfere as little as possible with nature. Consequently, the environmental protection, integrated in the production, must not be placed downstream of the production processes, but on the contrary, it is necessary to restructure the process itself in order to avoid emissions. Technological and social innovations are fundamental for dematerialisation. In 1996 the Ecological Footprint (EF) tool was created. That tool, developed by William Rees and Mathis Wackernagel, represents the overall area of which a certain geographical region "appropriates" for the functioning of its economic activities. If this area exceeds the extension of the region under consideration, there is a situation of exploitation of resources external to the territory considered. EF analysis can show whether a country is living within the biocapacity of its own territory or whether it is an “ecological debtor,” drawing on the ecological capital of other parts of the world. On 11/12/1997, Kyoto protocol was stipulated. It entered into force on 16/02/2005 committing the underwriting countries to a quantitative reduction of their greenhouse gas emissions. It ceased to be valid on the 31/12/2012. In 1999 was written Natural Capitalism. This is a book written by A.Lovins, Lee.H.Lovins and P.Hawken, in the book the authors postulate that an economic system requires four types of capital to function properly:

• Human capital (workforce, intellectual heritage, culture and organization);

• Financial capital (liquid money, investments and monetary instruments);

• Fixed assets (infrastructure, factories, machinery and tools);

• Natural capital (raw materials, living systems and functions performed by them).

In 2002 was written another important book, Cradle to Cradle. Written by William Mcdonough and Michael Braungart, it is a biomimetic approach for designing products and systems that models human industry on nature's processes, viewing materials as nutrients circulating in an healthy, safe metabolisms. The next step was the creation of the Ellen MacArthur Foundation in 2009. The foundation has made the reputation of the circular economy grow internationally through a global partnership with important multinationals. The organisation has created the CE 100 program to promote best best practices and the CE Government & cities program dedicated to national, regional and municipal public administrations in order to train administrators capable of supporting circular economy. The purpose of the foundation is to accelerate the transition towards a regenerative and circular economy and make it effective and concrete. Its work is concentrated in four areas:

• Thought leadership - The chance for revolutionary re-design;

• Education - Inspire to rethink the future;

• Business - Catalyst of companies on innovation;

• Communication - Involve a global audience around the circular economy.

In 2010 was written Blue economy. The report, written by Gunter Pauli, deals with the complex issue of the economic-environmental and social crisis of these years, pointing a series of possible solutions. The starting point is the application to the territory of the functioning mechanism of ecosystems to enhance their qualities and solve environmental and social problems. By using the available resources in cascade systems, the waste of a product becomes the input to create a new cash flow. The aim is no longer just to invest in environmental protection but to move towards regeneration. In 2013 we had Upcycle. That book was written by William Mcdonough and Michael Braungart. In the book the idea of cradle to cradle has been further developed, thus, in production cycles resources not only never lose value but even increase it (upcycling instead of downcycling). Finally in 2014, was presented “Towards a Circular Economy”. This was the moment where circular

economy has became a global phenomenon. The report was presented on the occasion of the World Economic Forum (WEF) in Davos in 2014. The WEF's report highlights how linear consumption is reaching its limits. Circular economy, according to the report, has enormous potential for innovation, job creation and economic growth. As claimed by the report the main obstacle for the realization of the circular economy of scale are the systemic losses.

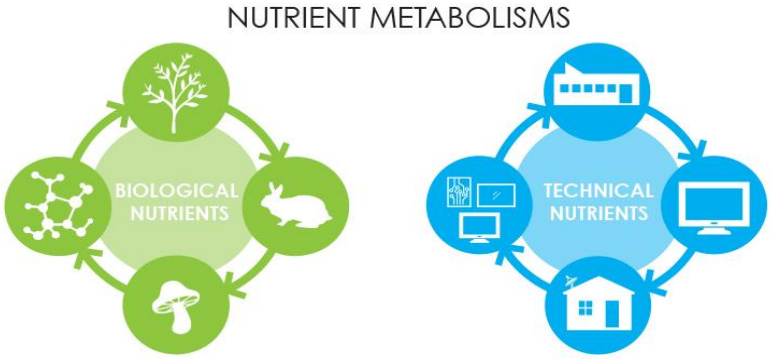
II. Authors and notions that contributed to develop the concept of circular economy

The circular economy model summarizes several important schools of thought. They include the Functional Service Economy (Performance Economy) of Walter Stahel; the Cradle to Cradle design philosophy of William McDonough and Michael Braungart; Biomimicry as articulated by Janine Benyus; the Industrial Ecology of Reid Lifset and Thomas Graedel; Natural Capitalism by Amory and Hunter Lovins and Paul Hawken; and the Blue Economy systems approach described by Gunter Pauli.

I. Cradle to Cradle (C2C)

Cradle to cradle is considered by the authors William McDonough and Michael Braungart as a sort of manifesto for a new approach towards sustainable design. Cradle to Cradle is a biomimetic approach that consists mainly in adapting industry models to nature, or converting production processes by assimilating the materials used with natural elements, which must therefore regenerate, all inserted in an economic framework that intends to create systems that are not only efficient, but essentially environmentally compatible. The model is not limited to industrial and manufacturing design, but conversely, it can be applied to multiple and different aspects of human society such as urban environments, buildings, economy and social systems. It is an holistic view. Materials are viewed as nutrients circulating in an healthy, safe metabolisms. C2C suggests that industry must protect and enrich ecosystems and nature's biological metabolism while also maintaining a safe, productive technical metabolism for the high-quality use and circulation of organic and technical nutrients. The aim is to create arrangements that are not only efficient but also essentially waste free and launch a new industrial revolution which ensures that production has a positive impact on society, on the economy, and on our planet. In the cradle-to-cradle model, all materials used in industrial or commercial processes, fall into one of two categories: "technical" or "biological" nutrients.

Image 7. Nutrient Metabolism



Source: mcdonough.com

Technical nutrients are strictly limited to materials that have nonnegative consequences on natural environment. They can be used in continuous cycles without losing their integrity or quality. In this manner materials can be used over and over again instead of being "downcycled" and consequently becoming waste. Biological nutrients are organic materials that, once used, can be disposed of in any natural environment and decompose into the soil, without affecting the natural environment. As a matter of fact, all materials used in Cradle to Cradle certified products possess the property of being fully recyclable, either biologically or technically. Instead of trying to minimize the damage we inflict, Cradle to Cradle reframes design as a positive, regenerative force. Cradle to Cradle looks at a product through five quality categories:

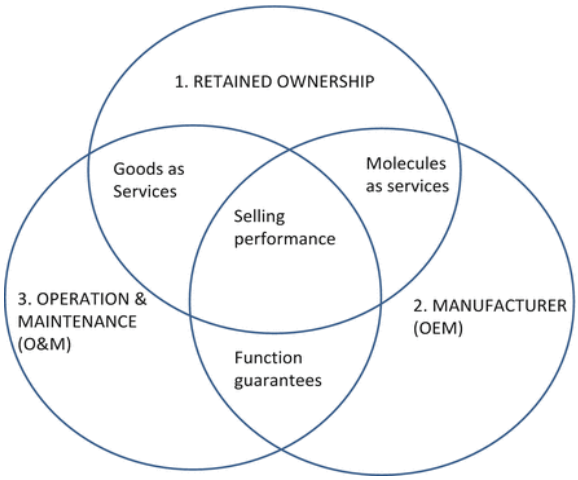
- Material health;
- Material reutilization;
- Renewable energy and carbon management;
- Water stewardship;
- Social fairness.

The great difference between C2C and cradle to grave (C2G) stands on the fact that by using the traditional C2G methods (recycling etc.) an item can pass through a finite number of lives and at the end, the quality of that item could degrade so much that it could become unuseable. C2C objects, on the contrary, are infinitely sustainable and materials can be used over and over for a variety of things. The cradle-to-cradle vision is that products should not merely be recycled, cause this will only postpone their inevitable decline. Instead, products should be upcycled, hence they should be re-processed for use at the same level of application.

II. Performance economy (PE)

The concept of the Performance economy was elaborated by Walter Stahel. According to the author, Performance Economy consists of an economy that focuses on the sale of goods and molecules as a service or in the supply of operating guarantees, therefore of performance. In the PE, economic actors sell results rather than objects, they maintain the ownership of the objects, of the incorporated resources and internalize responsibility throughout the life of the product. They sell the use of objects as a service. The sale of the use of products as a service on one hand maximizes profits by exploiting solutions of efficiency and sufficiency, on the other it extends the useful life of the objects as much as possible. 2000 years ago Aristotle stated that true wealth does not lie in possession but in use. In a rental economy, users don't need capital to buy goods but they also don't profit from capital gains. Owning goods is economically reasonable for individuals, only if the aformentioned goods increase in value over time. By renting objects, users gain flexibility in use, know in advance the costs of using a product and pay them only when they use it. The PE is considered the most sustainable business of the circular industrial economy, (CIE), because it internalises the costs of legal product liability, risks and waste, and thus, represents a strong financial incentive to prevent losses and waste.

Image 8. Performance Economy's framework



Source: link.springer.com

PE main characteristics:

• It is profitable, it allows consumers to take advantage of solutions of sufficiency, efficiency and system. Compared to the linear industrial economy, (LIE), transaction and compliance costs are lower, moreover it is not subject to carbon taxes or duties on the import of resources. In addition, the economic actors of the PE can expand their activities and increase revenues and profits through: shared use, the sale of results using sufficiency, pay for performance, (e.g Bayer sells precision agriculture services as an alternative to chemicals), system innovation;

• It is desirable on an ecological point of view, it minimizes fossil fuels, transport distances and packaging, making full use of local reuse and of the extension of the life cycle of objects;

• Sustainable at a social level because it is labor-intensive and internalizes the legal responsibility of the producer and users, it also internalizes the risk costs of waste.

The activities of the PE can promote the attitude to the care of users, by rewarding good administration and punishing the abuse of objects. The performance theory also include time as a factor in the economy. With time, uncertainty also arises. The prevention of loss of money and resources therefore becomes an entrepreneurial challenge for economic actors and part of a new definition of the quality of objects and systems. In the Performance Economy the actors play on the result level, rather than on the product and on the production of objects.

III. Biomimicry

Is a concept elaborated by Janine Benyus. It is the conscious study of the biological and biomechanical processes of nature as a source of inspiration for the enhancement of human activities and technologies. It is an approach of research for sustainable solutions that takes inspiration from the chemical processes and recipes of life and from the strategies of entire ecosystems. According to the Biomimicry Institute, Biomimicry can be defined as an attitude towards innovation that seeks sustainable solutions to human challenges by emulating nature's time-tested patterns and strategies. The goal is to create products, processes, and policies that are well-adapted to life on earth in the long run.

Biomimicry sees nature as:

- A model. It studies nature's models and imitates them or uses them as inspiration for designs or processes, with the goal of solving human problems;
- A measure. It uses ecological standards to judge the rightness of human innovations;
- A mentor. It is a new way of observing, assessing and valuing nature, not on the base of what we can extract from the natural world, but on what we can learn from it.

It can find application more or less directly to all sectors. The core concept of the model is based on the fact that nature always operates on the principles of economy and efficiency while generating no waste. No matter the field of application, the biomimetic philosophy is part of a global strategy of responsible and sustainable development that aims to stabilize the way the planet's resources are used.

Essential elements of Biomimicry:

- Ethos. It concerns the respect, the responsibility and the gratitude towards other living species and their habitat;
- Emulate. It consists on the observations of natural processes to support the design phase;
- (Re)connect. It emphasizes the deep interconnection between humans and nature.

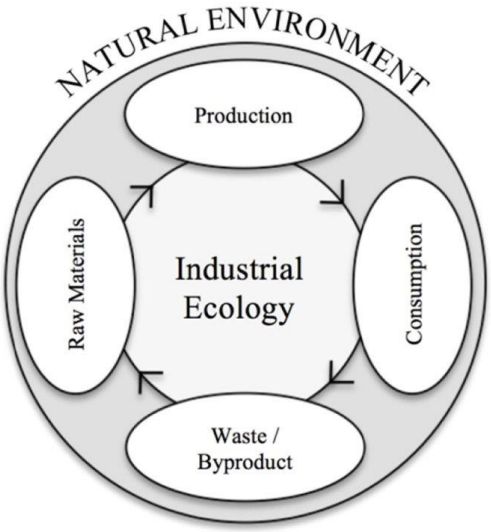
Humans have looked at nature for answering to problems throughout our existence.

Examples: Aircraft wing design and flight techniques have been inspired by birds and bats; regarding construction and architecture, researchers studied the termite's ability to maintain virtually constant temperature and humidity in their termite mounds in Africa despite outside temperatures that vary from 1.5 °C to 40 °C. Climbing pads capable of supporting human weight are a mimic of the biomechanics of gecko feet, the aerodynamics of the famous Japanese Bullet train was inspired by the shape of a bird’s beak. The first flying machine from the Wright brothers, in 1903, was inspired by flying pigeons, Velcro is born from the observation of the hooks implemented by some plants for the propagation of their seeds via animal’s coat, the study of shark skin is at the origin of particularly effective swimming suits, as well as a varnish for planes fuselage.

IV. Industrial Ecology (IE)

Industrial ecology is the study of material and energy flows through industrial systems. The name derives from the idea that the analogy of natural systems should be used as an aid in understanding how to design sustainable industrial systems. It represents industry as a man-made ecosystem that operates in a similar way to natural ecosystems, taking inspiration from the self-regulating functioning of a natural ecosystem. Industrial ecology is concerned with the shifting of industrial process from linear (open loop) systems, in which resource and capital investments move through the system to become waste, to a closed loop system where waste can become inputs for new processes. Furthermore, Industrial ecology seeks to quantify the material flows and document the industrial processes that make modern society works. IE aspires to contribute to sustainable development through two objectives: closing material cycles and shifting the thinking concerning the link between industry and ecology. The model approaches issues of sustainability by examining problems from multiple perspectives. It recognize the need of looking at environmental issues with a systemic thinking approach. The objective is to reduce environmental stress caused by industry and simultaneously encouraging innovation, resource efficiency and sustainable growth. Firms are seen as agents for environmental improvement due to the fact that they possess the critical technological know-how for the successful execution of environmentally informed design of products and processes.

Image 9. Industrial Ecology's framework



Source: researchgate.net

Industrial ecology founding principles:

•Creating industrial ecosystems, waste is a resource, developing partnerships with other industries to trade by-products which are used as inputs to other processes;

•Balancing industrial inputs and outputs to natural levels, managing the environmental-industrial interface;

•Dematerialisation of industrial output, use less virgin materials and energy by becoming more resource efficient, reuse materials, do more with less;

•Improve the efficiency of industrial processes;

•Energy use, incorporate energy supply within the industrial ecology;

•Align policies with the industrial ecology concept, incorporate environment and economics into organisational, national and international policies.

With an emphasis on restoring natural capital, industrial ecology also focuses on social well-being. The primary stakeholders are: business; industry; industry associations; engineers; research institutions; government; non-government organisations and economists. IE is best implemented when the transport distance between industries is reasonable.

V. Natural Capitalism

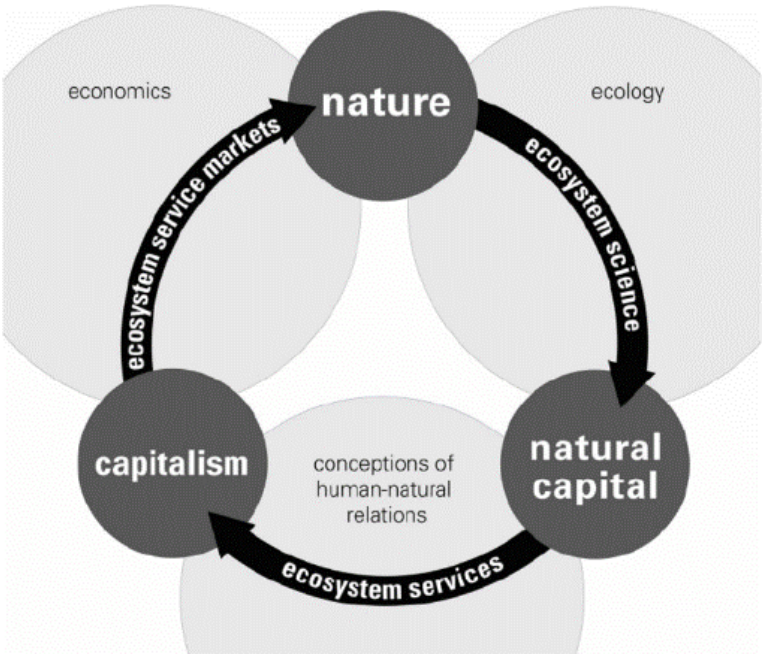
Natural capital refers to the world's stocks of natural assets: soil, air, water and all living things. "Natural Capitalism: Creating the Next Industrial Revolution" is a book written by Paul Hawken, Amory Lovins and L. Hunter Lovins. In the book the authors describe the concept of Natural Capitalism, a global economic system in which business and environmental interests overlap, recognising the interdependencies that exist between production and the use of human-made capital. The authors suggest that only through recognizing this essential relationship with the Earth's valuable resources businesses can continue to exist. Connection enable business to behave responsibly towards, both nature and people while increasing profits, inspiring their workforce and gaining competitive advantage. That model combines a radically increased resource productivity; closed circuit and non toxic production, zero waste.

The four principles of Natural Capitalism are:

- Increasing the productivity of natural resources. Thanks to radical changes in design, production and technology, natural resources can be made to last much longer than they currently do. As a result there would be savings in terms of costs, time and capital investment. This will help to implement the other principles;
- Shift to biologically inspired production models and materials, which means that Natural capitalism seeks to eliminate the concept of waste by modelling closed-loop production systems shaped on nature's designs where every output returned harmlessly to the ecosystem as a nutrient, or becomes an input for another manufacturing process;
- Move to a "service-and-flow" business model. Value is provided through to a continuous flow of services rather than through the traditional sale-of-goods model, aligning the interests of providers and customers in a way that rewards resource productivity;
- Reinvest in natural capital. As human needs expand and pressures brought on natural capital mount, the need to restore and regenerate natural resources increases.

Together, the four principles of natural capitalism allow businesses to behave as if ecosystem services were properly assessed, reversing the loss of those services, while increasing profits. The limiting factor to future economic development is the availability and functionality of natural capital.

Image 10. Natural Capitalism's framework



Source: researchgate.net

VI. Blue Economy

This economic philosophy was first introduced in 1994 by Prof. Gunter Pauli. The Blue economy is a global economic model focused in creating a sustainable ecosystem by transforming previously wasted substances into profitable commodities. It puts great emphasis on gravity as the primary source of energy. It takes examples from nature to develop a sustainable economic system. Blue Economy is based on the development of physical principles, using scientific techniques such as biomimesis. To achieve the goal of eco-sustainable growth, much attention is paid on innovation, understood as a change generated by sharing knowledge. The Blue economy applied to business translates into "blue thinking". Blue thinking embraces sustainability and environmental responsibility to adapt to climate and economic changes. Sustainable development is considered the strength of the Blue Economy. It is a form of development that does not bias the growth opportunities of future generations, taking care of the assets and of exhaustible natural reserves. It is therefore, not an obstacle to development, but rather a tool for economic growth for respecting the environment and its limits.

The following are the twenty one priciples behind this approach:

•The Blue Economy respond to basic needs of all with what you have, introducing innovations inspired by nature, generating multiple benefits, including jobs and social capital, offering more with less;

•Solutions are first and foremost based on physics. Deciding factors are Pressure and Temperature;

• Question any resource regarding its necessity for production;

•Natural systems cascade nutrients, matter and energy, thus waste does not exist. Any by-product is the source for a new product;

•Nature evolved from a few species to a rich biodiversity. Wealth means diversity. Industrial standardization is the contrary;

•Nature provides room for entrepreneurs who do more with less. Nature is contrary to monopolization;

•Gravity is the main source of energy, solar energy is the second renewable fuel;

•Water is the primary solvent;

•In nature the constant is change. Innovations take place in every moment;

•Nature only works with what is locally available. Sustainable business evolves with respect not only for local resources, but also for culture and tradition;

•Nature responds to basic needs and then evolves from sufficiency to abundance. The present economic model relies on scarcity as a basis for production and consumption;

•Natural systems are non-linear;

•In Nature everything is biodegradable;

•In natural systems everything is connected and evolving towards symbiosis;

•In Nature water, air, and soil are free and abundant;

•In Nature one process generates multiple benefits;

•Natural systems share risks. Any risk is a motivator for innovations;

•Nature is efficient. So sustainable business maximizes use of available material and energy, which reduces the unit price for the consumer;

•Nature searches for the optimum for all involucrated elements;

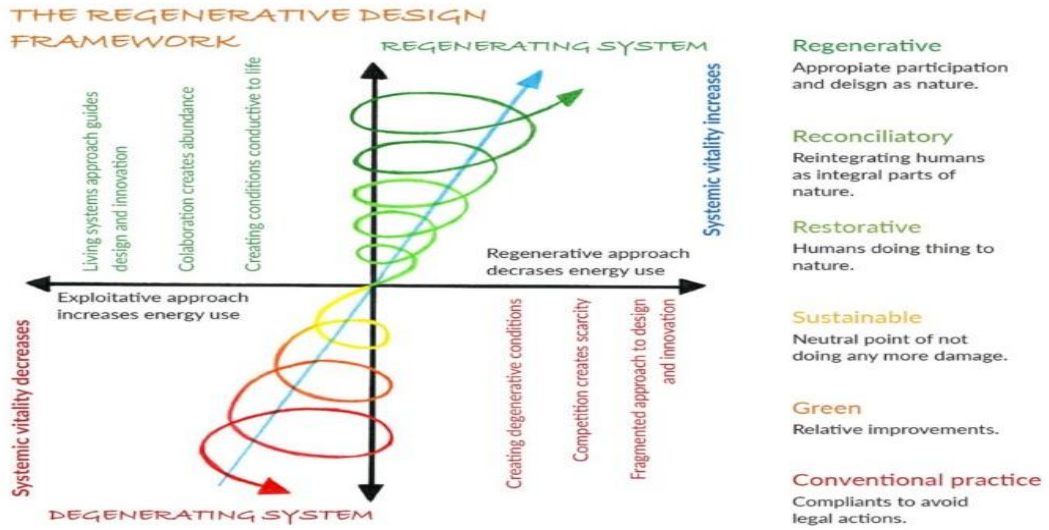
•In Nature problems are opportunities;

•Nature searches for economies of scope. One natural innovation carries various benefits for all.

VII. Regenerative Design

The idea of Regenerative Design was originally developed by John T. Lyle, a professor of landscape architecture at Cal Poly Pomona from 1968 to 1998. Regenerative design has been influenced by approaches like Biomimicry, Biophilic design, Ecological economics, Circular economics. Furthermore it is linked with the approaches of systemic thinking. Regeneration basically consists on the restoration or renewal of sources, on utilizing areas that can be made productive through energy and materials. Regenerative design uses whole systems thinking to create resilient and equitable arrangements which integrate at the same time the needs of society with the integrity of nature. It is built on the idea that, humans and the built environment exist within natural systems and thus, the built environment should be designed to co-evolve with the natural one. Understanding the location of the project, the unique dynamics of the site and the relationship of the project with the living natural systems is a core step in the regenerative design process. Last but not least, Regenerative design gives more importance on conservation and biodiversity rather than on preservation. Humans are considered as a part of natural ecosystems.

Image 11. Regenerative Design's framework

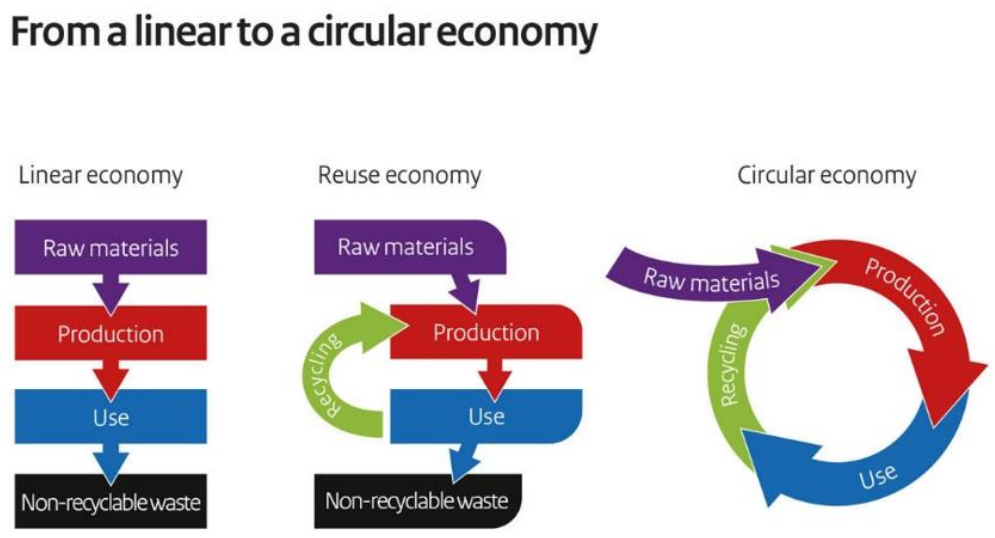


Source: laraeisaacson.wordpress.com

III. CE vs LE

Industrial economy has hardly moved beyond a fundamental characteristic established in the early days of industrialization: a linear model of resource consumption that follows the take-make-dispose pattern. Companies harvest and extract materials, use them to manufacture a product, and sell the product to a consumer, who then abandons it when it no longer serves its purpose. The currently prevailing economic design has its roots in the historically unequal distribution of wealth by geographic region. Since the consumers of resources have been mostly concentrated in developed regions (i.e. in the western societies), and the material inputs have been sourced increasingly from the global arena, industrial nations have experienced an abundance of raw materials and energy. In this arrangement, resources are cheap compared to the cost of human labor. Hence, producers have been motivated to adopt business models that rely on extensive use of materials and economized on human work. However, it has become clear that the blueprint of the linear economy has met its limits, this economic system is unsustainable because the earth's supply of natural resources is limited. Natural environment seems to be no longer able to tolerate the current level of resource exploitation. The prevailing notion governing production and consumption “more is better” needs to be entirely switched by positive development in which markets work to automatically, and systematically make things better both locally and globally. In such a scenario the circular economy is a more sustainable post-production business model, it plays the role of the counterpart of the linear model. It makes use of natural, human, cultural and industrial stocks to improve ecological, social and economic factors that together embody the concept of sustainability. The circular approach implies a conception or system that keeps the added value of a product as much as possible and eliminates waste. It is not the only existing green strategy, there are several versions: ecology and industrial symbiosis for example provide for the cascade reuse of waste from production processes that are part of the linear industrial economy.

Image 12. Linear vs circular approach

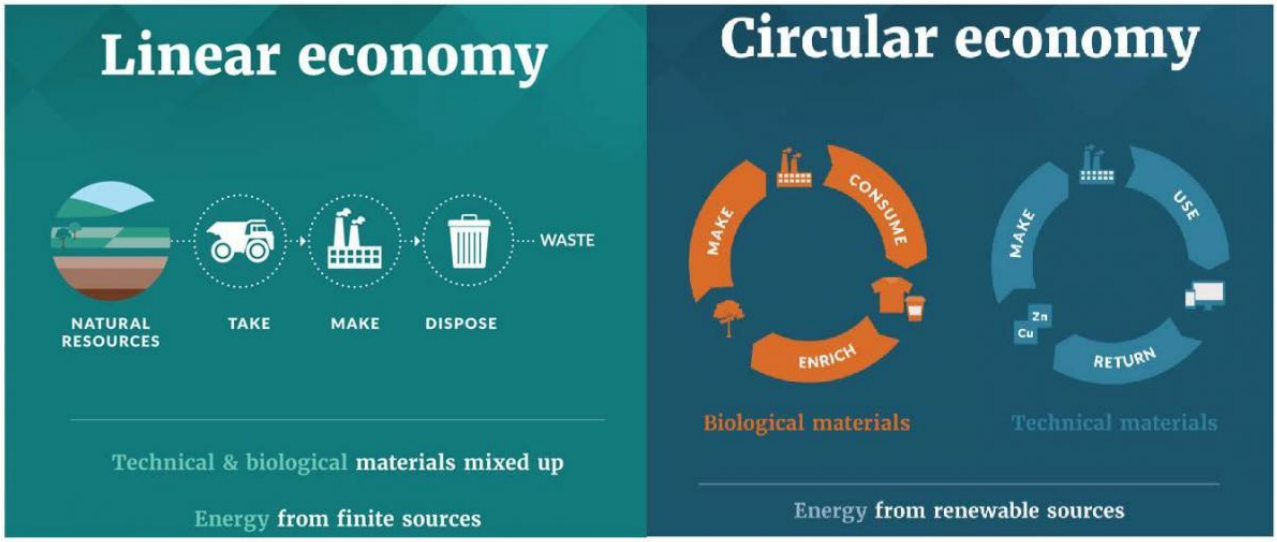


Source: 3Dprint.com

Circular economy is a better system because it employs resources more efficiently. One of the main feature that distinguishes it from the LIE is the introduction of the time factor, without limits, in economics and in matters of property and responsibility. The CIE manages stocks of industrial products with the aim of maintaining their highest value and usefulness for as long as possible. The traditional linear model assumes an unlimited supply of natural free of charge resources and an unlimited capacity of the environment to absorb waste and pollution. In contrast CIE is a regenerative industrial system by intention and design, which offers a new perspective on waste and resources management. CE's strategy is implemented to accomplish sustainable development through increased resource efficiency. In the linear approach opportunities to increase efficiency still exist, but the gains are largely incremental and insufficient to generate real competitive advantage or differentiation. Futhermore, it differs from the LIE due to the fact that its objectives are the maintenance of value (not the creation of added value), the optimization of the management of stocks (not of flows), and the increasing of efficiency in the use of goods (not of the production of goods). It is interesting to note how some processes of the CIE are also exploited by LIE (i.e. repair and preventive maintenance services for production machinery and equipment). Another important difference between these two models lies on the fact that the circular approach starts where the linear one stops. Thus, the LIE stops, and the CE starts when products arrive at the store or leave the factory hence, where the ownership and financial responsibility of the goods are sold by producers to the users. Infact the purpose of the LIE pattern is to create added value and

minimize unit costs up to the point of sales (POS), post-POS activities are limited to guarantee or paid customer support services, such as the supply of parts of replacement. While in contrast, the CE's approach aim is to sale the use of products as a service and consequently promote the attitude to the care of users in order to prevent waste. Further important differences: CIE needs managers and workers with holistic understanding of systems, while the LIE is based on specialized school education; waste prevention is part of the process of optimizing the use of resources in the CIE, while waste management is the final stage of the LIE model, infact it is the responsibility of the last owner of an object and consequently, in most cases the stock of resources is lost; LIE uses virgin resources to produce raw materials which are then used to produce goods while CIE mainly promotes virgin material minimization, the use of clean technologies and the exploitation of recycled materials to produce goods.

Image 13. Comparison between linear and circular economy



Source: circulareconomy.ie

In the LIE scheme, the manufacturers on the supply side are the innovator who decide what ends up on the market, the buyer has the task of selecting, choosing from the available options, whereas in the CIE are the owners of the goods that decide, and their choices regarding the extension of the product life cycle or the sale of the goods for reuse are crucial. In the logic of the LIE, the legal responsibility for end-of-life objects and the materials they contain (waste) is exclusive to the last owner / user of the object. On the other hand in the CIE arrangement, since the use of products is sold as a service, the responsibility remains up to the producers. Politicians should prioritize the promotion of reuse and options that extend the life cycle and then focus on technologies of selection of pure fractions of materials and technologies for the recovery of molecules and atoms. Analysis of circular manufacturing installations in Europe shows that the long-term benefits would

be the highest in the automotive, machinery and material-intensive equipment sectors. One of the early adopters of the circular economy approach in the automotive industry is the french car maker Renault. According to Walter Stahel, in an ideal economy, LIE and CIE operate in symbiosis, the LIE produces:

• New components and innovative materials and designs compatible with existing objects and allow technological and stylistic upgrades to these objects;

• Processes for the recovery of the stocks of molecules and atoms incorporated in the existing stocks of objects.

As a consequence LIE and CIE are intertwined in many ways, the LIE is complementary to the CIE in that it updates existing stocks by introducing innovative materials and components and replaces obsolete stocks that have been damaged or destroyed.

I. CE's SWOT analisys

Strengths:

- Expertise in the reverse material flow cycle;
- Value chain waste elimination can reduce systemic and direct material cost and decrease resource dependence;
- The integration between CE features and the R&D phase of operation may create progress in material sciences and may pursue the development of higher quality and more durable components;
- Closed-loop processes, make the economic growth less exposed to the price fluctuations of the materials, this ultimately results in more efficient use of resources in terms of value and volume;
- Lower material consumption decreases the exposure to externalities.

Weaknesses:

- Circular economy still requires the amalgamation of the entire product life cycle from raw material provision to annihilation (Van Ewijik, 2014);
- Specific guidelines on how to implement circular economy sector-by-sector are not avaliable yet;
- Circular Economy may omit the feature of semi-recyclability when choosing a raw material for production process;
- The knowledge about this topic is still not widespread;
- Lack of legal regulation about circular economy and its application;
- Insufficient investments to introduce the system into sectors.

Opportunities:

- Thanks to the reduction of material input needed, billions of dollars can be save. The EU may save up to 600 billion USD in material costs annually;
- Better and less expensive materials can be obtained by implementing the circular design approach in technological products;
- Developing expertise in circular solutions allows for new business opportunities;

- Developing expertise in sectoral or cross-sectoral challenges in circular solutions opens business opportunities for the enablers.

Threats:

- If companies can control the entire life cycle, they can easily cross-subsidize multiple activities and consequently causing higher prices;
- Strong collaboration combined with the management of the entire product life cycle can cause cartel structures;
- Financial disruptions in the system can cause unpleasant outcomes, due to the interdependance of sectors.

Chapter 3. Circular business model's definition

Business models can be presented as structured management tools, used to depict company's organisational structure and value creation processes. According to Osterwalder and Pigneur' definition, a business model describes the rationale of how an organization creates, delivers, and captures value. As stated by the authors, a business model can best be described through nine building blocks. The nine building blocks are: customer segments, value propositions, channels, customer relationships, revenue streams, key resources, key activities, key partnerships and cost structure. Those building blocks cover the four critical areas of a company's business: customers, offer, infrastructure and financial viability. Currently, most business models are designed and optimised to fit the linear system, in which the negative externalities related to the environment are not included in resource prices. The distinctive feature of circular business models, compared to the linear ones, lies on the fact that the primary corporate objective stands no longer on profit maximisation or on pursue of cost-cutting through greater efficiency in supply chains, factories, and operations. Rather, they are focused on redesigning and restructuring the product-service-systems to ensure the future viability of business activities and market competitiveness. Furthermore, they represent not only a new way to connect suppliers and customers, besides there are a series of economic and environmental benefits associated with them. Circular business models are significant because they look for value creation in places usually of minor interest for companies, that operate in accordance with the traditional linear production archetype. Circular business models thus, combine the nine building blocks innovately. They are deeply involved in the product usage phase, they generate revenues by providing services instead of selling physical products, they rethink the conventional producer-consumer relationships, value creation activities and the structure of value chains. Ecological and social factors complement the overall business culture and values. As said in the previous chapters, in a circular economy, the conventional linear flow, resources – products – waste, is replaced by a new one, the circular one, resources – products – waste – renewable resources. Hence, from a business model perspective, this requires firms to be able to attach and handle to the typical activities of the forward supply chain the activities of the reverse supply chain, such as: reverse logistics, inspection and evaluation of products' current state, reuse, remanufacturing and recycling. The implementation of a closed supply chain model would allow the decreasing of the amount of virgin material purchased and of the amount of energy needed for its transformation, with a consequent reduction of input costs.

I. Circular business models' priciples (CBM)

The Ellen MacArthur Foundation first, and then Nguyen, Stuchtey and Zils have found four distinct ways thanks to which companies can create value within the circular economy, all of them are closely connected to the improvement of material productivity. **First**, the power of the inner circle. It basically consists in keeping products alive and in operation for as long as possible, preferably with the original owner or user. About that, product design and supportive business models play a crucial role in order to take advantage of this opportunity. The Ellen MacArthur Foundation illustrates that the tighter are the circles, the larger could be the savings in terms of material, labour, energy, capital and of the associated burden of externalities, such as GHG emissions or toxic substances. **Second**, the power of circling longer. It consists on keeping products in as many as possible consecutive cycles and lengthening the time of each cycle. **Third**, the power of cascaded use. The idea is to diversify the reuse of products and materials, within and between industries. This is a fundamental step, since reused products and materials can replace an influx of virgin material and therefore can reduce the cost of raw materials for the companies involved. **Finally**, the power of pure circles. The notion emphasizes the importance of uncontaminated material steams, since this is the key to maintain the quality of the materials for lots of consecutive cycles. Understanding which of the aforementioned circular principles are most relevant to incorporate into a company's new business model depends on a number of factors such as:

- Trade and market conditions;
- Focus, interests and values of the company;
- Existing competences and internal capabilities.

Based on the degree of application of these principles, three kind of firms can be distinguished. The first group is represented by the so called Full Circular firms. These kind of firms directly adopt the aforementioned principles in their internal activities and relationships with suppliers, as well as in their customer value proposition and interface. These companies invest heavily in marketing campaigns to promote their circular value proposition. The second most frequent type are the so called Upstream Circular firms. Those firms work more on the internal and network dimension of the Circular Economy, in fact most of their effort is not even visible to the customer. Finally, we have the Downstream Circular firms. They mostly consists of intermediary platforms which provide products through a circular approach, for example by developing business-to-business (B2B) or business-to-customers (B2C) sharing marketplaces, which enable companies to communicate with

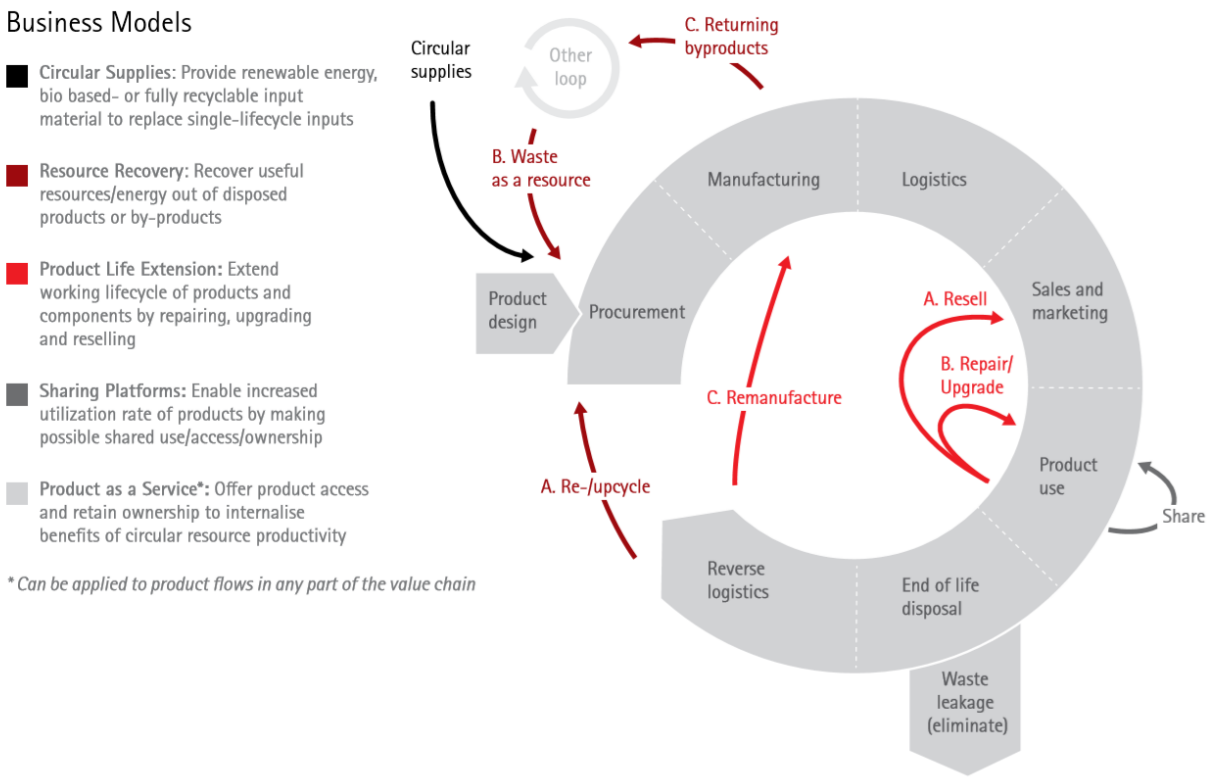
each other for exchanging underutilized goods. As said before, circular business models have been implemented in several industrial sectors, in both business-to-business and business-to-consumer markets. For examples H&M collects garments in all stores to close the textile loop, BMW and Cisco Systems are extending the life of used products through refurbishment and resale, Philips offer “light as a service” to cities and municipal governments, Carlsberg joins forces with suppliers to eliminate waste by developing next generation of packaging for high-quality upcycling.

II. Five Business Models Driving the Circular Economy

There are five circular business models, and they are:

- Circular supplies;
- Resource recovery;
- Product life extension;
- Sharing platform;
- Product as a service.

Image 14. CBM representation



Source: Accenture 2014

It's important to say that the aforementioned business models can be used both individually or in combination, to help companies achieve huge resource productivity gains and, in the process, increase differentiation and customer value, reduce the cost to serve and own, generate new revenue, and reduce risk.

I. Circular Supplies model

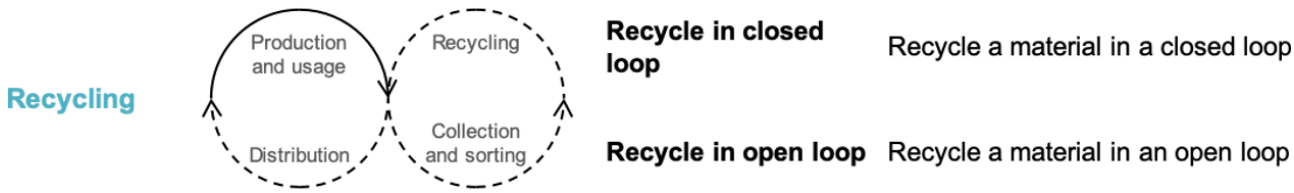
The logic behind this model is often referred to the “cradle to cradle” product design. Circular Supplies business model involves the replacing of the usual production inputs with bio-based, renewable or recovered materials, that support circular production and consumption systems. By making early strategic sourcing decisions in product development, adopting firms can reduce the environmental pressures deriving from their supply chains, while ensuring, at the same time, that the materials embedded in their products will not become waste. The model can be seen as a sort of resource recovery pattern, where material recovery is taken in consideration at a much earlier stage of the product life cycle. Basically, waste is designed away. Through it, companies are able to replace linear resource approaches and gradually eliminate the use of scarce resources, while cutting waste and removing inefficiencies. This model is most suitable for companies dealing with scarce commodities or for those one with a significant environmental footprint. The advantage of using this model is twofold. First of all, replacing traditional inputs with bio-based, renewable, or recovered equivalents, allows firms to promote their products as “green”. Thus, by characterizing their products in this way, firms can target environmentally conscious consumers who are willing to pay a premium for the knowledge that their consumption decisions allow for a lower environmental footprint. Secondly, switching towards alternative material inputs is a way for managing regulatory and supply chain risk. In fact the progressive introduction of an increasingly stringent environmental regulation in many countries, represents an important business risk for companies that are using polluting inputs in their production process. Another important aspect that should be taken into consideration concerns the fact that natural resources, from which key production inputs are derived, are often geographically concentrated in a small number of countries, sometimes in politically unstable parts of the world. Consequently, producers could partially mitigate the associated supply risk by integrating locally derived secondary materials into their supply chains. As highlighted above, circular supply business model affects the conceptualisation of the product design and the manufacturing process, it also regards product branding and the eventual distribution channels. Hence, in order to be succesfully implemented, certain conditions need to be met. The first condition is that there must be sufficient market demand, and willingness to pay, for green products. The second is that the adopted biobased, renewable, or recovered material inputs must be good substitutes for the materials that they replace. Furthermore they also need to be

sufficiently available and affordable because, logically, firms are unlikely to adopt a circular supply business model when it significantly increases their cost of doing business or risk profile.

II. Resource recovery models (or recycling)

The founding element of the model involve the production of secondary raw materials from waste streams. Having its root in traditional recycling markets, this business model leverage new technologies and capabilities to recover almost any type of resource output at a level of value equivalent to or even higher than that of the initial investment.

Image 15. Resource recovery model's framework



Source: 2019 Gate C. All Rights Reserved.

There are three main activities involved, each of which is typically undertaken by different market actors:

- **Collection**. As the name suggests, it involves the acquisition of waste materials generated by households, businesses, and industry. It is generally organised by local governments;
- **Sorting**. It involves the separation of a particular waste stream into its constituent materials, in some cases it is undertaken in public facilities and in others by the private sector;
- **Secondary production**. It concerns the transformation of sorted waste materials into finished raw materials. It is generally implemented by firms that operate in the private sector.

The resulting secondary raw materials, metals, plastics, paper, and so on, are then sold to various manufacturing firms. This model, enable companies to eliminate material leakage and maximize the economic value of product return flows. It is particularly suitable for companies that produce large volumes of by-product or where, waste materials from products can be reclaimed and reprocessed cost effectively. As stated above, Resource Recovery models focus their attention on the valorisation of the materials contained in waste streams. It's important to note that raw waste is available at little or no cost, indeed the households and firms that generate it, are often willing to pay to have it taken away. At the same time, finished secondary raw materials can gain significant prices in the

commodity markets. The challenge for companies which adopt that model is to ensure that the unit cost to undertake this valorisation process is sufficiently small compared to the market price of the finished materials. The adoption of the Resource Recovery business model is practicable only under certain conditions. First, there must be a market for secondary raw materials. Second, a sufficient volume of waste material being generated. This not always happens, especially if we consider those regions that are characterised by low population densities or low levels of consumption.

There are several variants of that model:

- **Downcycling.** It involves the transformation of waste into secondary raw materials. Recovered materials are of an inferior quality, and can be used in a limited subset of applications;
- **Upcycling.** It is exactly the opposite of downcycling. It concerns the transformation of waste into secondary raw materials, and their subsequent use in relatively high value applications;
- **Industrial symbiosis.**

Image 16. Industrial Symbiosis's framework

Source: 2019 Gate C. All Rights Reserved.

It involves the use of production by-products from one firm as production input by another. Industrial symbiosis is most common in industries in which pure and homogeneous material flows are produced, such as the chemical industry. These close relationships usually are the result of a carefully planned industrial parks/clusters that connect one firm with another one through pipelines or short-distance truck deliveries.

III. Product life extension models

As can be understood from the model's name, the core of this pattern lies on the extention of the lifecycle of products and assets. This is particularly attractive from a circular perspective because products, and also the materials embedded in them, remain in the economy for longer, and thereby the extraction of new resources is radically reduced.

Image 17. Product life extension's framework

Source: 2019 Gate C. All Rights Reserved.

Values that would otherwise be lost through wasted materials are instead maintained or even improved by repairing, upgrading, remanufacturing or remarketing products. Additional revenues are generated thanks to extended usage, in fact through the implementation of this model, a company can secure that products stay economically useful for as long as possible and that their upgrades are done in a more targeted way. The interesting thing is that this model is appropriate for both capital-intensive B2B segments and B2C companies that serve markets where used products are common or new versions of a product typically generate only partial additional performance benefits for customers over the previous version. Tipically three mechanisms are involved for the implementation of this model. First of all, manufacturers can lengthen the service life of their products by designing them in a way that increase their durability. Secondly, reuse and repair activities, ensure that products actually attain their intended service life instead of being prematurely dumped. Finally, remanufacturing processes extend the life of products by resetting the clock, consequently, remanufactured products will have a new service life. By adopting the Product Life Extension business model, Google is addressing the obsolescence challenge in the mobile phone arena, in fact company's Project Ara initiative is focused on reinventing the smartphones by breaking them down into replaceable modules that can be assembled and customized according to user requirements. Consequently, users can easily alter their phone with basic skills and tools, keep the phone relevant for a longer period of time and repair the phone more

easily and inexpensively by replacing only the broken parts instead of the entire phone. In that way, Google is able to reduce the need for virgin resources, while minimizing the amount of E-waste generated.

Table 1. Product life extension models

	Key characteristic	Business case
Classic long life	The expected life of a product is extended through changes in product design	Manufacturers can charge a premium for higher quality, more durable products
Direct reuse	Involves the redistribution and reuse of products that would have otherwise been discarded before reaching their expected end of life	Firms that facilitate transactions of second-hand goods (whether online platforms or physical shops) can charge a percentage of the selling price
Maintenance and repair	By fixing or replacing defective components, maintenance and repair allows degraded products to reach their full expected life.	For original equipment manufacturers, extending product care beyond the point of sale may help to promote customer loyalty. In addition, repairing existing products can be a profitable activity for third party repair firms.
Refurbishment and remanufacturing	Gives products a "new life" by restoring them to their original working condition	Refurbished or remanufactured products are sold at a lower price than new ones, but may generate higher profit margins due to material cost savings

Source: OECD 2019

Table 1 provides an overview of the product life extension models. In particular Classic long life model involves designing products with longer service lives. Direct reuse facilitates the redistribution of used products to new owners, consequently instead of been disposed, products continue to remain in circulation. Maintenance and repair, by fixing or replacing defective components, ensures that products attain their full expected service life. Refurbishment and remanufacturing involve the restoration of degraded products, either for a fee, or for subsequent resale. In refurbishment, the emphasis is mostly on aesthetic improvements, with limited restoration of product functionality. With the exception of the Classic long life model, not always product life extension is implemented by the original equipment manufacturer. In many cases, it is actually a third party operators that ease the reuse of second-hand goods, or carry out repair, refurbishment, or remanufacturing activities. For third party adopters, offering the aforementioned services means leveraging the cost savings associated with using already existing materials and products as inputs. These activities develop products of a similar quality to new equivalents, at a considerably lower cost. For original equipment manufacturers, the decision to adopt life extension activities lies upon two conditions. First, adoption is a strategic way of facing the threat from third party firms and may foster greater customer loyalty. Second, in the case of remanufacturing, adoption can partially mitigate supply risks associated with key material inputs.

IV. *Sharing models*

The Sharing Platforms business model basically concerns using under-utilised consumer assets more intensively, either through lending or pooling. Moreover, it encourages the collaboration among product users, either individuals or organizations. In recent years, thanks to the emergence of the phenomenon of "sharing between strangers", sharing models have become more widespread. This model could benefit companies whose products and assets have a low utilization or ownership rate.

Image 18. Product sharing's framework

Source: 2019 Gate C. All Rights Reserved.

Today's sharing practices are facilitated by online platforms. In fact Internet, mobile phone technology, and the development of referral and reputational systems, have reduced the transaction costs and risks associated with sharing assets. Potential buyers also may benefit to the extent that shared products are cheaper than their traditional equivalents. Furthermore, for the owners of under-utilised assets and products, the emergence of online platforms originate the opportunity of earning additional income.

The key features of that model are:

- It involves peer to peer or, alternatively, C2C transactions;
- It involves the temporary, rather than permanent transfer of product ownership;
- It involves the more efficient use of under-utilised physical assets, rather than services provided by private individuals.

Sharing models have two sub-types: co-ownership and co-access.

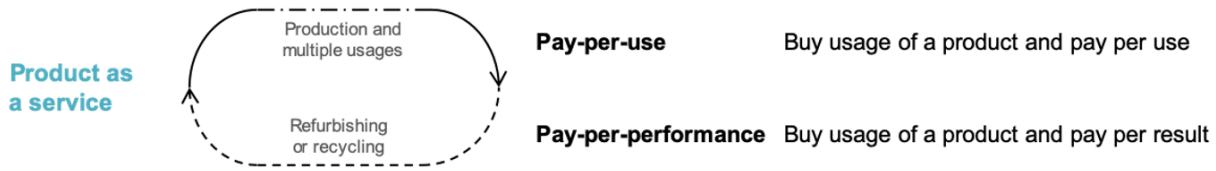
Co-ownership. It involves the lending of physical goods. Capital intensive, infrequently used, and low ownership rate products are the one that are especially suited for that model.

Co-access. It entails allowing others to take part in an activity that would have taken place anyway. Carpooling, for example, allows seats that would otherwise have remained empty to be occupied during a particular journey. Blablacar is a notable example of this business model.

V. Product as service systems models

Product as a Service business model presents a different picture compared to the traditional model of buy and own. In fact, according to that model, as the name may suggest, services rather than products are marketed. Additionally, it improves incentives for green product design and more efficient product use, thereby promoting a more sparing use of natural resources.

Image 19. Product as a service's framework



Source: 2019 Gate C. All Rights Reserved.

In a model like that, lease or pay-for-use arrangements are usually implemented to make products available to consumers. The peculiarity of this business model lies on the fact that it turns incentives for product durability and upgradability upside down, shifting them from volume to performance. Longevity, reusability, and sharing are no longer seen as cannibalization risks, but instead, drivers for creating revenues and reducing costs. The model is particularly attractive for firms whose product management costs are high and which have an advantage in terms of skills compared to their customers, in the management of product maintenance. In that model three main variants can be distinguished:

- **Product-oriented model**. Manufacturers that adopt this variant, continue to produce and sell products in a conventional way, but, and this is the interesting thing, in the value proposition are included additional after-sales service. For example, Patagonia an high-end outdoor clothing company, secures to repair broken apparel and manages a platform that allow customers to sell their products as secondhand products;
- **User-oriented model.** This variant allows customers to pay for the temporary access to a particular product, usually through a short or long-term lease agreement. The service provider maintains the full ownership of the product. Moreover, it can also guarantee consumers with access to high quality or technologically advanced products that otherwise

they could not afford. For example online platforms such as Amazon, Netflix and Spotify, allow the consumption instead of ownership of literature, film and music;

- **Result-oriented model.** Instead of marketing manufactured assets or goods in a traditional way, adopting firms, market the services or the outcomes provided by these goods.

III. Obstacles to the adoption of models

There is a question that could emerge in light of what has been said above, and the question is: "Why, if the benefits of circular economy are so obvious and its basic concepts have been avaliable for more than thirty years, circular economy's business models haven't made the world a better place yet?". The answer lies on many different factors:

- **Customer irrationality.** Customers evaluate transaction costs only at the point of sale. They choose the ownership of a product, due to the desire for convenience and due to other intangible benefits that relates with product ownership, even if temporary usage is more economical. It is emblematic that somethimes it happens even if the net present value of upgrading to a more expensive but more durable product would be more economical. Strong and deeply rooted believes toward existing objects could increase the resistance to change of consumers, preventing them from being open to innovations;
- **Conflict of interest within companies.** The issue, that is heavily influenced by short-term oriented corporate management, relates to the fact that to change an existing product design or to move from a sales-based to a usage-based revenue model, are required high capital or cash. The fact is that lots of companies today are not shaped for capitalizing on the opportunities offered by the circular approach. In fact, unlikily, their strategies, structures and operations are deeply rooted in the linear approach;
- **Misaligned profit-share along supply chain.** This phenomenon can be generated by an imperfect design at the beginning of the supply chain. This is partucularly true when the profits from a better design would only appear at the end-of-use phase;
- **Geographic dispersion.** Lots of companies nowadays are operating in a global marketplace, consequently, product's value chain is spreading over multiple countries, thus national initiatives may lose their potential power.

The focal point of this discussion concerns the fact that even if circular business models afford huge opportunities for customers, companies and enviroment, these benefits alone will not necessarily translate into widespread acceptance of the idea of the circular economy's business models. The key for changing that situation lies on the optimization of the value proposition of circular business models by taking into account non-rational motives of consumers behavior, such as habits and routines. Keeping in mind that without a paying customers you do not have a business, next to product-related motives, social motives also need to be considered.

IV. CE and Covid-19

The disastrous effects that Covid-19 is having towards humanity and economy are under the eyes of all. In particular, the aforementioned effects, are disclosing our system's exposure to a variety of risks. The demand for a more flexible and resilient economic model is increasingly pressing and has gained the support of a growing number of businesses, governments and experts.

Image 20. Circular economy as a shield against Covid-19

Source medium.com

In a context like that, the circular approach is proposing itself as a recovery solution for the economical threats caused by Covid-19. The early stages of the Covid-19 crisis have revealed the fragility of many global supply chains, emblematic the case of medical equipment's availability issues. In this scenario, circular principles such as repairability and reusability could provide reasonable solutions and opportunities to increse the resilience and competitiveness of the whole system and therefore facilitate the recovery. As witnessed by those countries that were severely hit by the virus, being able to quickly adapt industrial facilities and shift production has been of vital importance. To cite some examples, in the automotive sector FCA and Ferrari have joined Siare Engineering, one of the few companies that manufacture respirators, to help them double their productivity, in the fashion industry big names like Fendi, Armani, Gucci, Ferragamo, Celine, Valentino, Serapian Richemont and Prada, have started the production of gowns and masks to be destined to the healthcare personnel. Further confirmation of how important and particularly felt this topic is in this particular moment, a letter from thirty experts was written to governments worldwide to back the transition to a real circular economy as a key part of Covid-19 economy recovery plans. In particular in the letter they suggest that short-term carbon-intensive solutions are not the answer. The solution instead, lies on creating an economy where resources are only used if they are 100% recyclable or reusable. The implementation of a circular economy path could

realise the vision of a world free from the connected problems of climate change and waste crisis. The economic response to the crisis, according to them, must be executed in line with global sustainability goals, putting green stimulus measures in the centre. Moreover, they also show that investing in circular economy could create 700000 jobs by 2030 in Europe alone.

I. How can circular economy support recovery plans?

There are three key areas in which circular economy's principles can be exploited to support recovery plans, and they are:

1. **Decreasing supply-chain risks**: The Covid-19 crisis has clearly demonstrated that an over-reliance on global supply-chains is a significant risk to business continuity, especially in a context where international transports can be shut down in a matter of weeks. Consequently, nations and businesses should try to build greater supply-chain resilience by increasing the local purchase of raw materials, and also by reusing existing products that have reached the end of their useful life;
2. **Alleviating cost pressures**: Another result of the crisis is that both households and businesses are struggling financially thus, they need to prioritise their purchases. This means that second-life products will become a very attractive opportunity for them, since they can meet their needs at lower cost;
3. **Creating jobs**: Circular economy has the potential to bring production home, eliminate foreign dependencies and, consequently, create hundreds of new jobs. The EU's aim is to create 1 million of new green jobs. This potential for job creation stems from the fact that the circular economy has been known to create employment. For example, jobs will be created across industrial sectors thanks to the development of local reverse logistics.

The World Economic Forum has estimated that, thanks to reuse, recycling and upcycling more than $1 trillion can be saved in terms of materials costs. Furthermore, The Ellen MacArthur Foundation has estimates that circularity's principles in manufacturing, potentially, could provide net material cost savings of $630 billions per year in the EU alone.

V. Examples of companies that have succesfully implented CBM

I.

The company began to take an interest in the circular economy after the arrival of Frans Van Houten. This fact led to a drastic change in the way the company conceived the concepts of ownership and value. Thus, was born the program "Healthy people, sustainable planet", launched by the CEO in 2015. The program is based of three fundamental pillars:

- Create the value for the clients through sustainable solutions;
- Leading by example in sustainable operations;
- Multiply the impact driving sustainability through the supply chain.

This strategy was developed with the intention of attracting customers that seem to be more and more interested in the purchasing of green products, but also because the redraw of products and services by adopting a circular economy approach could produce superior margins for the company. Philips has for example adopted the sale as service approach, by introducing the sale of light as service, where the payment occurs only for the light that is used, while the company takes the technological risk and the investment. Furthermore they have also implemented the product life extension model, in fact when the equipment no longer works properly, Philips withdraws it to recycle it or to upgrade it. In this way, has been saved since 50 to the 70 percent of energy and the installation of the LEDs allows a longer duration of the product life, because they last five times more than a normal light. Moreover the company has invested 558 million of euros in green innovation, while in the healthtech business has invested over 1.3 billion in sustainable innovations. In particular, in the healthcare sector, they are developing some leasing relationships in order to be able to take back the equipment, to improve it and to offer it to new clients. This business is worth € 200 million. It is interesting to notice that, according to what the company says, the 9% of their revenues come from circular products and greens revenues reach the 59% of their sales only as it regards the healthtech businesses.

II.

In 2015, DHL has joined the Ellen MacArthur Foundation to find some circular solutions suitable for their business. In 2016 they have succeded in developing a new model of logistics: the Reverse Logistics Maturity Model. The model started defining three demand-driven archetypes based on the type of production. The first archetype involves the lows value extended producer responsibility in whose category are included the mass products that have a low value at the end of the life cycle. In this case, it is necessary to develop a solution in which the products are picked up in a centralized collection scheme and managed through a supplier of recovery services. In the second archetype, the products included are those that have a great residual value, but with a moderate expected return rates. In this case the return of used parts must be mixed with the supply of a refurbished part and with the optimization of the transports flows. Next the parts that have to be replaced are retired from a service partner and refurbished in the center. The last archetype includes comparatively complex high residual value products. In this case, the reverse logistic need to preserve and maximize the product return value, adding the replacing of the asset with a new or remanufactured product. The recovery responsible are different for each collection scheme and for this reason is easier to have a direct return. Christof Ehrhart, Head of Corporate Communications & Responsibility, Deutsche Post DHL Group said that about the Reverse Logistics Maturity Model: "The Reverse Logistics Maturity Model is a valuable tool for any organization that is committed to embedding the circular economy more integrally into their supply chain. It also highlights the opportunities that exist for logistics companies to adapt and expand their services and approaches to support the circular economy, which in turn creates additional value both for business and the environment". The principal advantages of the postal service use as a collection scheme, comprise a lower cost associated to the increase of the collection rates and the use of waste in a vast geographical zone. This engagement improves the image of the group, because consumers find more desiderable the use of logistic service for the collection of recoverable products that otherwise would end in dump, in comparison to the traditional points of collection. As a result the brand rised three positions on the Interbrand list of Best Global Brands.

III. RENAULT

The group has already introduced circular economy's principles within their product' lifecycle.

Company's fundamental assumptions:

- **Conceive ecological vehicles.** It involves the use of second-hand materials derived from recycled products and the creation of repairable vehicles easy to dismantle that contain useful materials for the reuse;
- **Vehicle' second life.** Through the subsidiary Renault Environnement, created in 2008, the company tries to maintain the control on the waste materials;
- **Second hand service.** Renault has launched a service that offers vehicles reparation with reconditioned and remanufactured parts. These parts are obtained from their end-of-life vehicles or from sales network. Hence, clients have a more affordable possibility to repair their cars and Renault can use a more echo-friendly approach;
- **Closing loops.** Renault is trying to develop a short cycle in conformity with the specifications of the automotive industry.

All these activities have allowed Renault to decrease the risk associated with the price volatility for raw materials and have also granted an increasing in terms of revenues and gross margins.

IV.

In the chemical sector, BASF is a leading company that has adopted the circular principles. BASF is actively involved in making its productive sites more eco-friendly. They also promote the efficiency for what concerns the use of the resources. The concept of using resources responsibly is based on three value pillars:

- Responsible production;
- Being a reliable partner;
- Try to find the best solution for market needs;

In 2017, BASF confirmed its commitment in the environmental issue announcing its membership to the CE100 program by the Ellen MacArthur Foundation. This collaboration has been made for discovering together which new possibilities the circular economy can offer. Consequently, BASF has become the pioneer of the "New Plastic Economy" initiative, through which it is revolutionizing the world of plastics design, starting from the packaging. The company has a broad plastic portfolio and makes use of experts in plastics that have also developed experiences with biodegradable material and bio-based plastics, as ecovio®. Moreover, products development is gotten through efficient processes that allow to get higher product yield in their plants with the aims of reducing emissions wastes. The firm also get involved in helping its own clients to improve their own processes and to avoid any by-product. BASF operates more than 60 wastewater treatment plants worldwide.

Chapter 4. CELENIT case study

I. History

CELENIT was born in 1963 thanks to Dr. Gherardo Svegliado, chemist-physicist at Montedison and passionate about mechanical engineering who, following market research throughout Europe, decided to acquire part of a small reality which was producing insulating panels. On the one hand, one of the most valuable know-how in the sector was collected and stored, on the other, was created a company that today is among the most efficient and automated in the world in sustainable solutions for thermal and acoustic insulation. When Dr. Svegliado leaved Montedison, he took over from the historic S.A.F.F.A. of Milan - active since 1871 - the production line of insulating panels for the building industry, the famous Populit, similar to the modern CELENIT. At the beginning the process was manual, carried out by operators whose job was to fill the molds with a special mixture made of wood fibers, water, Portland cement and marble dust, in order to determine their setting. These panels were the first example of insulators produced, they were particularly popular, and used in northern Europe where the insulation problem was particularly felt. Only later, with the advent of plastics, the current insulating materials deriving from polyurethane and polystyrene become established. This fact did not compromise the validity of CELENIT's natural product which has in fact remained intact and is constantly appreciated by a market increasingly sensitive to environmental issues. The production, with partly handcrafted machinery, continued until 1990, after which the automation and robotization process was progressively implemented and allowed the new CELENIT, conducted after 2003 by his son Piero and later by his daughter Giulia, to face the growing international demand for panels for acoustic insulation. Today, CELENIT operates in 20 markets and the factory based in Tombolo occupying a surface area of around 30,000 m2, has a production capacity of 10,000 panels per day. The production process is characterized by high-tech robots for the production of wood wool, automatically regulated driers and robots for pallet filling and packaging/labelling. The highly automated process ensures the consistency of the production standards required by the UNI EN 13168 guideline, which specifies the requirements for wood wool products used for thermal insulation of buildings and, according to the UNI EN 13964 standard, with regard to countertops. The company has made sustainability as its mission, producing, for over 50 years, a thermal and acoustic insulation made of natural and sustainable raw materials. It deals with thermal and acoustic insulation solutions, from the production of panels, up to technical support to designers and companies.

II. Fields of application

I. Acoustic design

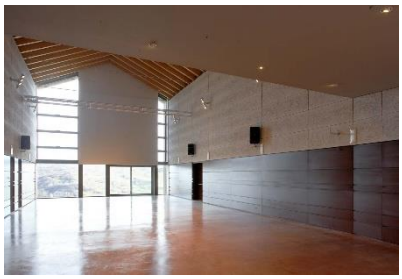
Through the range of coating products with high sound absorption performance, CELENIT offers cutting-edge solutions, that combine the sound-absorbing qualities with the sustainability and environmental friendliness of a natural, aesthetically appealing and mechanically resistant product. The wood wool panels, with their particular surface conformation, are in fact natural acoustic absorbers and ensure that the noise does not bounce from one wall to another, but on the contrary, it is partially absorbed and dissipated avoiding the annoying phenomenon of reverberation.

Examples:

Image 21. Padiglione Onlus Martino Sansi

Source: celenit.com

Image 22. Centro Civico Villa Minozzo



Source: celenit.com

Image 23. Uffici CISL

Source: celenit.com

II. Building Construction

CELENIT is used in all insulation solutions, both in traditional new buildings or existing redevelopments, and in innovative building products. The applications are manifold: the vertical partitions, the roofs, the upper surface and the soffit of floors and internal partitions.

Examples:

Image 24. Celenit iso-acustico

Source: celenit.com

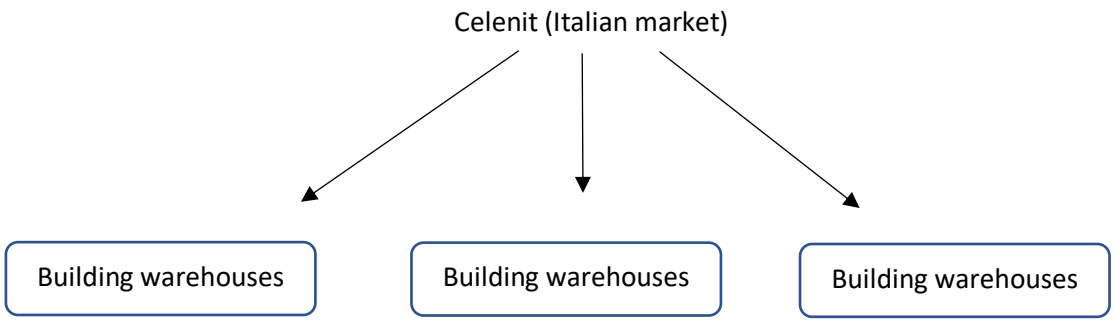
Image 25. Celenit iso-involucro tetto

Source: celenit.com

III. Markets

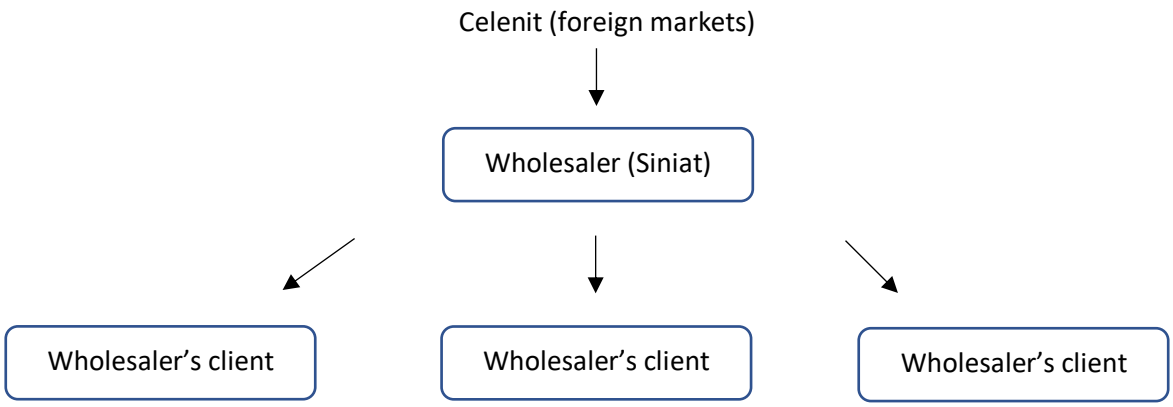
CELENIT is a company that operates in the construction market not only in Italy but also, and above all, abroad. In fact, 60% of their income comes from the foreign market and 40% from the Italian one. Is interesting the fact that in Italy, CELENIT is the only manufacturer of mineralized wool wood products, consequently, in the Italian market they offer the product as an alternative to other systems, whereas in the foreign markets where mineralized wool wood panels are well known, they make a commercial proposal as an alternative to the mineralized wood products already present in the market. They offer a very technical product, very specific, for a niche market. For what concerns the Italian market, their customers are generally building warehouses. Abroad, CELENIT provides purely wholesalers, large companies that then distribute the material on the market. Wholesalers are chosen on the basis of CELENIT's experience, and on the basis of the approach they use, even if more often, it is the wholesaler itself that chooses them, that asks them to become its suppliers. Abroad, very often, the product that CELENIT furnishes has not CELENIT's brand but it has the wholesaler's brand. For example in France, they supply a wholesaler called Siniat and consequently CELENIT's products in France are sold as Siniat.

Graph 2. Italian market



my reworking

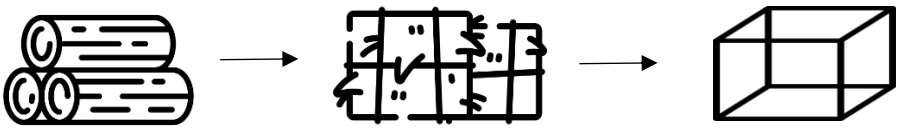
Graph 3. Foreign market



my reworking

IV. Productive process, why are they circular?

CELENIT's panels are manufactured in a very modern factory which has a production capacity of around 12000 m2 per day. The plant is characterized by low energy consumption and part of the necessary energy, about 20%-25% of the entire requirement, is supplied by the photovoltaic system that covers the entire surface of the roofs. The highly automated process guarantees the consistency of the production standards required by the UNI EN 13168 guideline, this standard deal with the product technical regulation, it regulates the production methods, the material and the technical characteristics that the panel must have. It allows the company to regulate the production of the mineralized wood wool insulation panel. High production capacity and complete automation offer the possibility of satisfying both large and limited orders in very short times. CELENIT's production cycle encompasses the use of wood spruce trunks, which are scratched to form a sort of wool that is then mixed with water and Portland cement (white or gray), this straw, wet with water and Portland cement, is then placed in the inside of molds which are then put under pressure, at room temperature. When the cement sets (about 2 days), the slab is separated from the mold and then squared and packed. The wood wool bonded with white Portland cement is specific for visible application (e.g. false ceiling), whereas the wood wool bonded with gray Portland cement is specific for non-visible applications. CELENIT's products are divided into two ranges, visible white products are used for acoustic applications (acoustic insulation), non-visible gray products used for thermal applications (thermal insulation).



Is interesting to notice that all products placed on the Italian and European market must be provided with CE marking, connected to the laboratories notified in the EU and supplied by the DoP (Declaration of performance). The notified body, Istituto Giordano, periodically checks the production control system of wood wool panels, by issuing the certificate of constancy of performance. The technologically advanced system and the constant checks required, are a guarantee of quality for CELENIT's products.

Why are they circular?

- The first reason deals with the fact that when they saw the trunks some wood dust is created, the same happens when they make the squaring of the panels or when they work on the panels. This sawdust (waste product), is reused in agriculture, to make the bed for animals, or is scattered in the fields to fatten them. A very small part of the aforementioned sawdust, is then reintegrated into the production process. Moreover, in the case of panels that come out from the production line defective, not compliant with UNI EN 13168 guideline, they are grounded and used in the same way as sawdust. What they produce as waste, which is provide to fatten the fields, or for breeding does not bring them any profit, they give it away free of charge. The economic benefit in this case lies in the money saved for the disposal of waste;
- The second reason lies on the fact that, compared to all other building systems, CELENIT's ones is mainly used on dry application systems, like metal structures, this imply that they are employed in assembly systems that do not require the use of mortars, cements, poured concrete. This provides a characteristic of disassemblability to the material, a concept also reported by the CAM regulation (minimum environmental criteria) for public buildings, since 2017, all the materials used inside public buildings must have this type of characteristic. I must be able, in the case of ordinary or extraordinary maintenance, or disposal of the material, to disassemble / replace or reassemble or use them in other systems. Through healthy material choices and design for disassembly, it is possible to recoup some of the original investment. This building system's characteristic, allows the recovery of the material used in its entirety;
- The third reason lies on the fact that suppliers must furnish a product that falls within CELENIT's standard. They need to have suppliers, especially for what concerns cement and wood, close to their production plant, otherwise they risk loosing their sustainability certifications. Is interesting to observe that the company has drafted an LCA, life circular assistment, which dictates the parameters of the product life cycle, from the withdrawal of the raw material on the territory to the disposal of the material itself. The fact that they have all the material they need to manufacture their panels, close to their plant, allow them to save money in terms of transport costs;
- The fourth reason deals with the fact that, the roof of the production plant, is completely covered with photovoltaic systems, it does not cover all the energy requirements, just about

20-25% of it. Considering that CELENIT's production process is an energy-intensive process from the purely electrical point of view, the fact that part of the energy is provided by photovoltaic system allows savings in terms of energy costs;

- The fifth reason lies on the fact that in their production cycle, when they insert the cement, they also insert a small percentage, 15%-30%, of calcium carbonate, (marble powder waste from the cuts of the processing of marble waste, taken from Verona's marmerie). This powder gives even more strength and compactness, offers the material mechanical and anti-fire characteristics. Furthermore, their products have a whole series of technical characteristics that allow their durability over time, e.g. (insensitivity to humidity, mechanical resistance / strength). CELENIT also offers a material safety data sheet in which is indicated the material disposal "CER" code. Their products are designed to last.

V. Sustainability and Ecocompatibility

CELENIT has made sustainability as its mission, by producing a natural insulator made up of natural and sustainable raw materials. The certifications of raw materials and products are a guarantee of reliability and respect for the environment. ANAB-ICEA and Natureplus certified panels for product and production process sustainability. The raw materials that compose the CELENIT eco-friendly panels include: spruce wood from sustainably managed forests (PEFC ™ or FSC® chains of custody); Portland cement and calcium carbonate, residue from marble processing, to constitute the percentage of recycled material (ICEA certified). The production process has low resource consumption and low emissions. CELENIT's panels can therefore contribute to the assessment of the sustainability of buildings through certification protocols. Ensuring the sustainability of materials, elements, components and building processes, requires the definition and verification of a series of requirements that ensure the construction of high-performance buildings. There are some regulations that define these sustainability requirements, their measure and the acceptability thresholds that allow for assessments. Some of these norms are defined by the Regions, others by the various Nations and still others are drawn up internationally. Additional tools that allow the assessment of sustainability requirements are the result of the work of Research Institutes and Universities and are proposed to the actors of the building process in the form of certifications and assessment methods.

The following are all the certifications that CELENIT possesses:

1. PRODOTTO IDONEO CAM CRITERI AMBIENTALI MINIMI

MINIMUM ENVIRONMENTAL CRITERIA

This particular certification establishes which are the minimum enviromental criteria for the assignment of design services and works for the new construction, renovation and maintenance of public buildings (DM 11 October 2017). CELENIT, in order to meet the increasing demands of designers looking for technical support and specific indications, has prepared a detailed analysis of the criteria that can be met by using insulation solutions with mineralized and bonded wood wool products with Portland cement.

2. EPD®
THE INTERNATIONAL EPD® SYSTEM
S-P-00477 www.environdec.com

EPD®

It basicaly is the environmental booklet of the product. It quantifies the environmental performance of a product through appropriate categories of parameters calculated with the Life Cycle Assessment (LCA) method and therefore following the standards of the ISO 14040 series.

3. ICEA CERTIFIED

ICEA - RECYCLED MATERIALS

The Institute for Ethical and Environmental Certification (ICEA), has developed the "Standard for the Certification of products made with recycled materials" which aim is to reduce the consumption of resources (virgin raw materials, water and energy), increase the quality of recycled products, minimize dangerous emissions in the air, in the water and soil as well as any impact on human health. CELENIT's products are certified according to the ICEA standard.

4. natureplus.org
natural sustainable building

NATUREPLUS

It regulates sustainability criteria in europe, in particular it identifies products for sustainable construction.

5. Il marchio della gestione forestale responsabile FSC® C122980

FSC®

The Association promotes the conservation and the improvement of forest resources worldwide, through economically sustainable and socially useful management of forests. It dictates the sustainability of the wood raw material. CELENIT's wood wool panels can be made, on request, with FSC® certified wood. This certification allows the company to enter in the French, Dutch and USA markets.

6. PEFC/18-31-168

PEFC™

PEFC is an international non-profit and non-governmental organization which is dedicated in promoting sustainable forest management. CELENIT is in compliance with PEFC standards for the production of its wood wool panels. When you see the PEFC certification mark, associated with a product, you know that the wood used in the production process of that product is part of the chain of custody for the traceability of the raw material "wood" coming from certified forests for sustainable sustainable management PEFC. All the wood wool panels made by Celenit, are realized with PEFC ™ certified wood.

7. ANAB PRODOTTO CERTIFICATO PER LA BIOEDILIZIA

ANAB-ICEA

ANAB (National Association of Bioecological Architecture) is the most important Italian association in the field of sustainable construction and involves professionals and operators throughout the national territory. It identifies single-layer wood wool products that produce a reduced environmental impact, respecting the requirements for construction materials provided by the most important building certification and evaluation systems and provide the guarantee of respect for

the health and safety of end users and workers. CELENIT was the first company in Italy to be ANAB certified. It has been ANAB certified for 20 years.

8.

LEED

LEED (The Leadership in Energy and Environmental Design), developed by U.S. Green Building Council (USGBC), is an American and international system that, through its certification schemes, identifies and measures the environmental and sustainability performance of buildings. Through the ICEA certification, CELENIT's products can contribute to LEED credits by giving the designer the tools for the creation of environmentally sustainable buildings

9.

ITACA PROTOCOL

It is a tool for assessing the environmental sustainability and energy efficiency of buildings. By using CELENIT's products, the designer has the opportunity to increase the total score of the ITACA PROTOCOL, thereby promoting the design and development of an environmentally sustainable building.

10.

As said above, CELENIT's products are CE marked according to UNI EN 13168 standard, which specifies the requirements for wood wool products used for thermal insulation of buildings and according to UNI EN 13964 guideline as regards countertops.

11. DoP

Regulation (EU) no. 305/2011 on the CE marking of construction products, obliges the manufacturer to draw up the Declaration of Performance (DoP) for products that fall within the scope of a harmonized standard or if they comply with a European technical assessment.

Conclusions

The objective pursued with this elaborate, was to highlight the main characteristics of the circular model in relation to the classic linear approach. In light of the foregoing, it is evident that the classic take-make-dispose approach is no longer sustainable neither from an economic point of view nor, above all, from an environmental point of view. In a situation such as the current one, dominated by the linear approach, it becomes increasingly clear how it is necessary to carry out a turnaround, which brings an advantage to all the stakeholders involved. In this sense, the circular economy is proposing itself as a solution to the problems that traditionally characterize the linear model. As highlighted above, by designing out waste and pollution, keeping products and materials in use, and regenerating natural systems, everything can be reinvented. The circular approach is conceived as a continuous cycle of positive development, that preserves and enhances natural capital, optimizes resources exploitation and minimise system risks by better managing the finite resources and the renewable flows. Circular economy is restorative and regenerative by design and aims to keep products, components, and materials at their highest utility and value at all times. It is an economic system that can benefit everyone and simultaneously respect planetary boundaries. The objective is to, little by little, decouple growth from the consumption of finite resources and to re-build capital, whether this is financial, human, social or natural. This ensures enhanced flows of goods and services. The opportunities that this system can create are manifold and as highlighted many times within the paper, consists on the improving of economic growth, on the substantial net material cost savings, on the creation of employment, and on the increasing of innovation. In terms of environmental opportunities, the progressive reduction of emissions and primary material consumption, the preservetion and improvement of land productivity, and the minimization of negative externalities. In terms of opportunities for companies, new and bigger profit pools, greater security in supply, new demand for business services, and as a consequence greater resilience could be achieved. Finally, in terms of opportunities for citizens, lower prices, and lower total cost of ownership could be obtained. The implementation of the circular approach could increase the disposable income of an average household due to the reduction cost of products and services and due to the conversion of unproductive to productive time. To allow this switch from the linear to the circular system, fundamental will be the role of politics, institutions and governments because they will have the critical task of creating and enabling the conditions for the circular economy to emerge and prosper. They will set direction but more importantly, they will be the drivers for innovation and investments. Again, the circular system, to be implemented, needs changes from a

social, cultural and civil point of view. In particular, what is absolutely necessary to change, in order for the concept of the circular economy to spread and prosper first of all concerns customer irrationality, especially their attitude towards the principles of the circular economy. Strong and deeply rooted believes toward existing objects could increase the resistance to change of consumers, preventing them from being open to innovations. Secondly the mentality of companies, the fact is that lots of companies today are not shaped for capitalizing on the opportunities offered by the circular approach. In fact, unlikely, their strategies, structures and operations are deeply rooted in the linear approach. The demand for a more flexible and resilient economic model is increasingly pressing, especially now that the Covid-19 crisis has revealed the fragility of many global supply chains. Circular principles such as repairability and reusability could provide reasonable solutions and opportunities to increse the resilience and competitiveness of the whole system and therefore facilitate the recovery. Through the analysis of the CELENIT business case I wanted to highlight how a company, by adopting principles inspired by the circular model, can succeed and become one of the most important and famous companies in the sector, not only in Italy but also, and above all, globally. After centuries of indiscriminate exploitation of the planet and of its resources, the time has come for humanity to remedy and the adoption of the circular approach is certainly an excellent starting point.

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