The Current State and Future Perspectives Regarding the Sustained Activity within a Circular Economic System

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A circular approach in the economy means and promotes, in principle, the reusability of products and materials through different processes such as recycling. refurbishment and remanufacturing. The question that has been frequently asked in the past was: 'Is the transition from a linear model necessary?' But, as the time passed and multiple sources of pressure began to appear (even if we speak about the resource finiteness or the actual state of the environment), forcing multiple states to take more and more severe regulatory action by refining exiting laws or introducing new ones, and to release incentives to counterbalance the negative effects generated until then, the need of transition is more urgent than ever. So, in this paper, I review the main characteristics of the circular system, giving arguments for why the transition to it is so important, as well as the benefits of doing so, present the actual state of things, both in Europe and the United States of America, describing the main actions undertaken to facilitate it (the Green Deal initiative in Europe, as well as the EPA initiatives in USA), then analyze how the modern era contributes and will contribute in all the process (by including some important aspects about digitalization and artificial intelligence and how they can help).
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1 Introduction

1.1 Circular economy: definition and characteristics

In the present economy that we are currently living in, we grasp raw materials from Earth, use them to construct various products, only to throw the latter away as waste, when their usage lifecycle has been completed. The process described until now is linear by nature (if we take the steps and imagine the flow of execution, we will see that it has a well determined start and a well determined end), Figure 1.

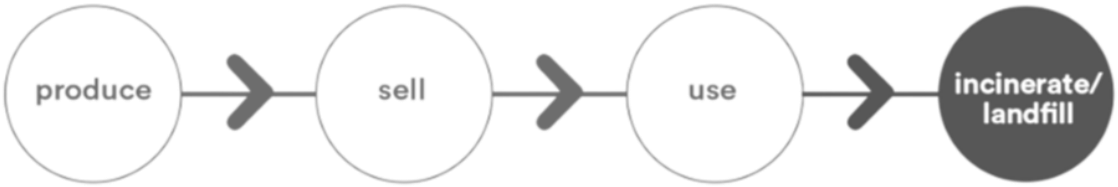


Fig. 1. Linear economic model [2]

On the other hand, the circular model approaches the material flow from a different perspective; as its name says, the course of action forms a never-ending circle, and one traversal of it represents a cycle of consumption (Figure 2). In other words, when a motion has been completed, the respective product has been in the economic system one time (in its original form or derivatives). The more times a cycle completes, the better.

A circular economic model is one of consumption and production, inside which materials, products, and items are reused whenever possible, instead of being discarded or wasted. It involves leasing, sharing, reusing, recycling, repairing and refurbishing materials as long as possible. It has sustainability promoting intrinsic features that focus on reusing and

recycling materials to reduce consumption and avoid waste generation. It seems that, ultimately, the model tries to decouple the global economic development from the finite resource consumption I talked about.

Although the term was created by Dame Ellen MacArthur back in 2010 [1] and has a wide application range among all the known industries, the notion of circularity itself has some deep and philosophical origins, as both the terms of circularity and feedback loops, in the real world as we know it, date from very distant times. And so, the main notion cannot be attributed to a specific place or person, as, over decades, it has been developed and refined under the auspices of a small group of academics, leaders, and different businesses. [2]

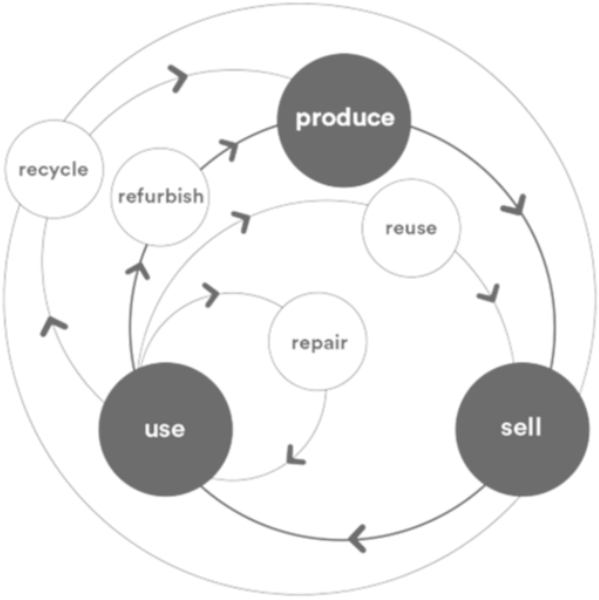


Fig. 2. Circular economic model [2]

At its core, the circular economic model focuses on three main principles:

- Preserve and improve the natural capital by balancing regenerative resource sources – when some resources are needed for a specific flow, the system filters and chooses ways of action regenerative by design, wherever possible.
- Extension of the useful life of materials and products – in other words, the process of optimization by cycling at the highest utility at all times, in both technical and biological cycles. A biological cycle incorporates all the characteristics of consumption, where both the biological substances and all the nutritive substances (for example, cotton or wood) are projected to be reused as much as possible: they can rejoin the system (return to the soil) through specific processes, i.e., composting, and anaerobic digestion. On the other hand, technical cycles restore and recover materials, components, and products through numerous procedures (repair, reuse, recycling, remanufacturing). The extension is obtained through various processes of active reuse, remanufacturing and repair of the items used in the economy.
- Waste and pollution minimization – by reducing the damage created from some economic activities (for example, buying new products instead of reusing the existing ones or buying used ones), this principle supports reducing waste and pollution as much as possible. [3]

1.2 The real power resides in circles (cycles)

The real power of a circular economic system comes from the immanent cyclic processes that can be used and improved efficiently to maximize the effects:

- **The power of the inner circle** => refers

to the concept that the more value is generated the tighter the circle is. As an example, repairing a car preserves the majority of its value. If this thing is not possible, individual components can be reused, instead. This ensures product integrity (Figure 3).

Fig. 3. The power of the inner circle [4]

- **The power of circling longer** => refers to the process of maximizing the number of cycles in consecution and/or the period spent in each cycle (extending the product lifecycle by reusing it or by reusing a derivative). Each cycle duration is inverse proportional with the potential quantity of resources needed, meaning that the usage of resources to create a new component is avoided more if the current product stays in a cycle for a longer period (Figure 4).

Fig. 4. The power of circling longer [4]

- **The power of cascaded usage** => refers to the diversification in usage, that continuous transformation which I spoke about earlier in this paper. For example, cotton can be used in many forms among various cycles: secondhand apparel => in the furniture industry => stone wool (Figure 5).

Fig. 5. The power of cascaded usage [4]

- **The power of pure inputs** => refers to uncontaminated material streams that increase collection efficiency, at the same time keeping the quality intact (Figure 6).

Fig. 6. The power of pure inputs [4]

1.3 A necessary transition

So, this, "take, make, dispose" economic model, which heavily relies on substantial quantities of materials and energy that are cheap and easy obtainable, has been the soul and heart of the relatively current industrial development and advances, generating a never seen before level of growth. Yet, finite resources are finite, and, when it comes to their availability, a constant pressure is applied in all sectors, pressure that continues to grow even today. That, along with price volatility, risks created by supply chains, and other factors, has caused concern among different policy makers and business leaders, making them rethink the usage strategies. [4]

To reiterate, here are the factors that indicate the impossibility of the linear model to adapt to the new environmental and technologic changes, being constantly challenged by the context within which it operates:

- **price volatility**: many companies have noticed that higher exposure to the linear system increases their exposure to risks, due to supply disruptions and price volatility. This, in turn, leads to uncertainty, discouraging businesses from investing. Moreover, in the last decade, these parameters were very high in the agricultural area, as well as in the metallurgical industry. [5]
- **structural waste**: as already stated, the linear model is very wasteful in terms of value creation. For example, in Europe, the average car is parked 92 percent of its total time, the average office is actually used 35-50 percent of the time, and 31 percent of the aliments is wasted. [6]

- **technological advance**: advances done in technology outmatched the speed of economic development that was imposed by the linear model. Now, technology can generate even greater opportunities for the society, allowing more efficient knowledge sharing, collaboration, and increased use of restorative energy.
- **urbanization**: over half of the world's population resides in urban areas [7], and continued urbanization and significative demographic growth will increase this percent to a staggering 68% by the end of 2050, adding another 2.5 billion people in the urban zones [8]
- **business model exploration and acceptance**: new business models are slowly emerging, models that enable the individuals to access services, rather than owning the products which deliver them, transforming the individuals into final users
- **supply risks**: many areas around the globe do not have power over many natural providers of resources, so they must rely on other ways to obtain them (such as imports). The European Union is a victim of this, importing six times more than it exports [9]. Others that fit into this category are India and Japan, being dependent on imports regarding petroleum and natural gas, the latter having the entirety of its imports in the form of liquefied natural gas. [10], [11]
- **natural system degradation**: as the nature degrades and the finite resources are depleted, the productivity of different economic systems is affected.
- **increased regulatory trends**: as many negative repercussions were introduced by the actual economic model, the number of rules that had to be imposed by different authorities increased significantly. For example, the number of climate change laws has increase from 300 to 500, since 2009 [12]. In addition, carbon pricing has been implemented or it is programmed to begin in over forty countries and twenty cities. [13]

1.4 Benefits

Given the context and environmental changes that were stated above, as well as the regulatory interventions intended to revitalize the economic system as a result of the current adopted linear model, the situation is pressuring, or, better said, urging us to find and adopt new business and action models to adjust to the new conditions. So, the circular system that I talked about emerged to try to address these things. Still, one important question that must be asked is "How exactly is CE helping the environment?". In other words: "What are the benefits of implementing such an economic model, in the first place?". And so, here is a list that is intended to answer this question:

- **environment protection** => recycling and reusing can help in slowing down the use of natural materials, helping in limiting the biodiversity loss [14]. Moreover, an overall reduction in the total annual greenhouse gas emissions can be achieved in this way and, creating more efficient products that can introduce sustainability can help reduce energy utilization. Finally, of course, waste minimization is considered, in the EU the aim being to tackle the excessive packaging that is done at the moment. [15]
- **job creation and money saving =>** moving towards a circular system can stimulate the innovation process across multiple sectors of the economy, improve the competitiveness, create jobs (it is estimated that, in the European Union, seven hundred thousand additional jobs would be created by 2030) and increase economic development. More durable products will be created, thus increasing life quality, and generating money savings on the long term.
- **softening the dependence on raw materials** => as already stated, we live with infinite wishes in a finite world. Finite supplies means that some countries are overly dependent on them or on other countries to provide them (being acquired through imports). By reusing resources in multiple cycles, in the same form or in a different

one – as Antoine Lavoisier said in his Law of Conservation of Mass: "*Nothing is lost, nothing is created, everything is transformed*" [16] – we can ensure that risks associated with supply (import dependency, price volatility and availability) are mitigated. This is applied especially to the materials that are crucial at the moment to achieve the climate change goals and to impose different laws in this area (electric engines, batteries etc.)

- **waste is "designed out"** => this represents a design characteristic, so it is done by intention. In a circular model, waste does not exist.
- **promotes thinking in systems** => in CE, system-thinking has a wide application. To transition to it, the consequences, and the links between real world elements (like people, plants, businesses, that are, in turn, part of complex systems), must be considered.
- **makes the feedback-price-cost relationship more transparent** => in this system, prices act as messages, therefore they must reflect full costs.
- **diversity builds strength** => diversity is a main factor in obtaining resilience and versatility. Economies need to put into balance numerous businesses in order to survive on the long term. When crises are occurring, the large enterprises come with efficiency, whereas smaller ones offer different other models to implement.
- **the economy is powered up by energy sources that can be renewed** => system resilience is increased; resource dependence and energy threshold levels are decreased [17]

2 Current state

2.1 A way to innovation

It is well known that medium and large companies are already taking big risks and making bold decisions to put themselves in line with the circular economy perspective and principles. To give some examples, according to a study made by Gartner [18], more than 70% of the supply chain leaders are taking into consideration the CE investment at the end of 2020, beginning of 2021. More than that, the circular business model has gained popularity among companies around the world, such as Cisco, who operates a program named "*Take-back and Reuse*", which has created subscription earnings in different markets by encouraging and promoting multiple cycles of use [19], or Caterpillar, which reduces operating costs through the program named "*Cat Reman*" [20], or Unilever, who has pledged to reduce its virgin plastic usage by half by 2025. As all these mentioned actions and efforts are taken to bigger and bigger scales, entire industries are beginning to transform, little by little, changing their modus operandi. By the year of 2029, the clothing industry will rely more on clothes resale, rather than on fast fashion. This has been influenced as well by the crisis we have gone through (Covid-19), which encouraged second-hand sales and boosting the online market (the latter having a 69% grow between 2019 and 2021). The world's most important plastic-oriented group – the New Plastics Economy Global Commitment – which is consisted of companies that represent more than 20% of all the plastic packaging, as well as associations, investors, governments, and other associations has set a target for 2025 to try to alleviate plastic pollution at its source. [21]

The changes are beginning to be felt also at the government level, examples for this being the different legislations from countries like China, France, Chile, Netherlands, and Finland. In the year of 2019, the European Union presented the *Green Deal* (having circular economy as a crucial starting point and pillar), and in 2020 the *Circular Economy Action Plan* (I will talk about those later in this paper).

As for the initiatives regarding the level of circularity implemented by a specific company, state, or system in general, here I present you most important ones:

- **Global Reporting Initiative** – they use the so-called Waste Reporting Standard 306, which is designed, along with many other standards, to be used by companies (organizations) as a reporting tool when it

comes to their impact on the society, environment, and the economy [22]. Well, starting from May 2020, this standard will also include circular economy principles.

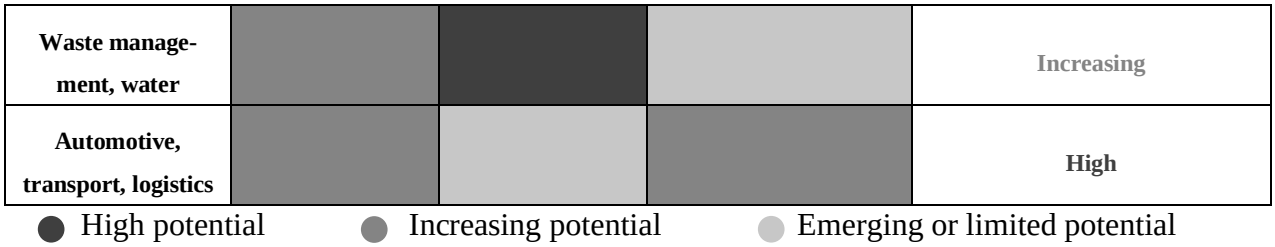
- **World Benchmarking Alliance** – will use circular economy (being one of the seven system criteria) to measure over 2000 companies.
- **Materials Circularity Indicator** – intended to be an assessment tool that allows companies to identify circular strategies which will further improve material gathering and product design.
- **New Plastics Economy Global Commitment Annual Progress Report –** provides transparency about the industries circular transition.
- **EU Taxonomy –** its objective is to create the first *green list* for sustainable activities investors.
- **Circular Transition Indicators –** defined by the World Business Council on Sustainable Development, representing a self-assessment adjuvant which helps companies understand their energy consumption, material flows, as well as the impact of their current activities on the environment. [23]

2.2 Circular opportunities among different areas of activity

When it comes to the opportunities it can generate across many different sectors, circular economy enjoys an enormous privilege. Among the most affected, the fashion, food, and plastics stand out as being the ones are possibly to be significantly impacted or even deranged by the CE on short term, changes determined by regulation, innovation and evolving personalized preferences of customers.

Table 1. Drivers of CE growth potential by sector [23]

Sector	Drivers of circular economy growth potential			Overall circular economy growth potential
	Innovation & corporate action	Policies & regulation	Customer preferences & macrotrends	
Electronics				**High**
Food & agriculture				**High**
Tech, media, telecommunication				**Increasing**
Engineering, construction				**Increasing**
Plastics, packaged goods				**High**
Fashion, textiles				**High**
Industrial manufacturing				**Increasing**
Paper, pulp, forestry products				**Increasing**



The Table 1 shows the link between three circular economy growth drivers and different sectors. It only focuses on the potential of growth and does not show the actual implementation maturity of the circular point of view (for example, a specific sector may have a high implementation percentage in the present, thus limited growth potential). [23]

2.3 The European Green Deal

This initiative was first approved in the year of 2020 and represents a collection of regulations and policies emitted by the **European Commission** with the main objective of making the EU (European Union) climate neutral by the year of 2050. Also, it aims to reduce the greenhouse gas emission by at least 50% and at most 55% by the end of 2030 (this being compared with the 1990 levels). To do this, a series of the current laws is to be made, along with the introducing of new legislation on circular economy, biodiversity, farming, innovation, and building renovation.

The strategy is focused to make Europe a net-zero greenhouse gases emitter by the end of 2050 and to prove the fact that, by living in virtue of circularity, the resource usage will decrease. In addition, countries that already rely on fossil fuels are targeted as well, because the green transition represents a priority.

Ursula von der Leyen, the president of the European Commission, has stated that the Green Deal would be the European equivalent of "the man on the moon moment". And so, despite Poland's last minute opt-out [24], the plan was voted by the European Parliament on 15 January of 2020. The plan includes:

- an EU forest strategy => forest preservation, restoration
- changes in the **Energy Taxation Directive**, with the focus being on tax exemptions and measures to keep the prices destinated to the customer below market levels, when it comes to fossil fuel
- a possible revision to all the existing climate-related instruments and laws, including the Emissions Trading System
- a smart and sustainable mobility action plan
- **Farm to Fork strategy =>** focus to shift from compliance to performance (rewarding the farmers for applying circular economy principles)
- a Circular Economy action plan => the European Commission is asking and requiring the member states to adopt new strategies and carry out activities regarding the circular transition. Indeed, CE is a vital pillar both in the European Green Deal and in the Coronavirus Recovery Plan, and a key component in creating a competitive, sustainable, low-carbon and resource efficient economy. [25]

The goals are to be extended on many different areas of activity, including energy, transport, and food. For this, the deal presents a roadmap to make the EU's economy sustainable by transforming climate environmental tasks and challenges into opportunities, boosting the efficiency of resource usage by transitioning to a clean and circular perspective, and by eliminating climate change (Figure 7).

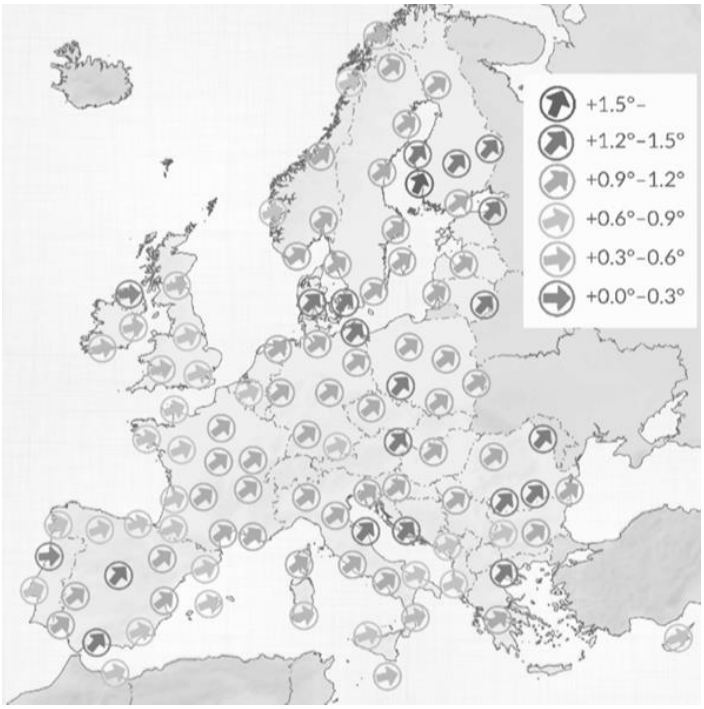


Fig. 7. The increase of average temperature across in EU the years [26]

To give details on the major aims that were mentioned above, there are several policy areas where this programme is to intervene. The **CEAP II** (Circular Economy Action Plan) was adopted with the main focus of boosting global competitiveness, to generate new jobs and to sustain the economic growth. It covers all the full cycles of products: production, usage, waste management, and the market for derivatives, aiming to keep resources in economic cycles as much as possible (the power of circling longer). The idea of **Regulation on Eco-design** refers to the way the products are designed, so its main aim is to make product more reparable, easier to maintain, more upgradable, reliable, reusable, and energy and resource efficient. Moreover, all the products will better inform the consumer of the environmental impact they have. The **Farm to Fork** strategy wants to ensure that aquaculture, agriculture, and fisheries contribute appropriately to the objective of climate neutrality. The forming of an environment that makes is easier to choose sustainable and healthy lifestyles regarding food consumption will benefit consumers. The **2030 Biodiversity Strategy** is an ambition long-term plan that wants to protect the degradation of ecosystems. Along with the circular economy, it is a very important pillar in the European Green Deal, which sets out new implementations of the current laws, new measures and targets meant to put the biodiversity on Europe on a recovery path by the end of 2030. The **p**roposed legislation on **Packaging and Packaging Waste**, as its name says, aims to terminate wasteful packaging, preventing further generation of packaging waste, boosting high quality recycling, and reducing the need for primary resources coming from nature. The **Zero Pollution Action Plan** has as its objective the termination and future prevention of pollution in all the relevant EU policies. Finally, the new **Regulation to curb EU forest degradation and deforestation** sets rules for companies that want to export relevant products or place them on the EU market. The former will have to prove that the products are both legal and deforestation free, and to collect accurate geographical data of the fields on which their products have grown, data that will be constantly checked and enhanced. [27]

2.4 US EPA

The European Union is not the only one who is taking measures to facilitate the transition towards a circular economic perspective. The

United States of America, through its **Environmental Protection Agency** (EPA), has stated countless times that they are also making efforts to protect the environment, businesses, and society, by adopting circularity practices and by following CE principles.
EPA represents an agency whose main mission is environmental protection. It was first established in 1970, on July 7, and began its activity on December, 2 of the same year, after the president of those times, Richard Nixon, signed an executive order. Its enforcement is represented by and includes sanctions, fines, and other measures, working with various industries placed at all levels of government to establish voluntary pollution prevention programs and energy saving efforts. Most of them are in conformity with the originally formed laws passed by the Congress. Additional programs have been implemented to reinterpret the primary missions. [28] It has a myriad of them, but this paper will mention only some:

- **PFAS (Per- and Polyfluoroalkyl) Substances National Primary Drinking Water Regulation** – a programme meant to enforce legal levels, called MCLs (Maximum Contaminant Levels) for six PFAS (PFOA, PFOS, PFNA, PFHxS, PFBS and HFPO-DA). The first two are individual working contaminants, the rest being a PFAS mixture. Public water systems are now required to notify the public of these levels, reduce them if they exceed the set threshold (so, also monitoring them). On this proposed incentive, EPA is requesting public opinion (Table 2). [29]

Table 2. Proposed water contamination levels [29]

Compound	Proposed MCLG	Proposed MCL (enforceable)
PFOA	Zero	4 parts per trillion
PFOS	Zero	4 ppt
PFNA	1 (unitless) Hazard Index	1 (unitless) Hazard Index
PFHxS		
PFBS		
HFPO-DA (commonly referred to as GenX Chemicals)		

- **Inflation Reduction Act** – a programme that helps the various through various was of action: it provides tax credits that will help in money saving and make buildings more energy efficient, all of this while lowering greenhouse gas levels; invests more than one billion dollars to replace dirty and heavy-duty vehicles with clean, zero-emission vehicles, and to train and develop workers; creates the Greenhouse Gas Reduction Fund to finance different circular-oriented projects. [30]
- **Climate Change Acts** – EPA is measuring gas emissions using to programs developed to help the policymakers and public understand the sources of the emissions. Also, it works with different industries to reduce them through partnership and regulatory initiatives. Its research is done in partnership with international organizations and other federal agencies. Finally, it provides the necessary tools, assistance, and resources to help Tribal, local, and state governments in building climate resiliency. [31]
- **EnergyStar Tax Credits** – the act of 2022 that is meant to reduce inflation provides several federal tax credits and deductions that empowers American citizens to modify their homes to be more energy-efficient and help reduce energy costs and also demand, as the transition towards cleaner energy sources is made. They are available through 2032, being able to cumulate up to 3200 dollars annually to improve homes by 30%. By improvements, they refer to the installation of heat pump

water heaters, doors and windows, insulation, heat pumps, as well as home energy audits and electrical panel enhancements. [32]

- **Honoring Farmworkers –** when buying anything from a grocery store, perusing the aisles gracefully, most of us do not think about the provenience of those vegetables or fruits that we take in our shopping session. According to EPA's official website: "*When reaching for a banana to put in our breakfast, do we think about how many hours of labor went into picking the whole lot? Do we take into consideration the risks faced by the workers who pick it? How about the climate conditions for that specific day when our favorite ripe strawberries were harvested?"* When shopping for anything food-related, it is very easy to forget that, for us to be able to buy them easily in the first place, someone has to do the hard work of retrieving them from the field. In other words, the food on our plate does not appear by magic. That being said, farmworkers have a vital part to play for our wellbeing, also having a great impact in our economic, social, and environmental systems. And so, the health of the former is of the same importance for our livelihoods. So, to protect them, first of all, EPA ensures safety when it comes to pesticides interaction, by setting the **WPS** (Worker Protection Standard) in the agricultural environment. Those standards were established to provide a limitation regarding the risk of using pesticides, which can expose farmers to poisoning. Farmers undertake an annual pesticide safety training, developed to decrease pesticide exposure. Second of all, EPA offers complementary programs meant to empower farmworkers. In 2020, EPA funded a program that created specifically constructed trainings for the workers in Guam and the Pacific Islands. [33]
- **Climate Change Recommendations** – EPA is of the opinion that the most efficient way to reduce waste is to prevent the generation of it. It is like the old saying: "*You must not clean if you do not make dirty, in the first place."*. So, it gives out some recommendations to follow and practice three main R's (reduce, reuse, recycle). First of all, all the consumers must think green before they shop for anything, therefore reducing associated greenhouse gas emissions. A specific product's durability, sustainability and ease of recycling must be taken into consideration. Second of all, consumers can reduce the food waste by buying only what they need, donating unused food to food banks or shelters, or by composting food scraps. Third of all, old items can be reused or repurposed (such as, grocery bags, old containers, old clothing). Buying used items can also be a way to reduce waste as well as the new emissions generated by designing and producing new materials. Also, by donating their own used items, users can make sure that others can make use of them, too. Buying items made by recycling other items can promote reuse and stop the producing of new items in the market. Before throwing or disposing any product, consumers should consult the local area recycling program, to see if the latter collect them and encourages the right way of recycling. And, finally, consumers should learn the things that they can do, according to their local environment and their conjuncture. For example, students can learn to package their home-brought lunch in reusable containers, or office workers can save documents into the hard drive or email them to save the paper used to print hard copies of them. [34]

3 Future perspectives

3.1 Digitalization and the circular economy

The market of ICT is vast and incorporates a collection of proven and established circular economy paradigms. And so, different ways co-exist in the market to bring the value inherent in circular business models to a maximum. By "inherent value", the circular economy system refers to one of the following: maintenance, durability and reliability, warranty

plans, upgrading, reuse, hardware, and software updates, etc.

Products are designed and constructed to be used. Usually, a component of a product or a product itself needs to be repaired at least once in its lifetime. Therefore, I can conclude that the main objective of manufacturers is to design in such a way that the probability of the product to never be repaired tends to one. But this can also come at the expense of the repairing process being more difficult, so the former must also provide reliable, convenient, and cost-efficient solutions. Digitalization can help introduce longevity, reliability, and durability through a series of practices:

at first, integrated designs of devices bring to the table reduced exposure to humidity and dust, and increased structural integrity and rigidity, each of them having its contribution towards longer lifetimes. Second of all, better software support ensures the longer usage of older generation devices, without security breaches or data loss. This decreases the necessity to upgrade to new hardware (as an example, physical storage is slowly replaced by cloud storage, making the persistence possibilities a lot richer than before). Finally, water proofing guarantees that devices will not need to be repaired in case of an accidental drop into the sink, rain, or other similar activities and events.

When it comes to the efficiency of the repair services, companies prefer to form service points configured in networks, and to implement multiple solutions in the logistics field, including online ones. Why? Because repairs conducted on a bigger level has its advantages: maximizes safety, quality, productivity and introduces distributed learning (manufactures can find precious information about the defects of a products through a myriad of experiences from the field). In other words, companies can offer better designed repair services at better and more competitive prices. [35]

Digitalization is responsible with enabling circular solutions quite frequently. In fact, the former can be the spark to the creation of such solutions, in the first place. Digital innovation and the circular economy principles are correlated positively, but the former does not seem to play a very big role for the second. It is a vital part of approximatively 30% of all the identified innovations. Roughly put, it is most used to connect partners, devices, partners, and customers, but in isolated area of the whole value chain. By using streams, it enables the efficient use of data, which in turn is used to design and implement circularity.

As a consequence, individual companies have a major opportunity to rethink their future, strategy, value chain, value creation, the pricing, the operations, and so on. There are ten types of innovation frameworks which companies can seize and enhance their operations: process, product system, channel, customer engagement, brand, service, network, profit model, product performance, and structure. [36]

3.2 AI and the circular economy

In the recent 150+ years, the human race has shown impressive progress regarding the development of an industrial economy that has brought to the table prosperity never seen before. This collective effort had the result of gradual improvement over the years, the latter being supported by the newest technologies. Nonetheless, the need of a change in the system appeared; a change that promotes the sustain of vertiginous growth in the global middle class without being overburdened by negative social and environmental effects.

As it was stated early in this paper, a circular economic system can provide a solution, because it decouples the consumption of the finite resources from growth. The benefits are visible, as it is predicted that CE can create a net benefit in Europe of approximatively 1.8 trillion EUR by the year of 2030, while tackling many challenges that can appear along the way, such as the need of jobs, a need to spur innovation, and environmental improvements. New technologies, which offer more agile learning processes with multiple cycles of prototyping, designing, and collecting feedback, are needed to empower some aspects of the economy.

One such technology is represented by AI (artificial intelligence), that can be a vital pillar in this systemic transition or shift. AI is a collection of sub technologies that can be an adjuvant in enabling the newly arising "Fourth Industrial Revolution" eve, which is occupied with emulating systems and models that perform functions similar to how a human does them (for example, continuous learning as the data accumulates, or reasoning based on experience), but also expanding them when necessary. This result in faster responses when faced with complexity, reliability when faced with tedious tasks, and, of course, continuous, autonomous, and faster learning processes.

In short, AI can improve and enable circularity among many industries in three principal ways:

- **by optimizing circular infrastructure** – AI can help in building logistics infrastructure needed to enable the power of circling longer ("close the loop") for specific products and materials, as well as enhancing some of the circular processes (recycling, remanufacturing, reusing etc.)
- **by introducing a circular design process** – this is done through iterative machine-learning assistance
- **by helping to operate circular business models** – it can better strength of circular business models (such as leasing and PaaS)

First of all, the potential value promised by Artificial Intelligence in helping reduce waste in the food industry is somewhere up to 130 billion USD a year in 2030. This is done through processing, farming, and consumption opportunities, at different stages. As an example, we can use the image recognition algorithms to determine whether some fruit is ready to pick or not, or we can use other techniques to match the food supply and demand more effectively.

Second of all, the consumer electronics area can benefit from this transition as well, the potential value being around 90 billion USD a year in 2030. This is done through predictive maintenance, which can extend the lifetime of products, through automating e-waste recycling infrastructure (by combining some AI technologies – image recognition and robotics).

If we take a look at both sectors, some similarities can be observed: the value unlocked is not industry-specific, and, by harnessing the power of this technology correctly, we can fundamentally reshape the economy into a more regenerative and resilient one. But to do that, we must ensure that strong collaboration between stakeholders is exercised, as we must make sure that the implementation is inclusive and fair to all the involved parts. [37]

4 Conclusions

First and foremost, based on the specialty literature studied and reviewed, I can conclude that the concept of circular economy can be expressed as an approach implemented to reduce waste, leakage, and emissions by closing the loops of different products and materials, thus maximizing the number of cycles a resource is spending into the system (in its main or derivative forms). This, of course, is achieved because of the three main ideas CE is focusing on (preservation of natural capital, minimization of waste, and longevity), as well as the four 'powers' it has and that were explained above (all are related to the circular way in which elements are supposed to traverse the economic system). The transition from a linear model was not taken into consideration until pressure started to be felt, pressure that came in the form of improved existing regulations, new regulations, risks, environmental changes (urbanization), and technological evolution. Furthermore, another important factor that influenced the transition was the myriad of benefits provided by this new approach, because it forced actors to think in systems and accept diversity rather than sticking to a single path and it brought innovation and facilitated job creation. This can also be seen in the table that presents potential opportunities among different sectors in the economy, some of them being already high, and some of them increasing as we speak.

And so, different regions of the world became more attentive and acted for this matter by

promulgating different laws and giving incentives to different sectors of activity.

One relevant example is represented by the European Union, which, through its programme entitled **The Green Deal**, that was voted din 2020. It incorporates a series of strategies that are thought to facilitate the circular injection and, for existing European states, the transition of it. Among many, the strategies affect areas like forests, taxes, current laws, packaging, pollution, and farming. The goals are planned to be extended to incorporate other areas, including energy, transport, and food.

Another environmental systemic regulator is located in the cross-Atlantic counterpart, the United States of America: **EPA**, the Environmental Protection Agency. In collaboration with the government, third parties across the country, and also international allies, they imposed a series of rules and offered incentives to reduce the risk environmental factors and to promote a green point of view. The focus was especially set on drinking water, climate change, helping the farmers, and giving recommendations to and teaching the consumers green principles, the main idea being that that the later can help themselves by influencing the environment directly.

Finally, as technology is in a continuous evolution, digitalization is beginning to influence more and more how circular practices are being designed and implemented. Consequently, in the last section of the paper, I have presented some of them and how the booming subject of artificial intelligence is beginning to have its interferences here.

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