THE AGRI-FOOD CIRCULAR ECONOMY E-BOOK

University of Bologna
Department of the Arts - DAR (advisory partner)

*** 1st draft version ***

This version: April 2021

Table of Contents

Introduction

Circular economy is increasingly recognised as a new economic paradigm, industrial, or business model, as opposed to the traditional linear *open-ended* economy model (Millar et al. 2019). In the last decade, it gained prominence as it is expected to be instrumental to harmonious and sustainable development, becoming of great interest to scholars, policymakers and entrepreneurs for its social and economic implications (European Commission 2015, 2019b; European Union 2018; Ghisellini et al. 2016; WHO 2018).

The current concept of circular economy has multidisciplinary roots and, accordingly, no unique definition. Environmental and climate issues related to the outflow of resources, efficiency and, in general, to the development of a greener and sustainable economy, rationalise and inspire this new approach to economic development. Generally, there is common agreement in recognising it as the result of different approaches to a common problem consisting in the reduction, reuse and recycle of resources. Such aspects are at the core of the European agenda for sustainable growth, as set out by the first Circular Economy Action Plan in 2015 and underlined recently by the 2020 version, that constitute one of the main blocks of the European Green Deal of the European Commission (2019b).[1] [2] In addition, moving toward a circular, less wasteful, efficient and sustainable system is a common objective under different international agreements as the Paris Agreement, the Convention on Biological Diversity, and the United Nations Convention to Combat Desertification, while ensuring sustainable consumption and production patterns is also part of the current 2030 Agenda for Sustainable Development of United Nations (Goal 12).[3]

Adopting a circular model implicate an efficient use of resources that would lead to boosting economic growth through different channels as the creation of new employment, enhanced innovation and the reduction of material costs and externalities, with a multiplier effect in the economy (EC 2018; EMF 2013a, 2013b; EMF et al. 2015). At micro level, the gains include, among the other things, an improved efficiency on the use of resources through savings in net material costs, the low volatility in prices of resources, enhanced competitiveness and technological progress and new business opportunities (EMF 2013a, 2013b).

Enhancing the capacity of Small and Medium-sized Enterprises (SMEs) to implement new models of production, and contribute to sustainable growth, is of crucial interest to the European Commission as they represent about 99% of all business sectors in the European Union (EU).[4] According to the recent figures, SMEs contributed to the creation of around 85% of new jobs and provided two-thirds of the total private sector employment in 2015 in the EU.[5] However, although Europe's economy is grounded on SMEs, the principles of circular economy are already applied by many large industries, while SMEs

---

[1] https://ec.europa.eu/commission/presscorner/detail/en/ip_20_420 .

[2] The European Green Deal sets out how to make Europe the first climate-neutral continent by 2050, boosting the economy, improving people's health and quality of life, caring for nature, and leaving no one behind. https://ec.europa.eu/commission/presscorner/detail/e%20n/ip_19_6691

[3] Refer to the following links for detailed information on Goal 12 and on SDGs Goals https://sdgs.un.org/goals ; https://sdgs.un.org/goals/goal12 .

[4] A detailed list of the current policy and current actions designed by the European Commission are available at the following link: https://ec.europa.eu/growth/smes_en .

[5] For recent statistics refer to: https://ec.europa.eu/eurostat/statistics-explained .

still remain uninvolved due to lack of capacity and support (European Commission 2020b, p.37; KPMG 2019, p.7). In addition, economic and demographic trends brought new challenges concerning the availability of resources and the rising demand for goods, while Covid-19 pandemic triggered a severe recession with unprecedented socio-economic repercussions, highlighting the vulnerability of the global economy and the need for global action. Accordingly, such transformations entail a global institutional commitment to reconsider food production, manufacturing, distribution and consumption, enhancing the efficiency of the entire supply chain and combining environmental, economic and social objectives.
Against this background, the improvements of regional policies targeted to SMEs transition to circular economy models are critical to the European Agenda, especially considering their potential role in promoting new employment and mitigating the economic uncertainty of Covid-19 pandemic. Building on previous *Interreg Europe* experiences, the SinCE-AFC project aims at improving policies in the field of regional innovation strategies by facilitating horizontal mechanisms that support and enhance SMEs entrepreneurship in the Agri-Food sector through the exploitation of circular economy opportunities. Furthermore, the project will promote innovation, derive knowledge and develop cooperation.
The main goal of this study is to provide an overview of circular economy, outlining the European regulatory framework, analysing the transition path, and illustrating the collected good practices at regional level. In particular, the first section deals with theoretical aspects introducing the concept and its limitations, and the agri-food sector context; the second section presents the regulatory framework and the recent developments in the EU; the third section reviews the recent research to identify and illustrate factors encouraging (or hindering) the transition. It elaborates also on the results of a survey carried out by project partners in seven countries; the fourth section mainly aims at monitoring the circular economy progress across EU deepening with the agri-food sector, while the following presents a systematisation of the good practices collected in each country. Finally, the last section briefly recaps and concludes with policy recommendations.

Covid-19 background

Since the first outbreak, Covid-19 has soon revealed its potential disruptive effect. First identified in China in late 2019, the virus rapidly circulated worldwide generating an unprecedented health crisis with heavy human toll for several countries. Accordingly, economic and social repercussions of becoming pandemic soon occurred at global level, accentuating the case for a global, rather than an international, development paradigm (Oldekop et al. 2020).
While the pandemic is predicted to radically alter the trajectory of global CO2 emissions, about 7% below 2019 level in 2020 (Le Quéré et al. 2021), the global economy faces an equally sharp slowdown. According to the World Bank Global Economic Prospects, the pandemic is expected to trigger the deepest global recession since World War II, with GDP contracting by 5.2% in 2020 (World Bank 2021). Although global output is expected to expand 4% in 2021 due to ongoing vaccination campaigns and governmental financial support, it remains well below pre-pandemic projections. In addition, Covid-19 further exacerbated economic inequality, with growing concerns for vulnerable countries. Under the latest scenario on global poverty, the pandemic is expected to generate an additional share of 119 million to

124 million people into extreme poverty in 2020, revising upwards October 2020 forecast (World Bank 2021). Previous estimated share of new poor was between 88 and 115 million.[6] [7]

Significant disruptions in Global Value Chains (GVCs) emphasised the fragility of a system built on a high interdependency between leading firms and suppliers, exposing countries to serious supply shortages of intermediate and final goods. Generally, a symmetric shock from both demand and supply side has characterised the Covid-19 impact. The transmission channel of the impact is a combined result of endogenous changes and government decisions, in a global structure of economic spillovers. The demand side has been affected by different aspects including losses of income, lay-offs, unemployment, and quarantines restrictions on mobility. In addition, a generalized uncertainty for the future might have affected individual and households' consumption, and firms' investments. On the supply side, the spread of the virus reduced labour productivity and the supply, and triggered protectionist and nationalist policies, while the different restrictions imposed on mobility and business activities inhibited the supply of goods and services.

Regarding the Agri-Food sector and the related supply chains, the United Nations and FAO agency raised the question of global food emergency and called for a transformation of food systems, also to continue supporting the transition to a greener and sustainable future. Significant reduction of demand from developed countries, with falling revenues from commodity exports and reduced remittances, together with climate change crises and pandemic restrictions, endanger food security and livelihoods of specific areas in African and Asian countries.[8]

In general, regardless of the significant increase in demand at the onset of Covid-19 and the initial challenge for easy access to food, Covid impact on food production is about the reduced production and the implications for food availability and prices. However, production and demand largely vary across countries and commodities. In the EU, despite the crisis, the Agri-Food trade slightly increased in 2020 compared to the previous year. In the first semester the value of Agri-Food exports reached 90.2 billion euro (about 3% increase), while the value of imports increased to 62.7 billion euro (a rise of nearly 2.5%), compared to the same period in 2019. Overall, according to the FAO (2020), "food markets will face many more months of uncertainty due to Covid-19, but the Agri-Food sector is likely to show more resilience to the pandemic crisis than other sectors".

However, Covid-19 pandemic is a global problem calling for a global response. In the EU, unprecedented economic and social repercussions by Covid-19 required a proportionate and joint policy initiative for the recovery. Despite the different unilateral reactions to the pandemic, and the contrasting visions among member states on the future recovery plan, European Council in July 2020 agreed to issue European sovereign bonds (750 billion euro) to support countries hit by the pandemic. This temporary recovery instrument (referred to as "Next Generation EU") combined with the EU 2021-2027 long-term budget (about 1.074 trillion euro) constitutes the multiannual strategy of the EU to address the crisis and unforeseen needs.[9] Against this background, as declared by European Commission (2020d), "the twin

---

[6] The number of COVID-19-induced new poor is calculated as the difference between poverty projected with the pandemic and poverty projected without the pandemic. https://blogs.worldbank.org/opendata/updated .

[7] This is equivalent to living on less than $1.90 a day.

[8] On the Covid-19 impact on food and agriculture see the Q&A online section from FAO http://www.fao.org/2019-ncov/q-and-a/impact-on-food-and-agriculture/en/

[9] For further details on the financial breakdown of the recovery plan refer to: https://ec.europa.eu/info/strategy/recovery-plan-europe_en

transitions to a green and digital Europe remain the defining challenges of this generation". Investments in renewable and clean energies, clean transport, sustainable food and a smart circular economy thus remain a great opportunity to get Europe's economy growing, and "Next Generation EU will give the EU budget the additional firepower necessary to respond decisively to the most urgent challenges".

1. Circular economy: General overview and the Agri-food perspective

Since 1970, the annual demand on resources is exceeding at a growing rate Earth's biocapacity going into a global "ecological overshoot". This means that demand exceeds the regenerative capacity of the Earth, using more than our planet can produce. According to the latest estimates of the Global Footprint Network, we would require 1.6 planet Earths to meet the current demand of natural resources. In other words, it now takes the Earth one year and eight months to regenerate what we use in a year (slightly less than previous years due to Covid-19 pandemic). Currently, more than 80% of the world's population live in countries that are running ecological deficits.[10]

Such evident limitations call for a new global sustainable development model, to keep us within the *safe operating space* of our planet, without compromising future prosperity: "we need a different economic structure, suitable for a world that must respect its own ecological limits" (Jackson 2016, p.194). According to the ecological economist Daly (1991), "... the necessary change of vision consists in representing macroeconomics as an open subsystem of an unlimited natural ecosystem (the environment), rather than as an isolated circular flow of value and abstract exchange, not bound by mass balances, entropy and exhaustibility" (in Jackson 2016, p.194). This new "ecological macroeconomics" must be "aware of social and ecological demands and put an end to the absurd separation between economy, society and environment" dealing with the concrete material flows underlying the financial ones" (Jackson 2016, p. 215). The first step towards the transition is thus to consider the material throughput, reconnecting it to those ecological processes that sustain life from ever. This is the core of the "Circular Economy", a concept gaining increasing relevance within the broad areas of green economy and sustainable development (Loiseau et al., 2016).

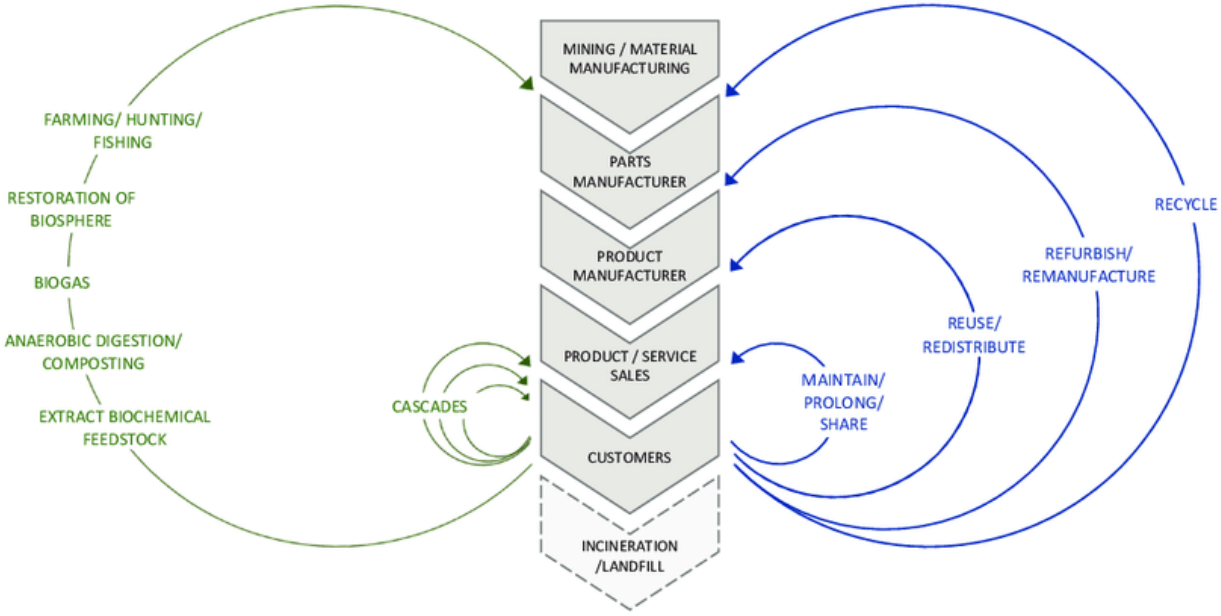
The basic underlying concept of circular economy (CE, hereafter), that is the creation of a "circular" or "close-loop" system, is commonly associated in the literature with the seminal work of the ecological economist Boulding (1966), that proposed the idea of Earth as a closed system with "limited assimilative capacity and as such the economy and environment must coexist in equilibrium" (see Millar et al. 2019). Pearce and Turner (1989) further extended the concept explaining the shift from an open-ended to a circular system building on Boulding's idea (1966) to integrate environmental, social and economic dimensions.

Ellen MacArthur Foundation (EMF 2013a, p.7) defines it as an "industrial system that is restorative or regenerative by intention and design. It replaces the 'end-of-life' concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models". This kind of economy "aims to keep products, components, and materials at their

[10] See https://www.footprintnetwork.org/ and https://www.footprintnetwork.org/our-work/ecological-footprint/ .

highest utility and value at all times, distinguishing between technical and biological cycles" (EMF 2015, Introduction). It is a way "to redefine growth, focusing on positive society-wide benefits. It entails gradually decoupling economic activity from the consumption of finite resources and designing waste out of the system. Underpinned by a transition to renewable energy sources, the circular model builds economic, natural, and social capital. It is based on three principles: 1) design out waste and pollution; 2) keep products and materials in use; 3) regenerate natural systems".[11] Figure 1 below illustrates a simplified system diagram for CE with a continuous flow of both materials, the technical and biological ones, through the "value circle".

Figure 1 - Circular Economy system diagram



Notes: adapted version based on McDonough & Braungart from Ellen MacArthur Foundation (2012) in Guldmann (2019).

More recently, Korhonen et al. (2018a) proposed the following wider definition: "Circular economy is an economy constructed from societal production-consumption systems that maximises the service produced from the linear nature-society-nature material and energy throughput flow. This is done by using cyclical materials flows, renewable energy sources and cascading-type energy flows. Successful circular economy contributes to all the three dimensions of sustainable development. Circular economy limits the throughput flow to a level that nature tolerates and utilises ecosystem cycles in economic cycles by respecting their natural reproduction rates" (p. 39). However, in a different article the author admits that CE remains a "substantially contested concept" (Korhonen et al. 2018b), that is a concept on which "there is agreement on the means and goals […] but disagreements on how to define it" (p.545).
Indeed, CE is a multidisciplinary concept with deep rooted origins that can be traced back to different schools of thought from academia and entrepreneurship, that contributed to the elaboration of the

[11] www.ellenmacarthurfoundation.org .

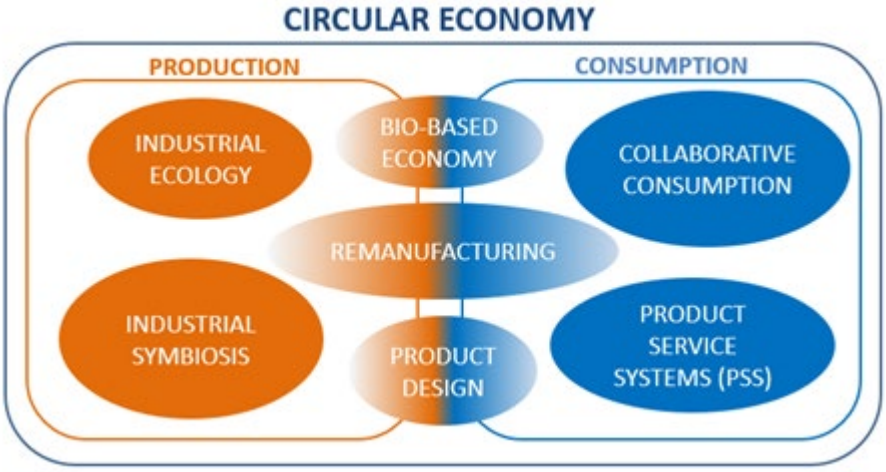
current one across the decades (see Ghisellini et al. 2016; EMF 2013b).[12] For the same reason, it may be also considered as "cluster concept" (Korhonen et al., 2018b), shaped or composed by several related concepts, such as, for instance, that one of "Industrial ecology", which suggests replacing the current industrial logic with something more similar to the "ecosystemic logic" of Nature. The term industrial ecology is specifically referred to as a more sustainable industry based on the use of cascade-type and renewable production cycles. A similar concept is "bio-based economy", in which bio-based production and consumption are strictly related to their capacity to be naturally and easily re-embedded into the natural cycle. Despite being often referred to the agri-food sector, it is also related to all kinds of biomasses, such as those getting from woods and forest or non-food aquaculture (such as, for instance, aquatic plants or algae productions).

Another important concept related to CE is that one of "industrial symbiosis", which is used about an increasing need for improving a positive relationship among different economic organisations, in order to promote collaboration, synergies and productive symbiosis along the same or different production chains (inter-organisational or inter-sectorial networks).

Moreover, in the CE the entire life cycle of a product needs to be considered, from production to consumption, and beyond. Therefore, specific attention to the design of products from "cradle-to-cradle" is also required, as well as the need to improve "product-service systems" (PSS). These latter are especially related, for instance, to the implementation of repair services, the availability of substituting elements, and to the improvement of "collaborative consumption" patterns (especially improving digital enabling systems).

Figure 2 below illustrates the different concepts and approaches to CE in a simplified production-consumption scheme.

Figure 2 - Different concepts and approaches to Circular Economy



Notes: authors' elaboration.

[12] The general concept has been mainly developed in the 1970s by the following schools of thought: "Regenerative Design" (Lyle 1994), "Performance Economy" (Stahel et al. 1981), "Cradle to Cradle" (McDonough and Braungart 2002), "Industrial Ecology" (Graedel and Allenby 1995), and "Biomimicry" (Benyus 2002).

Although all the above-mentioned concepts are shown as alternatively related to the production or consumption side (or both), they should not be considered as opposite or separated, but rather in terms of a desirable convergence.

1.1 Circular Economy in the Agri-Food Chain

Since at least the so-called "Green revolution", occurred during the final decade of the first half of the last century, agriculture is a great and largely mechanised industry, which uses a lot of chemicals, mechanical and energetic inputs to produce increasing amounts of food. At the same time, the manufacturing food-related industry and a large-scale organised distribution have grown too, as well as places and occasions of food consumption, determining a multiplication of intermediaries and a huge development of food-related economic activities. The whole set of these interrelated activities generally represents what is usually defined as Agri Food Chain (AFC, hereafter).

As mentioned in the introductory section, the main objective of the SinCE-AFC is to enhance the capacity of the SMEs of this sector to face the turn toward the CE practices. This is even more necessary because of the trade-off between an increasing world population, foreseeing to reach 9 billion people in 2050 (Brown, 2012), and the heavy ecological footprint of agriculture, accountable for the 24% of the whole GHG emissions (IPCC, 2014).

In this view, there is growing consensus about the fact the transition to a CE offers many opportunities for the entire agri-food system to become more resource-efficient, with positive food security implications (Jurgilevich et al. 2016; Núñez-Cacho et al. 2018). Indeed, the agri-food sector presents a major opportunity for the development of a CE (Muscio and Sisto 2020).

However, in order to provide useful items to its comprehension, a broad definition of the Agri Food activities is primarily required. Defining the exact boundaries is not an easy task, especially in relation with the CE activities potentially involved in. Food and Agricultural Organizations of United Nations (FAO) simply defines AFC as "the linked events in the agricultural production of food [...], from production to processing, trading, distribution and consumption. Literally "*from field to fork*". However, when analysing CE practices, it is necessary to also consider pre-production processes, as the planning-related ones, and the post-consumption processes, especially those related to food waste.

According to the NACE classification ("nomenclature statistique des activités économiques dans la Communauté européenne"), the industry standard classification system used in the European Union,[13] a general identification of the Agri Food chain includes the following two broad Sections:

- "Agriculture, forestry and fishing" (Section A), identifying the primary production sector, which includes "the exploitation of vegetal and animal natural resources, comprising the activities of growing of crops, raising and breeding of animals, harvesting of timber and other plants, animals or animal products from a farm or their natural habitats";

[13] For further details, refer to the tables in Appendix.

- "Manufacturing" activities (Section C) related to food transformation, distinguishing between "finished" outputs, ready for utilisation or consumption, and "semi-finished" ones, to be used as inputs for further manufacturing.[14]

In addition, a number of activities involved in the larger agri-food sector include food marketing, trade and transportation, as well as food preparation, part of the following NACE Sections:

- "Wholesale and retail trade" (Section G), which includes "the usual operations (or manipulations) associated with trade, for example sorting, grading and assembling of goods, mixing (blending) of goods (for example sand), bottling (with or without preceding bottle cleaning), packing, breaking bulk and repacking for distribution in smaller lots, storage (whether or not frozen or chilled)".
- "Transportation and storage" (Section H), including "the provision of passenger or freight transport, whether scheduled or not, by rail, pipeline, road, water or air and associated activities such as terminal and parking facilities, cargo handling, storage, etc. In this section is also included the rental of transport equipment with a driver or operator and the postal and courier activities."
- "Accomodation and food service activities" (Section I), which includes "the provision of short-stay accommodation for visitors and other travellers and the provision of complete meals and drinks fit for immediate consumption".

Therefore, in addition to the agricultural sector in the narrow sense, non-farm sectors (such as transformation and packaging), and all economic (and non-economic) food-related activities and services can be included in the definition of the AFC and should be considered as involved in the development of the CE practices related to the production and management of the biomasses.

Indeed, considering the already discussed concepts and approaches related to CE, firstly we can notice that the agri-food sector especially concerns the "left-side" of the Ellen MacArtur "butterfly scheme" (see Fig. 1), which is directly associated to the concept of bioeconomy, namely the part of economy directly involved in the production and management of the biomasses.

In the EU, the total supply of biomass amounts to more than 1.2 billion tonnes of dry matter (tdm). Agriculture is the biggest supply sector with a value of approximately 927 million tonnes of dry vegetal biomass equivalents (68% of total biomasses), followed by forestry (with 32% of the dry matter content). The fishery sector is instead quite small (less than 1%). Within the agriculture sector, "Feed and food" represent the most important category (68% of the total agricultural biomass supply and the 47-60% of the entire amount of European biomass), while other uses are instead especially dedicated to biomaterials (18-22%) and bioenergy production (from 18-21%).[15]

In general, CE business models fall in two main groups: those that foster reuse and extending the service life through repair, remanufacture, upgrades and retrofits; and those that turn old goods into as-new

[14] However, it is worth noting that the recovery of waste, i.e. the processing of waste into secondary raw materials, is not considered part of manufacturing activities. The primary purpose of these activities is considered to be the treatment or processing of waste and they are therefore classified in "Water supply; sewerage, waste management and remediation activities" (Section E). Conversely, the manufacture of new final products (as opposed to secondary raw materials) is classified in manufacturing, even if these processes use waste as an input.

[15] Data are underestimated because of the lack of available data. For instance, they do not consider biogas and bioelectricity production (Gurría et al. 2020).

resources through recycling the materials (Muscio, Sisto 2020). In the food sector the short life of edible goods is an avoidable limit for extending their life span. However, it is possible of course to improve transformation processes of by-products and, for instance, recovering edible food from retailers, canteens and restaurants in order to limit food waste.

This last theme is very important and greatly taken into consideration in the EU policies. Indeed, almost one-third of the biomasses dedicated to food uses - which corresponds to 1.3 billion tons of edible food products - are losses and wasted worldwide throughout the whole AFC (HLPE 2014), 88 million tons each year only in the EU countries.

Therefore, food losses and waste (FLW) represent an important part of the CE approach to the AFC: improving CE in the AFC allows to reduce the trade-off between the increasing need for food security and the great part of food lost or wasted worldwide. Indeed, facing increasing world population and social inequalities, FLW still remains a critical economic, ethical, social and environmental issue. The economic costs of FLW are equal to the GDP of entire countries such as Switzerland, while almost "a billion people in the world go to sleep still hungry every night".[16] Moreover, as already argued, agriculture is still accountable for a large part of the GHG emission and the enormous amount of food daily wasted represents wastage of additional resources that has been largely used to produce it, such as energy, soil and water. The carbon footprint relating to the phenomenon is huge: close to that of the entire industry of industrialised countries such as the USA or China and the water footprint is equivalent to the annual flow rate of a river such as Volga (HLPE 2014).

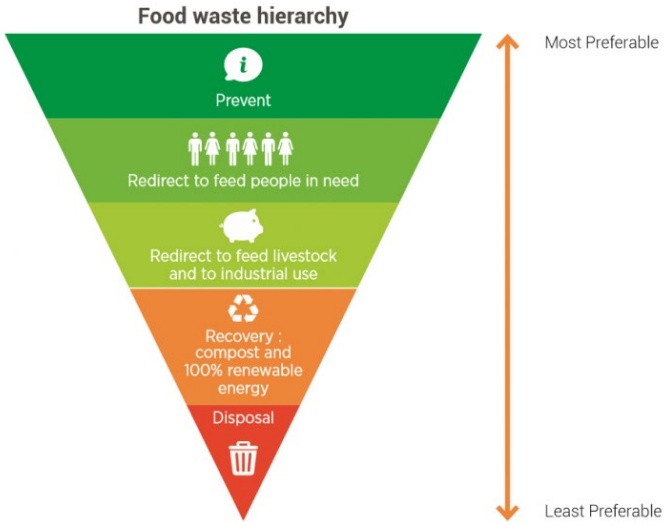
In the EU, FLW mostly occurred at household consumption (53%) and at processing, food services and distribution levels (36%), because of structural and cultural reasons. Indeed, throwing away food is often more convenient than preventing waste or reuse it, but the lack of knowledge and awareness, wastage habits, and the high aesthetic standards of the current consumption societies are also implied (Stenmarck et al., 2016).

However, it is necessary to highlight that there is no accordance and univocal definition of food waste, therefore also the estimation of it may change in different situations or for different countries. Generally speaking, it is possible to define FLW as "a decrease, at all stages of the food chain from harvest to consumption, in mass, of food that was originally intended for human consumption, regardless of the cause" (HLPE 2014 p. 11).

The discriminant is thus the early purpose of human feeding, excluding from the count all those crops explicitly produced for other aims, such as animal feeding, biofuel or energy production (even if these uses still remain rivals with respect to human feeding).

[16] Barilla Center for Food and Nutrition 2012 https://www.barillacfn.com/m/publications/spreco-alimentare-cause-impatti-proposte.pdf

Figure 3 - The food waste pyramid



Notes: *source:eurofoodbank.org*.

According to the so-called "food waste hierarchy" (Fig. 3), FLW must be primarily prevented wherever possible throughout the entire AFC, preferring redistribution to people (if still edible), for instance donating food surplus to charitable organisations or, just as a second option, its transformation in animal feeds. Supplementary uses, such as energy production or composting, must be considered as residuals. This residual amount of biomasses available for secondary uses is the most important for the implementation of the CE in the AFC[17]. These residual biomasses that come from the AFC, such as by-products and non-ate food, might be thus valorised in several ways within renewed production cycles.

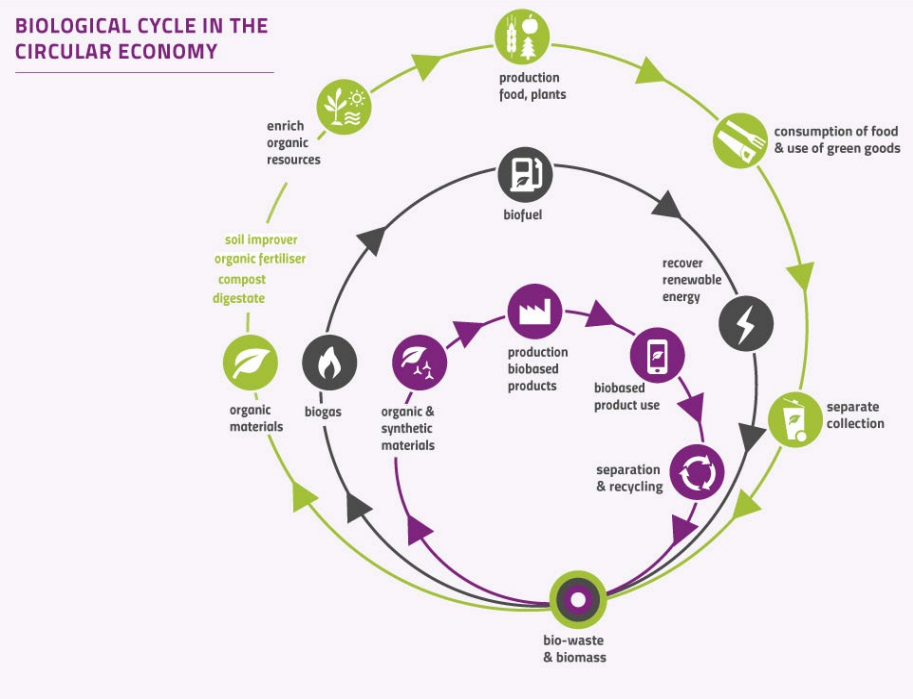
In the past, for example, residual food waste and agricultural by-products were always used as animal feeding or fertilisers, while nowadays bio-based fertilisers are widely used just in organic farming, which is primarily based on the caring of the natural organic nutrients share of soil (*humus*). However, organic farming is rapidly growing, especially in EU countries (Willer et al. 2020), driven by pull and push factors such as consumers' demand and institutional incentives. These latter are especially provided in the EU by the Common Agricultural Policy (CAP), which is aimed to promote a turn towards agroecology in all the countries of the Union (see section 2.1.1).

Residual biomasses from the agricultural sector are also used to obtain renewable energy, for instance, by industrial digestion processes, or as "secondary raw material" for renewed productions in different industrial sectors (e.g. natural fibers for textile industries obtained by milk or orange peels). These uses are also strongly encouraged by EU policies: currently, the largest share of renewable energy in the EU comes from biomasses (European commission, 2018), while industrial symbiosis implementation is strongly limited by financial, knowledge-related, organisational and cultural factors, such as, for instance, the limited investment capacity of SME in R&D, difficulties in the replicability of good practices, and inability to improve inter-organisational relationships (see section 3.1).

[17] An explicit reference to waste hierarchy and the need to implement food donations are included, for instance, in the revised Waste Framework Directive, adopted by the EU on 30 May 2018; while the Communication on Circular Economy calls on the Commission to elaborate a common EU methodology to measure food waste.

Moreover, the concept of product design is also applicable to AFC at different levels: from seeding - e.g. planning it to reduce food losses - to food packaging, redesign it to limit plastics or to make recycling easier. A general scheme of the potential circular processes in the bioeconomy is reported below (Fig. 4).

Figure 4 - The biological cycle in the CE



Notes: Source: European Compost Network .

Finally, consumer awareness should be also increased, providing them more information to prevent food waste (e.g. adapting portions to their needs), to better separate garbage or improving tools such as sustainable labelling schemes, to help them to better choosing recycled products or ones which are designed to be easily recycled, as well as promoting collaborative consumption. Especially thanks to the development of digital technology, indeed, nowadays the food supply chain could be "extended" beyond the grocery stores and the mere purchasing moment, allowing us to improve, for instance, the *peer-to-peer* exchange of edible food or to donate it to no-profit organisations (Spillare *et al.* 2019).

Therefore, considering the discussion above, is thus possible to affirm that implementing CE in the AFC basically means planning and improving an efficient use of resources (water, energy, raw materials, etc.) in a close loop that considers the use of biomasses and related nutrients, from the fields to the fork, even including the need to prevent food losses and wastage (FLW) at each stage of the AFC, wherever possible.

Table 1 illustrates some data related to CE in European countries, with a specific focus on the SinCE-AFC country partners. In particular, it shows 1) the circular material use rate, that is the percentage of total material uses (not only biomasses);[18] 2) the "Private investments, jobs and value added related to

[18] The indicator measures the share of material recovered and fed back into the economy - thus saving extraction of primary raw materials - in overall material use. The circular material use, also known as circularity rate, is defined as the ratio of the circular use of materials to the overall material use (*ec.europa.eu/eurostat*).

CE";[19] 3) the Total biomasses available" and 4) those "used for food purposes"; 5) the per capita share of recycled biowaste.[20]

Table 1 - CE in EU and in the SinCE-AFC country partners

CE-RELATED DIMENSIONS	COUNTRIES							
	EU(27)	BG	IE	EL	IT	HU	PL	RO
Circular material use rate* (% per year)	11,9	2,4	1,6	4,2	19,3	6,8	9,8	1,5
Private investments, jobs and gross value added related to circular economy sectors* (mln euro per year)	125.766	636,9	-	644,8	18.632,9	1.224,8	5.199,7	1.485,2
Total biomass vailable** (net trade, import+production: 1000 T of dry matter)	1.217.369	27808	16887	25009	121725	34100	94751	76265
Biomasses used for food purpouses** (feed & bedding + plant-based food supply: 1000 Tdm)	125.766	8906	15010	11432	77331	18095	70092	25495
Recycling of biowaste* (Kg per capita/year)	87	43	50	26	105	36	30	12

Notes: Eurostat (Last available data); ** Available in Gurrià et al. 2020.

A systematic approach to CE in the AFC is also proposed by the Ellen MacArthur Foundation, the Post Foundation and the McKinsey Center for Business and Environment (EMF et al. 2015). As illustrated in Table 2, it is especially based on the so-called "ReSOLVE framework", which highlights six major levers that seem especially promising.

Table 2 - ReSOLVE scheme for CE in the AFC

ReSOLVE	Levers for food sector	Short description
REGENERATE - Regenerate and restore natural capital	Restoration and preservation of natural capital.	Restoration of large, damaged ecosystems is commercially viable. The most famous example is probably the Loess plateau in China, where 1.5 million hectares of degraded land have been restored. This project lifted more than 2.5 million people out of poverty, almost tripling their income, by replacing low-value agricultural commodities with high-value products.
SHARE - Keep product loop speed low and maximise product utilisation	Peri-urban and urban farming	Interest in peri-urban and urban farming to meet the increasing demand for local, fresh, relatively unprocessed food is growing. Organising short supply chains between local farms and retailers or consumers in nearby cities reduces so-called food miles and related food transport waste.

[19] The indicator includes "Gross investment in tangible goods", "Number of persons employed" and "Value added at factor costs" in the following three sectors: the recycling sector, repair and reuse sector and rental and leasing sector (*ec.europa.eu/eurostat*).

[20] The indicator is indirectly measured as the ratio of composted/methanised municipal waste (in mass unit) over the total population (in number). The ratio is expressed in kg per capita. The underlying assumption is that, by and large, the only reasonable treatment of biowaste is composting or anaerobic digestion (*ec.europa.eu/eurostat*).

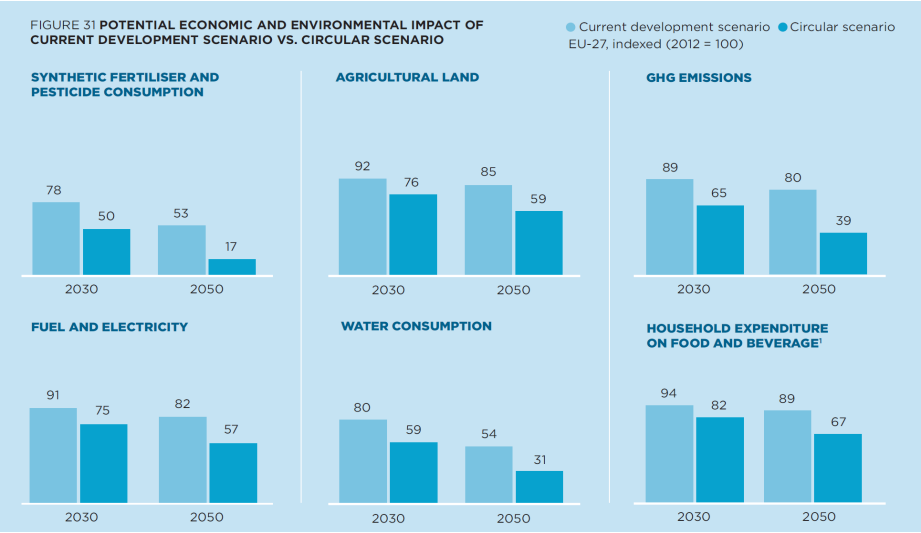
OPTIMISE - Optimise system performance	More resource-efficient agricultural practices.	IT and automation are positively disrupting farming practices by enabling precision agriculture – a whole-farm management approach that leverages IT, big data, remote sensing, and satellite positioning data. These technologies optimise returns on inputs while reducing environmental impact.
LOOP - Keep components and materials in closed loops and prioritise inner loops	Closed loops of nutrients and other materials.	The potential to extract valuable bio-chemicals or recover energy and nutrients from various waste streams is significant. For example, phosphorus recovered from sewage sludge, meat and bone meal, and biodegradable solid waste in the EU-27 amounts to almost 30 percent of today's use of synthetic phosphorus fertiliser. Recovery of energy and nutrients through digestion and composting is happening at a larger scale.
VIRTUALISE - Deliver utility virtually	Digital supply chains.	Digital supply chains could reduce food waste. To address the 20 percent of food wasted from farm to retail, players are leveraging big data and IT to take inventory management to the next level. Digital solutions, such as smart refrigerators, on-demand e-commerce delivery, and wearable monitors, also address the food waste caused by consumers.
EXCHANGE - Select resource input wisely	Regenerative farming practices.	Various sustainable and regenerative agricultural practices to preserve natural capital and optimise long-term yields are seeing growth. Organic farming is one of these examples. Other examples are agroforestry, holistic-planned grazing, silvopastoral systems, and pasture-based dairy systems with no/minimal fertiliser use.

Notes: authors' elaboration from EMF et al. 2015.

Given these six scopes the same report proposes a specific scenario in which "A development path predicated on circular principles and a system-based approach would create a regenerative, resilient, non-wasteful, and healthy food system". In this scenario "consumers would have ready access to fresh, high-quality food that would encourage healthier dietary choices" and "the nutrient loops would be closed" and natural capital preserved "by applying regenerative agricultural practices, minimising the need for synthetic fertilizers and pesticides". This kind of system would create a market for rehabilitating degraded land and fish stocks and the development of local-based "peri-urban farming and digital solutions would match supply and demand in an on-demand and less-wasteful supply chain" in which "consumers would have ready access to fresh, high-quality food that would encourage healthier dietary choice" (Ellen MacArthur Foundation et al. 2015, p. 75).

The realization of this CE and circular thinking scenario should realize a great reduction of the environmental impact of the AFC, restoring natural resources and gaining a healthier society (Figure 5).

Figure 5 - Confrontation of current development scenario and the circular one



Source: EMF et al. 2015

2. The Regulatory Policy Framework in EU

The magnitude of the environmental, economic, and social effects of the traditional industrial production system entailed a global political and institutional commitment. Since 2015, European Union (EU) is fully involved with such systemic change and set up a range of initiatives and significant financial resources (more than 10 billion euro) under a unique and comprehensive strategy for the period 2016-2020.

The first EU Circular Economy package was launched by European Commission in December 2015 with the aim of moving toward a circular economy model, covering the whole lifecycle: production, consumption, waste management and secondary raw materials. The package includes four legislative proposals on waste revising part of the previous related EU legislation: Waste Framework Directive; Landfill Directive; Packaging Directive; Directives on end-of-life vehicles, batteries and accumulators, and waste electrical and electronic equipment (WEEE) [21].

In addition, the package includes the first *Action Plan for the Circular Economy* (European Commission, 2015) aiming to "close the loop" by complementing the measures enclosed in the legislative proposals and to contribute to meeting the Goal 12 on sustainable consumption and production of the Sustainable Development Goals (SDGs) adopted in 2015 by United Nations. Such initiatives are complemented by each member state with national action plans for a circular economy.

The action plan supports circular economy targets in each step of the value chain with 54 key actions that operate from production to consumption, repair and remanufacturing, waste management, and secondary raw materials. On production side, measures to promote reparability, durability and recyclability of products, in addition to energy efficiency, are included in the *Ecodesign working plan* for 2015-2017, as well as the development of a guidance on best waste management and resource efficiency practices in industrial sectors in *Best available techniques Reference documents* (BREFs). On the consumption side, the aim is to provide better reliability, accuracy and clarity of information for consumers, ensure better enforcement of the rules in place, encourage reuse activities, support higher uptake of Green Public Procurement (GPP). In addition, the Commission aims at boosting the market for the use of secondary raw materials, developing new quality standards, revising previous Regulations, and proposing new actions to facilitate this process.

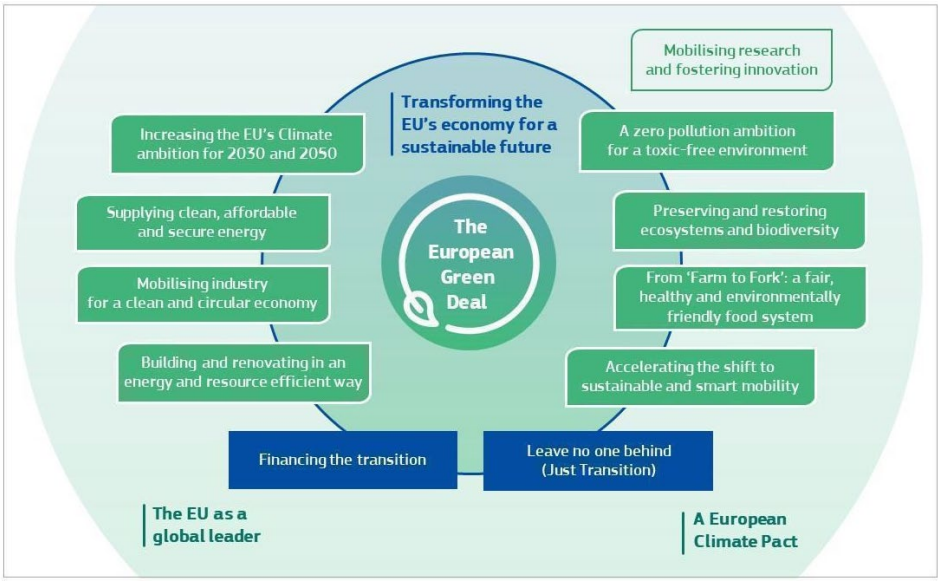
Finally, the plan indicates a number of priority areas that include sectors facing specific challenges, "because of the specificities of their products or value-chains, their environmental footprint or dependency on material from outside Europe", to be addressed in a targeted way. To this aim, initiatives includes: the adoption of a strategy on plastics, addressing issues of recyclability, biodegradability, the presence of hazardous substances in plastics; actions to reduce food waste, including a common EU measurement methodology, improved date marking, and tools to meet the SDG targets; guidance and dissemination of best practices and support for innovation in the bio-economy.

---

[21] Revised legislation includes the following legislative acts: Directive 2008/98/EC on waste; Council Directive 1999/31/EC on the landfill of waste; European Parliament and Council Directive 94/62/EC on packaging and packaging waste; Directive 2000/53/EC on end-of life vehicles; Directive 2006/66/EC on batteries and accumulators and waste batteries and accumulators and repealing Directive 91/157/EE; Directive 2012/19/EU on waste electrical and electronic equipment (WEEE).

The 54 actions under the first plan have been delivered and recently, in March 2020, the Commission has adopted the new CE Action Plan "for a cleaner and more competitive Europe" with the aim of accelerating the changes required by the European Green Deal, building on the results achieved with the actions of the first plan. Presented by the EU Commission in December 2019, the Green Deal is indeed the prominent road map to drive "the Union into a modern, resource-efficient and competitive economy" with the declared aim of transforming the whole of Europe into the first "zero-emission continent" by 2050. The plan forecasts an upcoming European Climate Law, in order to turn this political commitment into a legal obligation, and a so-called "Just Transition Mechanism", in order to leave "no one and no places behind", thus stressing on the need of a fair transition (see the targets illustrated in the Figure 6).

Figure 6 - The European Green Deal



Notes: from European Commission, 2019b, p.3.

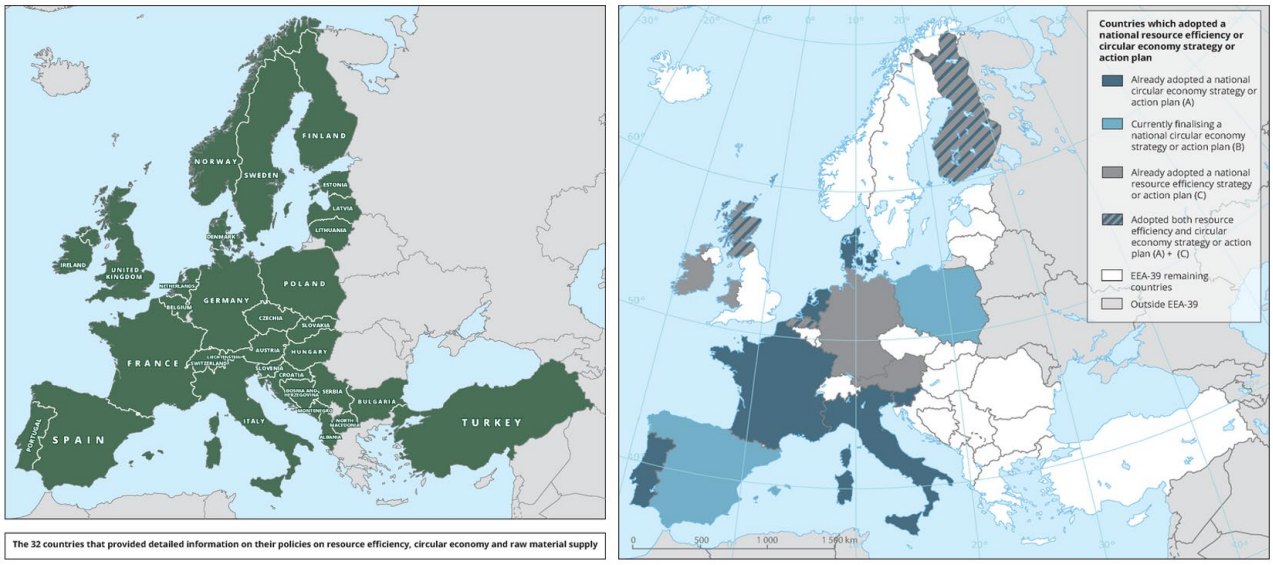
Within this frame the renewed CE Action Plan puts emphasis on the preventive actions to undertake in waste prevention and management, identifying food, water and nutrients as the main key product value chains in the promotion of circularity. In addition, the Plan stresses the importance of the food value chain in the resource and environmental issues, remarking how 20% of the total food produced in the EU is lost or wasted (European Commission, 2020a).

However, the overarching objective of moving toward a circular, less wasteful, efficient and sustainable system is a key contribution to the 2030 Agenda for Sustainable Development and other commonly agreed international targets under e.g., the Paris Agreement (within the United Nations Framework Convention on Climate Change), the Convention on Biological Diversity, and the United Nations Convention to Combat Desertification. In the new Action Plan, in order to identify knowledge and governance gaps in advancing a global strategy for circular economy and take forward partnership initiatives, the Commission proposes a "Global Circular Economy Alliance".[22] On this point, indeed, the document emphasises also that "the EU cannot deliver alone the ambition of the European Green Deal

[22] To deepen with the (potential) specific tasks of the Global Alliance refer to point 3.2 of the Staff Working Document of the European Commission (2020b).

for a climate-neutral, resource-efficient and circular economy"... confirming that "the EU will continue to lead the way to a circular economy at the global level and use its influence, expertise and financial resources to implement the 2030 Agenda for Sustainable Development and its Sustainable Development Goals, in the EU and beyond" (European Commission, 2020b).
Figure 7 shows a graphical illustration about the countries' commitment to the EU legislation on CE (European Environment Agency, 2019).

Figure 7 - Data on countries that adopt measures and/or detailed information about CE



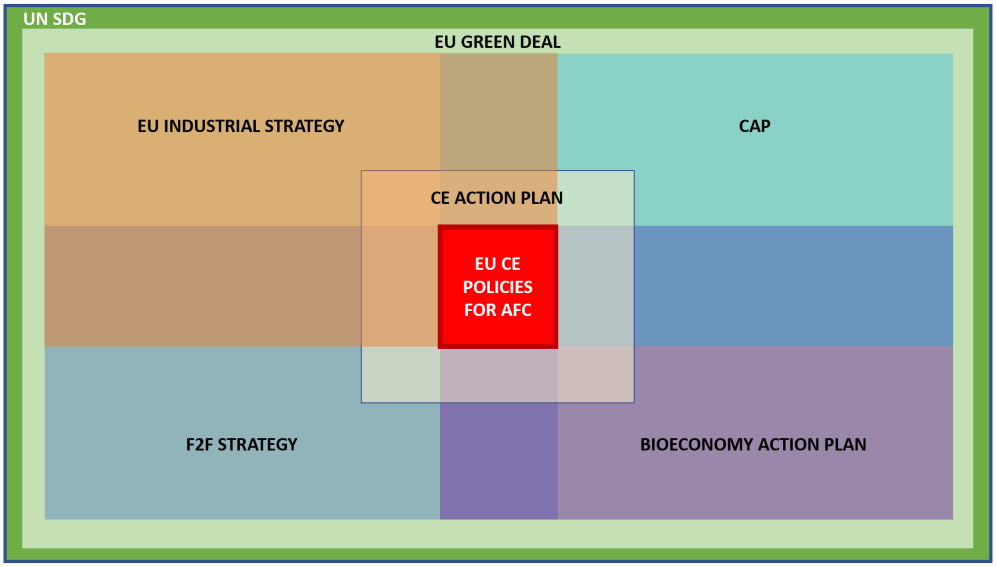
Notes: Source EEA, 2019 (www.eea.europa.eu/data-and-maps).

The left panel indicates that there is almost a full involvement in providing data on their respective policies on resource efficiency, circular economy, and raw material supply. On the other side, the right panel suggests that the implementation process of national strategy targeted to the CE (or national action plan) evolves at different speeds across countries.

2.1. A synergic and harmonised policy framework for the AFC

The complexity of the CE Action Plan needs harmonisation with several different EU policy instruments in different economic sectors and activities. The scheme below summarises the framework of the most relevant EU policies related to CE in the AFC (Figure 8).

Figure 8 - A scheme about the most relevant EU policies about CE in the AFC



Notes: source: authors' elaboration.

According to the *EU Industrial Strategy*, the EU Commission thus encourages and will enable greater circularity in industry, reviewing the Industrial Emission Directive, "including the integration of circular economy practices in upcoming Best Available Techniques reference documents" (European Commission 2020a, p. 6). It facilitates industrial symbiosis by developing an industry-led reporting and certification system, also promoting the use of digital technologies for tracking, tracing and mapping of resources, and adopting a system of solid verification by registering the EU Environmental Technology Verification scheme as an EU certification mark.

More in general, the EU Commission recognises the central role of SMEs announcing that the new SME Strategy "will foster circular industrial collaboration among SMEs building on training, advice under the Enterprise Europe Network on cluster collaboration, and on knowledge transfer via the European Resource Efficiency Knowledge Centre". This effort has a direct impact on all industrial sectors, even including those related to food processing and packaging. In the latter, already included in the CE Action Plan, "the Commission will review the Directive 94/62/EC to reinforce the mandatory essential requirements for packaging" (*ibidem*, p. 8). This will ensure that all packaging on the EU market will be reusable or recyclable in an economically viable way by 2030. This objective considers the reduction of (over)packaging and packaging waste, and the implementation of design for re-use and recyclability, reducing at same time the complexity of packaging materials. It encourages the "use of biodegradable or compostable plastics", in line with the new Directive on Single-Use Plastic Products, will assess the feasibility of EU-wide labelling that facilitates the correct separation of packaging waste at source, rules for the safe recycling into food contact materials.

More specifically focused on agriculture and biomass management are instead the Common Agricultural Policy (CAP), the Bioeconomy Strategy and the EU Farm-to-Fork (F2F) Strategy, which are in synergies with the CE Action Plan. The CAP is the main regulatory framework for the primary sector in the European countries, allowing to ensure the EU objectives of food security and food safety, recently sustaining small and medium-sized farmers in the turn toward an agro-ecology approach. The Bioeconomy and the F2F strategies are instead most directly related to CE and food waste reduction,

also providing, especially the F2F strategy, a whole set of actions and initiatives to promote a different approach to food consumption and food habits (see also the next paragraphs herein).
In this respect, the CE Action Plan is specifically focused on food and water waste, proposing to harmonise separate waste collection systems and the review of Directive 2008/98/EC on food waste reduction and the new Water Reuse Regulation, which will encourage circular approaches to water reuse in agriculture, as well as implementing the Drinking Water Directive, making drinkable tap water accessible in public spaces.
About consumers' empowerment, the CE Action Plan framework foreseen a revision of EU consumers law, which is going to ensure consumers receive trustworthy and relevant information on products at the point of sale, contrasting the greenwashing as well in the environmental claims of products. From this point of view the EU commission intends to enhance the "Product" and "Organisation Environmental Footprint" methods (PEF and OEF), as a support to existing environmental reporting tools such as the EU Ecolabel system and the EMAS certifications.
These aims will also be reached mobilising the potential of digitalisation of product information, including solutions such as digital passports, tagging, and watermarks.
As already noticed, to reinforce the role of Public buyer is another fundamental aspect of the framework: the Commission indeed will propose a minimum mandatory Green Public Procurement (GPP).

2.1.1 Common Agricultural Policy

A starting point for the identification of the EU policy frame for the agri-food sector is the Common Agricultural Policy (CAP), launched in 1962 with the aim of securing citizens with food at affordable prices and providing a fair standard of living for farmers.
The policy has been revised several times over time, evolving with the economic development and the environmental consciousness of the society (since 1992, in coincidence with the Rio Earth Summit, CAP supported farmers with direct payments encouraging them to be more environmentally friendly). From 2003 onward, farmers received income support, conditioned to the fulfilment of food safety, environmental, animal health and welfare standards. 0
In order to support jobs and growth in rural areas, the CAP of the programming period 2014-2020 boosted competitiveness, sustainable farming and innovation. As reported in the document overview on CAP reform 2014-2020, "European agriculture needs to produce more safety and quality food, while preserving the natural resources on which agricultural productivity itself depends" (European Commission, 2013). In particular, in order to reach these goals, the European Commission introduced in 2015 the "green payment", a specific type of direct payment to reward virtuous farmers. These kinds of payments represent 30% of the national funds. On 1 June 2018, the European Commission presented the legislative proposals on the future of the CAP for the period after 2020.
The 2021-2027 CAP will be playing a pivotal role for sustainable development in the framework of the European Green Deal.[23] The Policy will influence all significant ecological assets directly, having a wide influence on spatial development on various levels, contributing as one of the main drivers of economic

[23] See, for instance, the European Commission web page dedicated to the "Future of the common agricultural policy": https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/future-cap_en#a-new-way-of-working .

growth and jobs and playing a crucial role for healthy cultural landscapes and social development.

2.1.2 The bioeconomy Action Plan and Strategy

As declared in the EU Bioeconomy Strategy document, bioeconomy "covers all sectors and systems that rely on biological resources (animal, plants, micro-organisms and derived biomass, including organic waste), their functions and principles. It includes and interlinks: land and marine ecosystems and services they provide; all primary production sectors that use and produce biological resources (agriculture, forestry, fisheries and aquaculture); and all economic and industrial sectors that use biological resources and processes to produce food, feed, bio-based products, energy and services" (European Commission 2018, p. 4).

This part of economic products and processes are thus strictly related to the AFC and, if they consider in circular terms, they have a prominent role in achieving EU sustainable goals, as well as in the innovation and relaunch of the entire EU economic system.

More specifically: "A sustainable bioeconomy is the renewable segment of the circular economy" (ibidem, p. 8). Therefore, it can for instance "turn bio-waste, residues and discards into valuable resources and can create the innovations and incentives to help retailers and consumers cut food waste by 50% by 2030" (ibidem, p. 6).

Moreover, a sustainable bioeconomy is essential, for instance, to the reduction of GHGs emission in the energy sector. Bioenergy is currently the EU's largest renewable energy source and it is expected to remain a key component of the energy mix to encounter the EU 2030 renewable energy goals.

At the same time, bioeconomy represents also a great support to the modernisation and the strengthening of the EU industrial base through the creation of new value chain and greener, more cost-effective industrial processes: "with a turnover value of 2.3 trillion euros and accounting for 8.2% of the EU's workforce, the bioeconomy is a central element to the functioning and success of the EU economy. […]. The strong and fast-growing start-up ecosystem in the biotechnology sector will play a leading role in realizing this potential" (ibidem, p. 5).

However, as declared in the same EU document: "realising this potential will not happen on its own". Therefore, maximising the impact of EU Research and Innovation is a key factor in this respect, so is essential to stress on the Renewed European Agenda for research and Innovation, but also traditional funding lines such as Horizon Europe or the European Regional Development Fund.

These policies and financial instruments also crosscut other instruments and policies such as the Smart Specialisation Strategy and Platform, the Common Agricultural Policy, Common Fisheries policy, the renewed Industrial Policy, the CE Action Plan, the Clean Energy for All Europeans Package, Cohesion policy, the financial instruments under the InvestEU Programme, etc.

The bioeconomy strategy is articulated in five main objectives:

- Ensuring food and nutrition security;
- Managing natural resources sustainably;
- Reducing dependence on non-renewable, unsustainable resources whether sourced domestically or from abroad;
- Mitigating and adapting to climate change;
- Strengthening European competitiveness and creating jobs;

In accordance with these objectives, the main lead actions to improve a sustainable and circular bioeconomy, are the following:

- Strengthen and scale-up the bio-based sectors, unlock investments and markets;
- Deploy local bio-economies rapidly across Europe;
- Understand the ecological boundaries of the bio-economy.

2.1.3 The Farm-to-Fork Strategy

As we can read in the EU Commission document about the F2F strategy, it is considered a fundamental part of the EU Green Deal: it is "at the heart" of the sustainability strategy and policy of the EU. The F2F strategy, indeed, goes beyond the agroecology approach: "It addresses comprehensively the challenges of sustainable food systems and recognises the inextricable links between healthy people, healthy societies and a healthy planet" (European Commission 2020c, p. 2).
The F2F strategy is an holistic approach that tries to bring together consumers' health - changing peoples' habits and diet - with an ecological approach to food production and consumption, more responsible towards the environment. This is because "If European diets were in line with dietary recommendations, the environmental footprint of food systems would be significantly reduced" (ibidem, p. 4).
European Commission will make a legislative proposal for a framework for a sustainable food system before the end of 2023. This will promote policy coherence at EU and national level, providing also common definitions and general principles and requirements for sustainable food systems and food, as well as certification and labelling on sustainability performances of food products. Furthermore, the framework will address the responsibilities of all actors in the food chain and offer specific incentives, allowing operators to benefit from sustainable practices and contributing to the rise of sustainability as the norm for all food products placed on the EU market.
The F2F strategy is closely related to the other EU sustainability strategies, such as the CE Action Plan and the bioeconomy strategy.

2.2. EU main programmes: financial and non-financial instruments for SMEs

Europe's economy is grounded on SMEs, representing the 99% of all businesses and the two-thirds of private workforce composition in the EU. However, the principles of circular economy are already applied by many large industries, while SMEs still remain uninvolved with different concurring explanations. On this point, the European Commission (Directorate General for Environment) has implemented a pilot project with the objective to explore what route is most effective and efficient to boost the transition towards a CE among SMEs.[24] Results revealed a general increased uptake by firms to adopt resource efficiency, eco-innovation and/or CE strategies and practices, with evident hurdles for SMEs due to their limited organisational, technological and financial capacity, as well as limited access to

[24] For further details about the pilot project "Boosting the circular economy among SMEs" (previously named: Fostering a green and circular economy in Europe - Through Capacity Building, Networking And Exchanges Of Innovative Solutions Bridging The Green Innovations Gap), refer to the following link:
https://ec.europa.eu/environment/sme/circular_economy_boost_en.htm

skilled workers and financing (KPMG, 2019; European Commission, 2020b). In addition, such enabling/hindering factors may drive the transition to CE also according to local conditions (see the next section on drivers and barriers).

European Commission and other EU institutions, such as the European Investment Bank (EIB), implemented different programmes that incorporate various financial instruments to help SMEs adopting circular strategies and practices. In particular, the Commission set-up the Executive Agency for Small and Medium-sized Enterprises (EASME) with the purpose to manage on its behalf several EU programmes specifically (or partially) targeted to SMEs. The main programmes are the following: [25]

- *Horizon 2020* is the largest EU Research and Innovation programme that implements the flagship initiative *Innovation Union* of the strategy "Europe 2020" aimed at guarantee the competitiveness of the Union (https://ec.europa.eu/programmes/horizon2020/en);
- Under the programme Horizon 2020 there is also *InnovFin-EU Finance for Innovators*, a joint initiative by the EIB Group and the European Commission aims at facilitating and accelerating access to finance for innovative businesses with multiple financing instruments (https://www.eib.org/en/products/blending/innovfin/index.htm);
- The *LIFE* programme is a specific funding instrument with the general objective to contribute to the implementation, updating and development of EU environmental and climate policy and legislation (https://ec.europa.eu/easme/en/life);
- *COSME* is the EU programme targeted for the Competitiveness of Enterprises and Small and Medium-sized Enterprises, with the aim to provide an easier access to guarantees, loans and equity capital (https://ec.europa.eu/growth/smes/cosme_en);
- The *European Fund for Strategic Investments* (EFSI), the central pillar of the "Investment Plan for Europe", is a joint initiative launched by the EIB Group and European Commission to help overcome current investment gaps in the EU, supporting strategic investments in key areas (https://ec.europa.eu/commission/priorities/jobs-growth-and-investment/investment-plan-europe-juncker-plan/european-fund-strategic-investments-efsi_en);
- Finally, the *European Structural and Investment Funds* (ESIF) have the purpose to invest in job creation and a sustainable and healthy European economy and environment, focussing mainly on five strategic areas: research and innovation, digital technologies, supporting the low-carbon economy, sustainable management of natural resources, small businesses (https://ec.europa.eu/info/funding-tenders/funding-opportunities/funding-programmes/overview-funding-programmes/european-structural-and-investment-funds_en). In particular, with respect to the agri-food chain, sustainability and competitiveness are ensured through the European agricultural fund for rural development (EAFRD), the funding instrument of the EU Common Agricultural Policy (CAP).

The above mentioned programmes include different financial instruments, among these: equity funds, grants, loans. However, since the introduction of the circular economy package, the Commission has also adopted non-financial instruments to help the transition of firms to circular economy models. In

[25] For other instruments, services, or initiatives supporting SMEs activities refer to https://ec.europa.eu/easme/en .

particular, looking at the Food sector, the Commission offers further non-financial instruments with targeted actions.[26] In general, to help businesses of SMEs, the following programmes have been launched:

- The EU Eco-Management and Audit Scheme (EMAS) is an environmental management instrument developed by the European Commission for companies and other organisations to evaluate, report, and improve their environmental performance;
- The Product Environmental Footprint (PEF) and the Organisational Environmental Footprint (OEF) are harmonised methods to measure and communicate the life cycle environmental performance of products and organisations;
- The EU Ecolabel is a third-party certified Type-I ISO 14024 aimed to promote products and services that have a reduced environmental impact;
- Environmental Technology Verification programme (ETV) allows new environmental technologies that do not fall under existing labels or certification to obtain a statement verifying claims regarding their performance;
- In addition to the above mentioned instruments there is one major EU level programme to help SME support organisations with the implementation of circular economy amongst SMEs: the European Resource Efficiency Knowledge Centre (EREK), a platform to enable and reinforce businesses and especially SMEs to take action for Resource Efficiency in Europe and beyond.

Looking at the evolution over time of the European Policy one can notice that it is characterised by a number of programmes and instruments with significant financial commitments and cross-cutting objectives of innovation, development, and climate change mitigation. It is worth noting that along with the European policy, member states and regional governments have also implemented further specific measures in this common framework, and private and public actors further contributed to research and develop new technologies in this direction.

3. The transition to Circular Economy

The current economy system is for a large part stuck in an open-ended model of production and consumption. Yet, several disruptive trends stimulate and encourage the transition to a "circular" system, weakening the existing linear framework and mind-sets. The global economic and demographic transformations bring about important challenges concerning the availability of resources and the rising demand for goods. These trends imposed reconsidering to move from the traditional dominant take-make-disposal economy model to an alternative model with a built-in tendency to recycle. In addition, significant advances in information technology further facilitated the transition along different phases, from the tracking of materials to the dissemination of information on new products and services, to the mobilisation of customers through social media platforms. Finally, an increased awareness seems to drive a general shift in consumers' behaviour towards more sustainable choices (EMF, 2013a).

At this stage, the identification of the determinants reveals to be challenging as CE is an umbrella concept covering different and wide areas, and still undefined for the conceptual definition. However, progress

[26] On this point, refer to the following link for actions and good practices: https://ec.europa.eu/food/safety/food_waste/eu_actions_en

towards the transition has been investigated by many scholars in developed and emerging economies, and at sector and firm level, with promising results.

3.1 Drivers and barriers

Looking at the specific factors that can foster or hinder the transition to a circular economy, the recent research provided new interesting evidence to understand and systematise this issue. In general, limited progress in the CE implementation is associated with a variety of barriers concerning economic and technological factors, the market structure, institutional and socio-cultural aspects.
Analysing the results of the recent years, common specific aspects include the high initial costs, complex supply-chains, resource-intensive infrastructure lock-ins, limited dissemination of innovation and insufficient investment in technology, failures in company cooperation, lack of awareness and information (of consumers and firms), and limited (or inappropriate) sustainable public incentives.
De Jesus and Mendonça (2018) analysed the evidence applying the conceptualisation based on the "hard-soft" dichotomy, contributing to advance the research agenda on the CE transition. They separated "harder" technical and economic factors from "softer" regulatory and cultural issues to organise the extensive literature. Table 3 below reviews the findings and indicates factors facilitating and constraining the transition towards a CE as appeared in the original article.

Table 3 - Factors facilitating and constraining the transition towards a CE.

		DRIVERS	**BARRIERS**
"HARDER" FACTORS	Technical	Availability of technologies that facilitate resource optimisation, re-manufacturing and re-generation of by-products as input to other processes, development of sharing solutions with superior consumer experience and convenience.	Inappropriate technology, lag between design and diffusion, lack of technical support and training.
	Economic/ Financial/ Market	Related to demand-side trends (rising resource demand and consequent pressures resource depletion) and supply-side trends (resource cost increases and volatility, leading to incentives towards solutions for cost reduction and stability).	Large capital requirements, significant transaction costs, high initial costs, asymmetric information, uncertain return and profit.
"SOFTER" FACTORS	Institutional/ Regulatory	Associated with increasing environmental legislation, environmental standards and waste management directives	Misaligned incentives, lacking of a conducive legal system, deficient institutional framework
	Social/Cultural	Connected to social awareness, environmental literacy and shifting consumer preferences (e.g. from ownership of assets to services models).	Rigidity of consumer behaviour and businesses routines.

Notes: from de Jesus and Mendonça (2018).

The macro categories illustrated in the table are, of course, not mutually exclusive. Generally, there is a joint contribution of different factors that enable and encourage (impede and hinder) the transition to CE according also to local conditions. In particular, this can be noticed in the case of large integration areas such as the European Union, where the disparity in economic development, research and innovation, and level of institutional quality, is wide across and within countries. Such heterogeneity may explain different trajectories, with strong differences across firms and sectors, and should be taken into account in designing and implementing policies especially at local level, as well as in interpreting their results.

Kircherr et al. (2018) provide further insights on CE barriers in the EU. Building on 208 survey respondents (among businesses and policymakers) and 47 expert interviews, they find that cultural factors are considered the main barriers that derail or slow down the transition towards a CE in European countries. Table 4 below illustrates the coding framework used to run the survey and the semi-structured interviews. In the survey, respondents were asked to indicate the 5 most pressing CE barriers out of the 15 identified and included in the coding framework. Results from the study underline how "Lacking consumer interest and awareness" as well as "Hesitant company culture" are ranked among the most pressing barriers, contrasting with the common idea that identifies technological factors as core barriers.

Table 4 - Coding framework of CE barriers

Barriers			**Example source**
CULTURAL	Lacking awareness and/or willingness to engage with CE	- Hesitant company culture.	"No sense of urgency, company culture" Pheifer (2017, p.12).
		- Limited willingness to collaborate in the value chain.	"Difficult to collaborate with other companies" Mont et al. (2017, p.29).
		- Lacking consumer awareness and interest.	"Lack of consumer awareness" Mont et al. (2017, p.30).
		- Operating in a linear system.	"Current linear system in place" Pheifer (2017, p.15).
REGULATORY	Lacking policies in support of a CE transition	- Limited circular procurement.	"We need people who do not only look at costs when doing procurement, but also at other things" Manager (incumbent).
		- Obstructing laws and regulations.	"Current governmental legislations and ruling" Pheifer (2017, p.15).
		- Lacking global consensus.	"There are a lot of different countries, so you need a high level of consensus and that is not easy" Director (research institute).
MARKET	Lacking economic viability of circular business models	- Low virgin material prices.	"Low prices of many virgin materials" Mont et al. (2017, p.28).
		- Lacking standardization.	"There is a lack of standards" Scholar (university).
		- High upfront investment costs.	"High upfront investment costs" Mont et al. (2017, p.29).
		- Limited funding for circular business models.	"Financing of circular business propositions" Pheifer (2017, p.11).
		- Lacking ability to deliver high quality remanufactured products.	"Limited availability and quality of recycled materials" IMSA (2013, p.4) .

TECHNOLOGICAL	Lacking (proven) technologies to implement CE	- Limited circular designs. - Too few large-scale demonstration projects. - Lack of data, e.g. on impacts.	"Products are not designed for circular business models" Mont et al. (2017, p.30). "Limited application of new business models" IMSA (2013, p.4) . "Lack of data" Pheifer (2017, p.14).

Notes: from Kircherr et al. 2018.

When looking at the CE in SMEs, the core issue of the e-book, the evidence seems to not diverge much from previous results. Rizos et al. (2015), for example, reviewed the literature identifying the following main barriers: environmental culture, limited government support, lack of effective legislation, information deficits, administrative burdens, low technical skills, and financial barriers. In particular, they stressed how "finance has frequently been highlighted as a barrier in the analysis carried out", and underlined how the access to suitable sources of finance reveals crucial for SMEs involved in circular economy activities.

It should be noted that financial aspects are generally recognised as a key element for the innovation path of SMEs. Indeed, there is conclusive evidence, for example, on the differential impact of innovation support depending on firm size, and on kind and intensity of support (for a review see Mouquè, 2012). In the case of innovation incentives, first hints are in favour of loans and soft financial engineering (although grants are widely delivered), with greater effectiveness for SMEs (that commonly face problems in terms of credit constraints for their innovative projects due to the lack of guarantees they provide to financial operators, if compared to Large firms). In addition, there is positive evidence in favour of non-financial support (as business advice) and subsidies and innovation consortia in the form of grants plus networking (Mouquè, 2012; Rizos et al., 2015).[27]

Results from the 2016 Eurobarometer survey highlighted some concerns about CE implementation in EU SME.[28] Questionnaire faces several CE-related issues, such as R&D and innovation investments, implementing practices and activities, knowledge about financial opportunities, and financial availability and strategy among other things.

Regarding R&D and CE-related innovation, results indicate that 71% of SMEs invest less than 5% in R&D, while only 4% of firms invest more than 20%. Countries involved in the SinCE-AFC project have higher average value, with Romania scoring the highest percentage (9% of Romanian SMEs invest more than 20% in R&D).

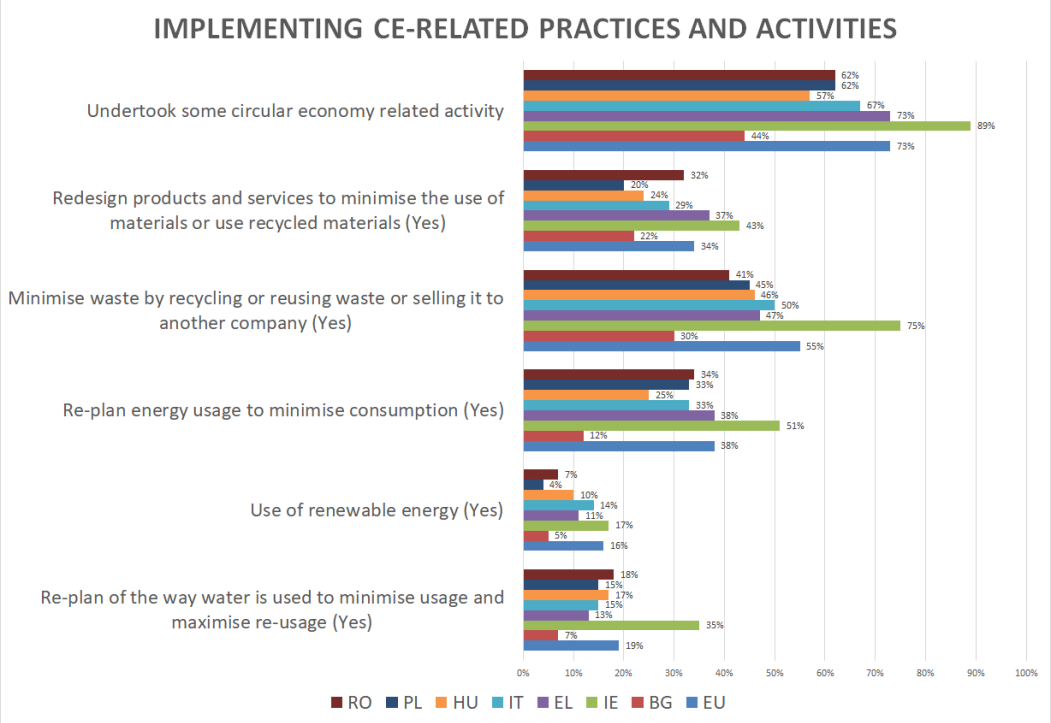
Figure 9 shows results concerning the implementation of CE related practice for countries involved in the SinCE-AFC project. During the previous three years, 73% of interviewed SMEs declared to have undertaken some CE-related activity, with an average value for the SinCE-AFC partners of 65% (73% for Greece and 89% for Ireland. In particular, 19% declared to had re-planned water uses to minimise usage and maximise re-usage (Ireland is over this value, with 35% of positive answers), 38% had declared to had re-planed also energy use (Greece reach the same percentage, while Ireland is over, with 51%), while 16% declared to use renewable energy (only Ireland is over, with 17%). 55% minimised waste by

[27] On this point, see the case of the thematic "Clust-ER Associations", "Clust-ER Agri-food" and "Clust-ER Green-tech", in Emilia-Romagna region in Italy: a public-private partnerships and networks created as a mechanism to promote and to support the competitiveness of the value chains through the share of skills, ideas and resources (https://www.retealtatecnologia.it/en/clust-er).

[28] Detailed data are available online at the following link: https://data.europa.eu/euodp/en/data/dataset/S2110_441_ENG.

recycling or reusing waste or selling it to another company (only Ireland is over with 75%). Finally, a redesign of products and services to minimise the use of materials or to implement the use of recycled ones has been undertaken by 34% of the EU SMEs. Among SinCE-AFC partners, Greece (37%) and Ireland (43%) reached higher values.

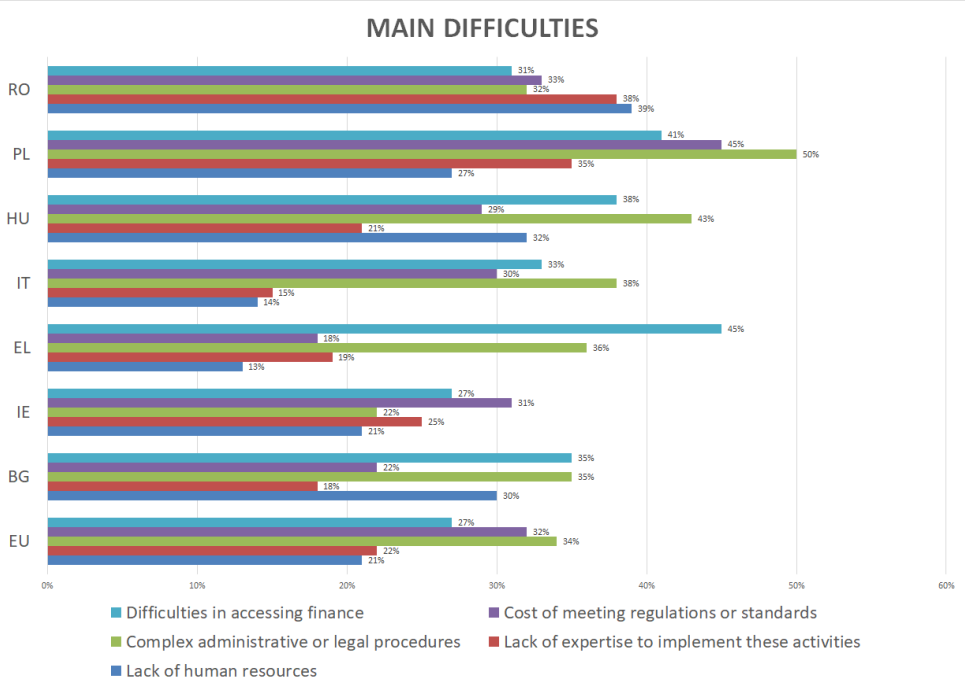
Figure 9 - Implementation of CE-related practice and activities (countries involved SinCE-AFC)



Notes: authors' elaboration from Eurobarometer data 2016

Figure 10 shows results with respect to the main difficulties faced by entrepreneurs in implementing CE initiatives. Respondents indicated bureaucratic complexity (complex administrative or legal procedures=34%) and related costs (cost of meeting regulations or standards=32%), and difficulties in accessing finance (27%), as the most pressing barriers. In the selected countries the average values are generally higher (except for "costs of meeting regulations or standards" which is limited to 30%).

Figure 10 - Main difficulties in implementing CE-related practices and activities (countries involved SinCE-AFC)



Notes: authors' elaboration from Eurobarometer data 2016

Moreover, a "no clear idea about cost benefits or improved work processes" (EU=27%) and about the "required investments" (EU=27%) are also the most cited reasons that discourage entrepreneurs from undertaking CE initiatives.

The majority of the EU respondents highlighted that "the company did not use external sources to finance the activities" (EU=63%, SinCE-AFC partners=63%) and this percentage grew up to 70% considering specific CE-related investments. The 18% still consider access to finance "difficult" (fairly difficult + very difficult) (SinCE-AFC partners=23%) and only 1% of interviewers had access to "EU related funds" (a percentage that reach the average value of 4% in SinCE-AFC partners).

Even if the larger part of the respondents admitted having "no searched for such information" (EU=48%, SinCE-AFC partners=45%), 30% (SinCE-AFC partners=32%) they also said there is "little or no information" readily available. Finally, "lack of human resources" (EU=21%, SinCE-AFC partners=25%) and "expertise" (EU=22%, SinCE-AFC partners=24%) are other important limiting factors.

3.2 Evidence from SinCE-AFC consultation process

Within the activities of the SinCE-AFC project a questionnaire was developed and distributed to project partners (PPs) with regards to regional policies in support of agri-food SMEs and the development of the Action Plan. The main goal is to assess the levels of awareness, knowledge, engagement and development needs of the PPs and their local stakeholders.

The first round of the survey involved 40 stakeholders in the agri-food sector from 7 European regions.[29] Respondents were from diverse backgrounds including representatives from research bodies, co-operatives, local authorities, local development authorities, waste management bodies, businesses and food producers.

Looking at the experiences of the actors involved, preliminary results from the first set of questions revealed a high heterogeneity in the level of knowledge and understanding of Circular Economy concepts, policies and practices. Respondents having a general knowledge of CE varied from 3% with no knowledge, 35% with a fair knowledge, 40% with good knowledge to 22% with excellent knowledge of the CE. Only 54% of the respondents stated that they were aware of current policies or strategies in their region (country). In line with the previous question, 57% of respondents were aware of current policies or strategies in support of the food/agri-food sectors in their respective regions (countries). About 60% did not know (or did not reply) what specific reference those policies or strategies make to the CE, while 40% knew some information. Accordingly, a similar share of respondents gave details about any specific CE model or project currently operating in their region.

The second set of specific questions related to the drivers or enabling forces supporting the CE confirmed a generalised lack of knowledge and awareness, receiving a high rate of no replies and fragmented responses. However, questionnaire respondents provided also interesting evidence, in line with the results found in the literature. In particular, regarding the inhibitors limiting the development of CE, 80% outlined different critical issues, mainly dealing with cultural and institutional factors: lack of knowledge, information and awareness, lack of cooperation with other companies and difficult networking, lack of specific policy/legislation, strategy and political will, unwillingness to make changes to processes, bureaucracy, lack of support.

With respect to driving forces, respondents (73%) outlined a broad set of factors partly in line with cultural and institutional issues that emerged in the literature. Replies dealt with knowledge and awareness of CE advantages, political initiatives for the transition to CE, funding motivation, technical help and support, sharing of experiences, regional and municipal action plans/policies/strategies or initiatives, promotion of EU policy, funding support tools, environmental protection. In addition, some technical factors emerged concerning reduction in landfill waste, energy production from residues, the need to stabilise local production systems. Regarding the support to encourage and drive CE in the agri-food sector, respondents (88%) indicated the need for, inter alia, information/promotion, funding as well as targeted implementation of investment policies in agri-food businesses, national strategies in the CE, actions related to the limitation of problems, financial and tax incentives, coordination of public funding, collective branding/promotion and training/research/education.

Finally, the lack of awareness is confirmed by the replies given with respect to policies and strategies to implement in support of the transition and the interesting good practices to apply in their region: no specific issue emerged from the respondents in the first case, while 70% were unaware of any good practices to replicate.

To sum up, the level of knowledge about the CE and the related policies/strategies varies greatly, even among representatives from the same regions. There would appear to be a lack of strong and meaningful policies and measures to support the CE within most partner regions. The responses would indicate that

[29] Regions belong to the following countries: Bulgaria, Greece, Hungary, Ireland, Italy, Poland, Romania.

while there is an awareness of between 55-60% of the concept and policies relating to the CE among project regions, there is limited knowledge. This is not surprising as many of the partners are not directly involved in the Circular Economy and in particular its broad implementation is still in its relative infancy in most of the regions.

These responses would indicate that while there is an understanding of the concept of the Circular Economy among participating partners and regions, there is very limited knowledge or experience of the practices involved in the CE. This would seem to indicate a significant gap between policy and practice within the partner regions, with the consequent challenge in translating the policies and associated opportunities with the needs of businesses. The lack of awareness and understanding within the partner regions points to the need for this fundamental challenge to be addressed at an early stage and to be an essential part of partner Action Plans. It is also suggested that the Project Partners and public agencies need to have a much better knowledge of the real market opportunities within the Circular Economy and of the commercial models that can be applied to the sector.

The responses with regard to good practices and in particular the significant lack of knowledge relating to good practice in the sector indicates that there is a significant opportunity for projects such as SinCE-AFC to identify and raise awareness of good practices in the CE and to use these as means of creating awareness, improving understanding and affecting future policies.

References

Benyus, J.M., (2002). Biomimicry. Harper Perennial, New York.

Boulding, K., (1966). The economics of the coming spaceship earth. In: Environmental. Quality Issues in a Growing Economy.

Brown L.R. (2012). Full planet, empty plates: the new geopolitics of food scarcity. WW Norton & Company, New York (US).

Chateau, J., Mavroeidi E. (2020). The jobs potential of a transition towards a resource efficient and circular economy. OECD Environment Working Papers, No. 167, OECD Publishing, Paris, https://doi.org/10.1787/28e768df-en.

De Jesus, A., Mendonça, S. (2018). Lost in transition? Drivers and barriers in the eco-innovation road to the circular economy. Ecological economics, 145, 75-89.

European Commission (2013). Agriculture policy perspective Brief. Overview of CAP Reform 2014-2020.

European Commission (2015). Closing the loop - An EU action plan for the Circular Economy. COM (2015) 614 final.

European Commission (2018). A sustainable Bioeconomy for Europe. Strengthening the connection between economy, society and the environment (updated bioeconomy strategy). COM(2018) 673/2.

European Commission (2019a). Report on the implementation of the Circular Economy Action Plan. COM (2019) 190 final.

European Commission (2019b). The European Green Deal. COM (2019) 640 final.

European Commission (2020a). Circular Economy Action Plan. For a Cleaner and More Competitive Europe. COM (2020) 98.

European Commission (2020b). Leading the way to a global circular economy: state of play and outlook. SWD (2020) 100 final.

European Commission (2020c). A Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system. COM(2020) 381 final.

European Commission (2020d). The EU budget powering the recovery plan for Europe. COM(2020) 442 final.

European Union (2018). Europe moving towards a sustainable future. Contribution of the Multi-Stakeholder Platform on the implementation of the Sustainable Goals in the EU. Reflection Paper, October 2018.

EMF, Ellen MacArthur Foundation (2013a). Towards the Circular Economy. Economic and business rationale for an accelerated transition. Report Vol.1. London UK.

EMF, Ellen MacArthur Foundation (2013b). Towards the Circular Economy. Opportunities for the consumer goods sector. Report Vol.2. London UK.

EMF, Ellen MacArthur Foundation (2014). Towards the Circular Economy. Accelerating the scale-up across global supply chains. Report Vol.3. London UK.

EMF, Ellen MacArthur Foundation & McKinsey Center for Business and Environment (2015). Growth within: a circular economy vision for a competitive Europe. Ellen MacArthur Foundation.

EMF, Ellen MacArthur Foundation (2015). Towards a Circular Economy: Business Rationale for an Accelerated Transition. Executive summary.

FAO (2020). Food Outlook – Biannual Report on Global Food Markets: June 2020. Food Outlook, 1. Rome.

Ghisellini, P., Cialani, C., Ulgiati, S. (2016). A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. Journal of Cleaner Production, 114, 11-32.

Graedel, T.E., Allenby, B.R., (1995). Industrial Ecology. Prentice Hall, Englewood Cliffs, N.J. (US).

HLPE (2014). Food losses and waste in the context of sustainable food systems. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome 2014.

IPCC (2014). Climate Change 2014 Synthesis Report. https://archive.ipcc.ch/pdf/assessment-report/.

Jackson T. (2016). Prosperity without growth. Foundations for the economy of tomorrow. Taylor & Francis.

Jurgilevich, A.; Birge, T.; Kentala-Lehtonen, J.; Korhonen-Kurki, K.; Pietikäinen, J.; Saikku, L.; Schösler, H. Transition towards circular economy in the food system. Sustainability 2016, 8, 69.

Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. Resources, conservation and recycling, 127, 221-232.

Korhonen, J., Honkasalo, A., & Seppälä, J. (2018a). Circular economy: the concept and its limitations. Ecological economics, 143, 37-46.

Korhonen J. Nuur C., Feldmann A., Birkie S.E. (2018b). Circular economy as an essentially contested concept. Journal of Cleaner Production 175: 544-552.

KPMG (2019). Accelerating towards a circular economy. Final report for European Commission project: Boosting circular economy among SMEs in Europe.

Le Quéré, C. et al. (2021). Fossil CO2 emissions in the post-COVID-19 era. Nature Climate Change, 11, 197-199.

Loiseau, E., Saikku, L., Antikainen, R., Droste, N., Hansjürgens, B., Pitkänen, K., et al. (2016). Green economy and related concepts: An overview. Journal of Cleaner Production, 139, 361-371.

Lyle, J.T., (1994). Regenerative Design for Sustainable Development. John Wiley & Sons, New York; Chichester.

McDonough, W., Braungart, M. (2002) Cradle to Cradle: Remaking the Way We Make Things, North Point press, New York.

Millar, N., McLaughlin, E., & Börger, T. (2019). The circular economy: swings and roundabouts?. Ecological Economics, 158, 11-19.

Muscio A., Sisto R. (2020). Are Agri-Food Systems Really Switching to a Circular Economy Model? Implications for European Research and Innovation Policy. Sustainability, 12, 5554.

Núñez-Cacho, P.; Molina-Moreno, V.; Corpas-Iglesias, F.A.; Cortés-García, F.J. (2018). Family businesses transitioning to a circular economy model: The case of "Mercadona. Sustainability, 10, 538.

Oldekop, J.A. et al. (2020). COVID-19 and the case for global development. World Development, 134, 105044.

Pearce, D.W., Turner, R.K., (1989). Economics of Natural Resources and the Environ- ment. Hemel Hempstead, Harvester Wheatsheaf, London. Italian edition 1991 by Il Mulino, Bologna.

Rizos, V., Behrens, A., Kafyeke, T., Hirschnitz-Garbers, M., Ioannou, A. (2015). The Circular Economy: Barriers and Opportunities for SMEs. CEPS Working Document (No. 412).

Spillare S., Paltrinieri R., Marciante L. (2019). From Civic Food Networks to Civic Food Platforms: collaboration, trust and empowerment in the New Food Economy. Sociology of Labour, 15, pp. 120-136.

Stahel, W. R. & Reday-Mulvey, G. Jobs for Tomorrow: The Potential for Substituting Manpower for Energy ((Vantage Press, 1981).

Stenmarck A., Jensen C., Quested T., Moates G. (2016). Estimates of European food waste levels. FUSIONS Reducing food waste through social innovation. Stockholm.

Urbinati, A., Chiaroni, D., & Chiesa, V. (2017). Towards a new taxonomy of circular economy business models. Journal of Cleaner Production, 168, 487-498.

WHO - World Health Organization (2018). Circular economy and health: Opportunities and risks. WHO Regional Office for Europe.

Willer H., Schlatter B., Tràvnìcek J., Kemper L., Lernoud J. (eds.) (2020). The World of Organic Agriculture. Statistics and Emerging Trends 2020. Research Institute of Organic Agriculture (FiBL), Frick and IFOAM -Organic International, Bonn.

World Bank (2021). Global Economic Prospects. Washington, DC: World Bank.

Appendix

The Statistical Classification of Economic Activities in the European Community, commonly referred to as NACE ("nomenclature statistique des activités économiques dans la Communauté européenne"), is the industry standard classification system used in the European Union.[30]

Tables below report the full disaggregation of the NACE "Section A" and "Section C", and the related "Divisions", "Groups" and "Classes", associated respectively to agriculture, forestry and fishing and to manufacturing activities identifying the agri-food sectors. The "Section G" (Wholesale and retail sale; Repair of motor vehicles and motorcycles), "Section H" (Transportation and storage), and "Section I" (Accomodation and food service activities) are excluded, although in part associated with the activities of the Agri-food chain.[31]

Accordingly, grounding on the NACE classification, a general identification of the agri-food sector may include:

- Primary activities of production belonging to the NACE codes 01, 02 and 03.
- Secondary activities of agriculture: activities of production of non-agricultural goods and services (i.e., not belonging to the NACE codes 01, 02 and 03) carried out within the agricultural sector or referable to it (mainly agricultural tourism, milk processing, fruit and meat, renewable energy production).
- Support activities for agriculture: activities related to agricultural production, not aimed at the collection of agricultural products, carried out on behalf of third parties. Activities that follow the harvest, aimed at preparing agricultural products for the primary market are included as well. Agriculture support activities are identified with code 01.6 in the NACE classification of economic activities.

				* part of
Division	**Group**	**Class**		**ISIC Rev. 4**
SECTION A — AGRICULTURE, FORESTRY AND FISHING				
01			Crop and animal production, hunting and related service activities	
	01.1		Growing of non-perennial crops	
		01.11	Growing of cereals (except rice), leguminous crops and oil seeds	0111
		01.12	Growing of rice	0112
		01.13	Growing of vegetables and melons, roots and tubers	0113
		01.14	Growing of sugar cane	0114
		01.15	Growing of tobacco	0115
		01.16	Growing of fibre crops	0116
		01.19	Growing of other non-perennial crops	0119
	01.2		Growing of perennial crops	
		01.21	Growing of grapes	0121
		01.22	Growing of tropical and subtropical fruits	0122
		01.23	Growing of citrus fruits	0123

[30] The current version is revision 2 established by Regulation (EC) No 1893/2006. For the complete list of NACE codes refer to the following page at the link: https://ec.europa.eu/competition/mergers/cases/index/nace_all.html.

[31] For the complete list of economic activities refer to: https://ec.europa.eu/eurostat/ramon/nomenclatures/index

		01.24	Growing of pome fruits and stone fruits	0124
		01.25	Growing of other tree and bush fruits and nuts	0125
		01.26	Growing of oleaginous fruits	0126
		01.27	Growing of beverage crops	0127
		01.28	Growing of spices, aromatic, drug and pharmaceutical crops	0128
		01.29	Growing of other perennial crops	0129
	01.3		Plant propagation	
		01.30	Plant propagation	0130
	01.4		Animal production	
		01.41	Raising of dairy cattle	0141*
		01.42	Raising of other cattle and buffaloes	0141*
		01.43	Raising of horses and other equines	0142
		01.44	Raising of camels and camelids	0143
		01.45	Raising of sheep and goats	0144
		01.46	Raising of swine/pigs	0145
		01.47	Raising of poultry	0146
		01.49	Raising of other animals	0149
	01.5		Mixed farming	
		01.50	Mixed farming	0150
	01.6		Support activities to agriculture and post-harvest crop activities	
		01.61	Support activities for crop production	0161
		01.62	Support activities for animal production	0162
		01.63	Post-harvest crop activities	0163
		01.64	Seed processing for propagation	0164
	01.7		Hunting, trapping and related service activities	
		01.70	Hunting, trapping and related service activities	0170
02			Forestry and logging	
	02.1		Silviculture and other forestry activities	
		02.10	Silviculture and other forestry activities	0210
	02.2		Logging	
		02.20	Logging	0220
	02.3		Gathering of wild growing non-wood products	
		02.30	Gathering of wild growing non-wood products	0230
	02.4		Support services to forestry	
		02.40	Support services to forestry	0240
03			Fishing and aquaculture	
	03.1		Fishing	
		03.11	Marine fishing	0311
		03.12	Freshwater fishing	0312
	03.2		Aquaculture	
		03.21	Marine aquaculture	0321
		03.22	Freshwater aquaculture	0322

Notes: n.e.c.: not elsewhere classified

Division	Group	Class		* part of ISIC Rev. 4
			SECTION C — MANUFACTURING	
10			Manufacture of food products	
	10.1		Processing and preserving of meat and production of meat products	
		10.11	Processing and preserving of meat	1010*
		10.12	Processing and preserving of poultry meat	1010*
		10.13	Production of meat and poultry meat products	1010*
	10.2		Processing and preserving of fish, crustaceans and molluscs	

		10.20	Processing and preserving of fish, crustaceans and molluscs	1020
	10.3		Processing and preserving of fruit and vegetables	
		10.31	Processing and preserving of potatoes	1030*
		10.32	Manufacture of fruit and vegetable juice	1030*
		10.39	Other processing and preserving of fruit and vegetables	1030*
	10.4		Manufacture of vegetable and animal oils and fats	
		10.41	Manufacture of oils and fats	1040*
		10.42	Manufacture of margarine and similar edible fats	1040*
	10.5		Manufacture of dairy products	
		10.51	Operation of dairies and cheese making	1050*
		10.52	Manufacture of ice cream	1050*
	10.6		Manufacture of grain mill products, starches and starch products	
		10.61	Manufacture of grain mill products	1061
		10.62	Manufacture of starches and starch products	1062
	10.7		Manufacture of bakery and farinaceous products	
		10.71	Manufacture of bread; manufacture of fresh pastry goods and cakes	1071*
		10.72	Manufacture of rusks and biscuits; manufacture of preserved pastry goods and cakes	1071*
		10.73	Manufacture of macaroni, noodles, couscous and similar farinaceous products	1074
	10.8		Manufacture of other food products	
		10.81	Manufacture of sugar	1072
		10.82	Manufacture of cocoa, chocolate and sugar confectionery	1073
		10.83	Processing of tea and coffee	1079*
		10.84	Manufacture of condiments and seasonings	1079*
		10.85	Manufacture of prepared meals and dishes	1075
		10.86	Manufacture of homogenised food preparations and dietetic food	1079*
		10.89	Manufacture of other food products (n.e.c.)	1079*
	10.9		Manufacture of prepared animal feeds	
		10.91	Manufacture of prepared feeds for farm animals	1080*
		10.92	Manufacture of prepared pet foods	1080*
11			Manufacture of beverages	
	11.0		Manufacture of beverages	
		11.01	Distilling, rectifying and blending of spirits	1101
		11.02	Manufacture of wine from grape	1102*
		11.03	Manufacture of cider and other fruit wines	1102*
		11.04	Manufacture of other non-distilled fermented beverages	1102*
		11.05	Manufacture of beer	1103*
		11.06	Manufacture of malt	1103*
		11.07	Manufacture of soft drinks; production of mineral waters and other bottled waters	1104

Notes: n.e.c.: not elsewhere classified

SinCE-AFC

Interreg Europe

European Union
European Regional
Development Fund