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The Circular Economy Applied to the Food Policies in the European Union

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Sommario

Introduction

Food waste is an issue of importance to global food security and good environmental governance, directly linked with environmental (e.g. energy, climate change, water, availability of resources), economic (e.g. resource efficiency, price volatility, increasing costs, consumption, waste management, commodity markets) and social (e.g. health, equality) impacts.[1]

According to FAO, almost one-third of food produced for human consumption – approximately 1.3 billion tonnes per year[2] – is either lost or wasted globally. World Bank stated that "those lost calories could fill hunger gaps in the developing world".

1.3 billion tonnes of food waste and loss is the equivalent of 1.4 billion hectares of agricultural land[3] or 30% of the world's agricultural land area[4;] a global water footprint of 250 km3 in 2007 or 20% of freshwater consumption[5;] 8% of global anthropogenic greenhouse gas (GHG) emissions[6;] and circa 38% of the total energetic consumption of the food supply chain[7.] Only considering CO2 emissions, if FLW were a country, it would be the third major emitter on Earth[8.]

In 2012, in Europe, it was estimated that the food waste generated is 88 million tonnes[9.] This equates to 173 kilograms of food waste per person in the EU-28. The total amounts of food produced in EU for 2011 were around 865 kg/person[10,] this would mean that in total we are wasting 20% of the total food produced[11.]

FLW is the consequence of an inefficient, unfair and unsustainable food system. It impacts food security by reducing the availability of food and the capacity of ecosystem

[1] EU FUSIONS Project, *Estimates of European food waste levels*, 2016.

[2] HLPE, *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,

[3] Food and Agriculture Organization (FAO), *Food Wastage Footprint & Climate Change*, Rome, 2015.

[4] Food and Agriculture Organization (FAO), *Food wastage footprint; impacts on natural resources*, Summary Report, Rome, 2013.

[5] Ibid.

[6] Food and Agriculture Organization (FAO), *Food Wastage Footprint & Climate Change*, Rome, 2015.

[7] Food and Agriculture Organization (FAO), *Energy-smart food for people and climate*, Rome, 2011.

[8] Food and Agriculture Organization (FAO), *Food wastage footprint; impacts on natural resources*, Summary Report, Rome, 2013.

[9] EU FUSIONS Project, *Estimates of European food waste levels*, 2016.

[10] http://faostat3.fao.org/download/FB/FBS/E.

[11] EU FUSIONS Project, *Estimates of European food waste levels*, 2016.

and natural resources to meet the increasing demand for food by wasting resources and damaging the environment.

Moreover, "it has been estimated that a 60 to 70% increase in global agricultural productivity is going to be needed to cope with world population growth, expected to reach nine billion by 2050"[12].

It is clear then that actual food systems do not work as they should, due to the increasing number of undernourished people, reaching 821,6 million people in 2018[13] (the same levels of 2011). Therefore, it is essential to create efficient, well-managed and sustainable food systems (SFS).

This is where the circular economy's principles are applied and shape the food systems. It is necessary to build a food system that is "regenerative, closing nutrient loops with minimal leakage and maximum long-term value extraction from each loop in short, local supply chains with almost zero waste. The system would offer accessible, fresh, and healthy food that would encourage consumers to embrace a healthier and/or less resource-intensive diet"[14].

A key role in shaping food systems is attributed to the cities, where lives the 55% of the world's population lives in urban areas, and it is expected to increase to 68% by 2050[15]. In fact, the urban food policies are becoming relevant, even for national legislation. Several examples of European cities are brought and explained.

A chapter is reserved to the several method of food waste management, with particular emphasis on the anaerobic digestion and the composting, wehere the former recover and recirculate nutrients, produce digestate and biogas, while the latter produce compost.

> Since the "95% of all food consumed by humans is grown in soil"[16], "up to 2 billion hectares of land is degraded, with agricultural activities and deforestation being one of the primary causes of land degradation"[17], sustainable methods that

[12] Food and Agriculture Organization (FAO), *Greening the economy with agriculture*, Rome, 2012.

[13] Food and Agriculture Organization (FAO), *The State of Food Security and Nutrition in the World 2019*, Rome, 2019.

[14] Ellen MacArthur Foundation, *Growth Within: a Circular Economy Vision for a Competitive Europe*, 2015, https://www.ellenmacarthurfoundation.org/assets/downloads/publications/EllenMacArthurFoundation_Growth-Within_July15.pdf

[15] Milan Urban Food Policy Pact Monitoring Framework, 2019, http://www.milanurbanfoodpolicypact.org/wp-content/uploads/2019/11/CA6144EN.pdf

[16] Food and Agriculture Organization (FAO), *Healthy soils are the basis for healthy food production*, 2015, http://www.fao.org/soils-2015/news/news-detail/en/c/277682/.

[17] United Nations Convention to Combat Desertification, 2017, http://www2.unccd.int/news-events/over-110-countries-join-global-campaign-save-productive-land.

preserve and enhance soil health are needed. Moreover, "2.6 billion people depend directly on agriculture [..]"[18], thus it is necessary a shift into the food value chain where the farmers and farm-workers' working conditions and wages are fair. Finally, a sustainable food system would reduce the percentage of food produced that is lost or waste.

Figure 1. Source: World Bank, based upon FAO and World Resources Institute's data, 2014

[18] United Nations Sustainable Development Goal 15, http://www.un.org/sustainabledevelopment/biodiversity./

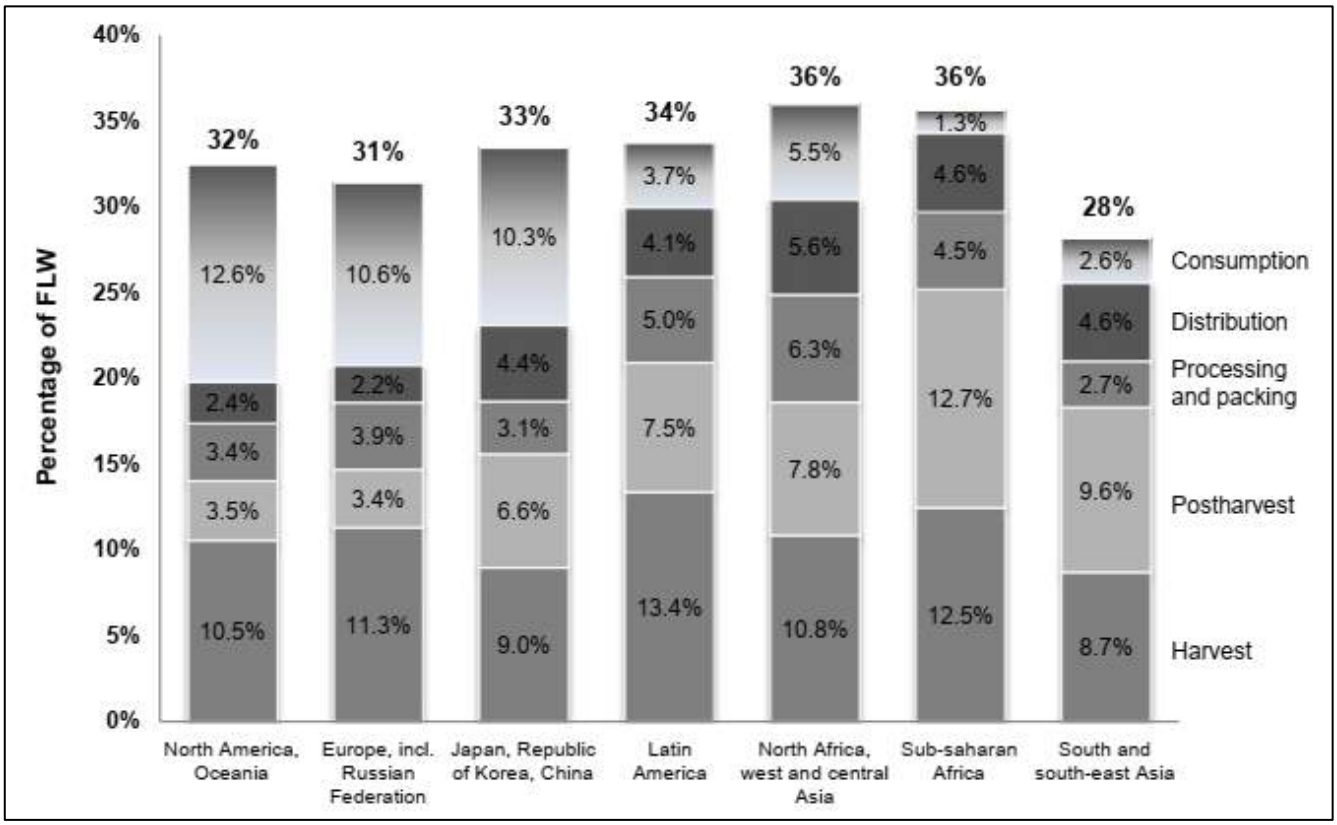

Figure 2. Source: *Food losses and waste in the context of sustainable food systems,* A report by The High-Level Panel of Experts on Food Security and Nutrition, June 2014

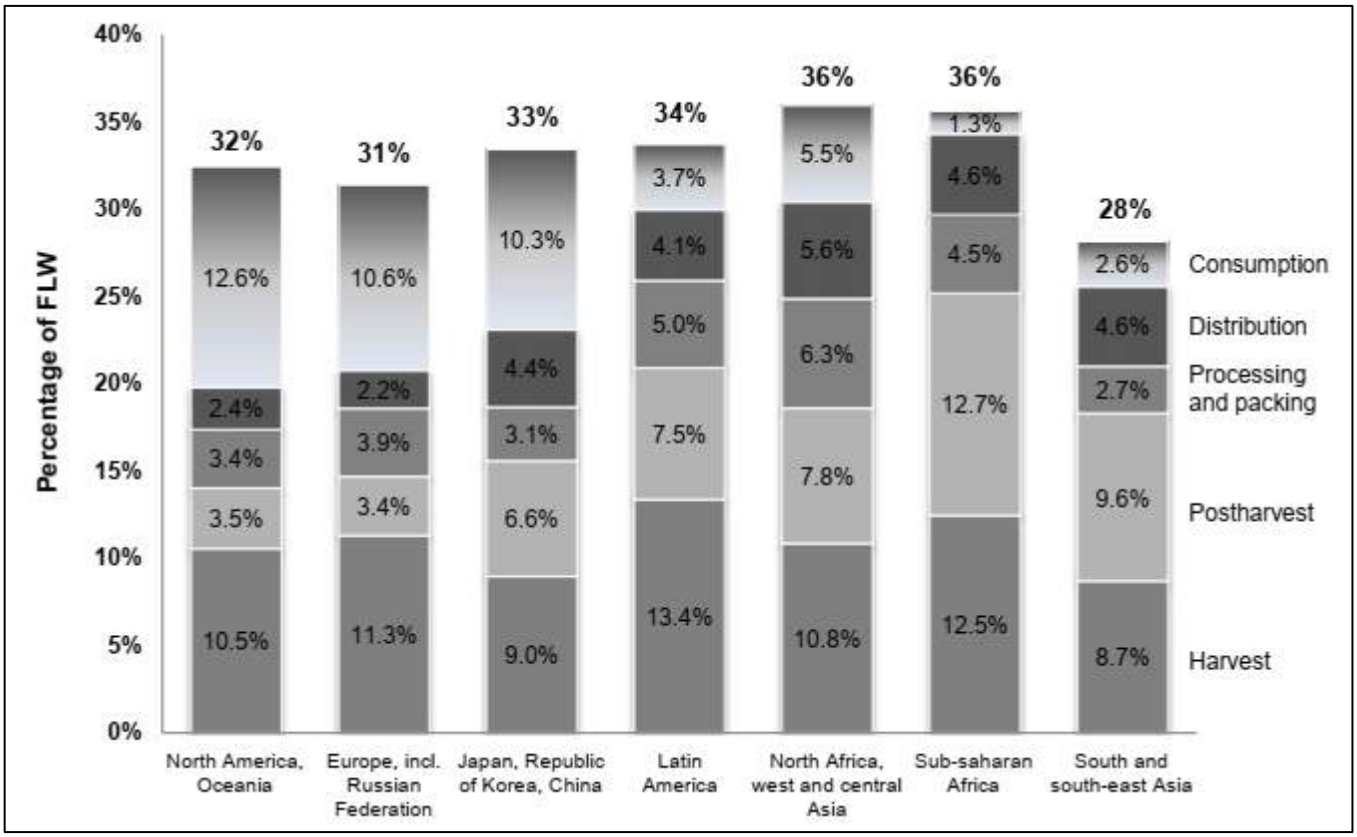

Figure 3. Source: *Food losses and waste in the context of sustainable food systems*, A report by The High-Level Panel of Experts on Food Security and Nutrition, June 2014

1. Circular Economy

1.1 Definitions

In a brief report of the European Parliament on the circular economy package, the circular economy is defined as follows:

> «In a circular economy, products and the materials they contain are valued highly, unlike in the traditional, linear economic model, based on a 'take-make-consume-throw away' pattern. In practice, a circular economy implies reducing waste to a minimum as well as re-using, repairing, refurbishing and recycling existing materials and products. […]»[1].

The EU, in the Communication "Closing the loop - An EU action plan for the Circular Economy", defines the circular economy as:

> «an economy "where the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimised»[2]".

In the EUROSTAT's website:

> «[…] circular economy aims to maintain the value of products, materials and resources for as long as possible by returning them into the product cycle at the end of their use, while minimising the generation of waste. The fewer products we discard, the less materials we extract, the better for our environment.
> This process starts at the very beginning of a product's lifecycle: smart product design and production processes can help save resources, avoid inefficient waste management and create new business opportunities[3]».

The Ellen MacArthur Foundation defined the circular economy 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 return to the biosphere, and aims for the elimination of waste through the superior design of materials, products, systems and business models»[4].

[1] https://www.europarl.europa.eu/RegData/etudes/BRIE/2018/625108/EPRS_BRI(2018)_625108_EN.pdf

[2] COM 614 final, Closing the loop - An EU action plan for the Circular Economy, European Commission, 2015.

[3] https://ec.europa.eu/eurostat/web/circular-economy

[4] Ellen MacArthur Foundation (EMF), *Towards Circular Economy 3*, 2014, https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Towards-the-circular-economy-volume-3.pdf

1.2 Concept of circular economy

The circular economy, for the EMF, rests upon three principles:

- "Principle 1: Preserve and enhance natural capital by controlling finite stocks and balancing renewable resource flows"[5], thus, for example, leading to the regeneration of the soil;
- "Principle 2: Optimise resource yields by circulating products, components, and materials at the highest utility at all times in both technical and biological cycles"[6], thus through reusing, remanufacturing, recycling, refurbishing the materials;
- "Principle 3: Foster system effectiveness by revealing and designing out negative externalities"[7], thus reducing the negative impacts on environment, human and animal health, ecosystems.

For the aim of the thesis, we focus on the biological cycle in the circular economy, which the EMF illustrates it as follows:

> Circular systems also encourage biological nutrients to re-enter the biosphere safely for decomposition to become valuable feedstock for a new cycle. In the biological cycle, products are designed by intention to be consumed or metabolised by the economy and regenerate new resource value. For biological materials, the essence of value creation lies in the opportunity to extract additional value from products and materials by cascading them through other applications[8].

The aim to apply circular economy to food policies is to create "food system that is regenerative, resilient, non-wasteful, and healthier[9]".

[5] Ellen MacArthur Foundation (EMF), *Towards A Circular Economy: Business Rationale for An Accelerated Transition,* 2014, https://www.ellenmacarthurfoundation.org/assets/downloads/TCE_Ellen-MacArthur-Foundation_9-Dec-2015.pdf

[6] Ibid.

[7] Ibid.

[8] Ibid.

[9] Ibid.

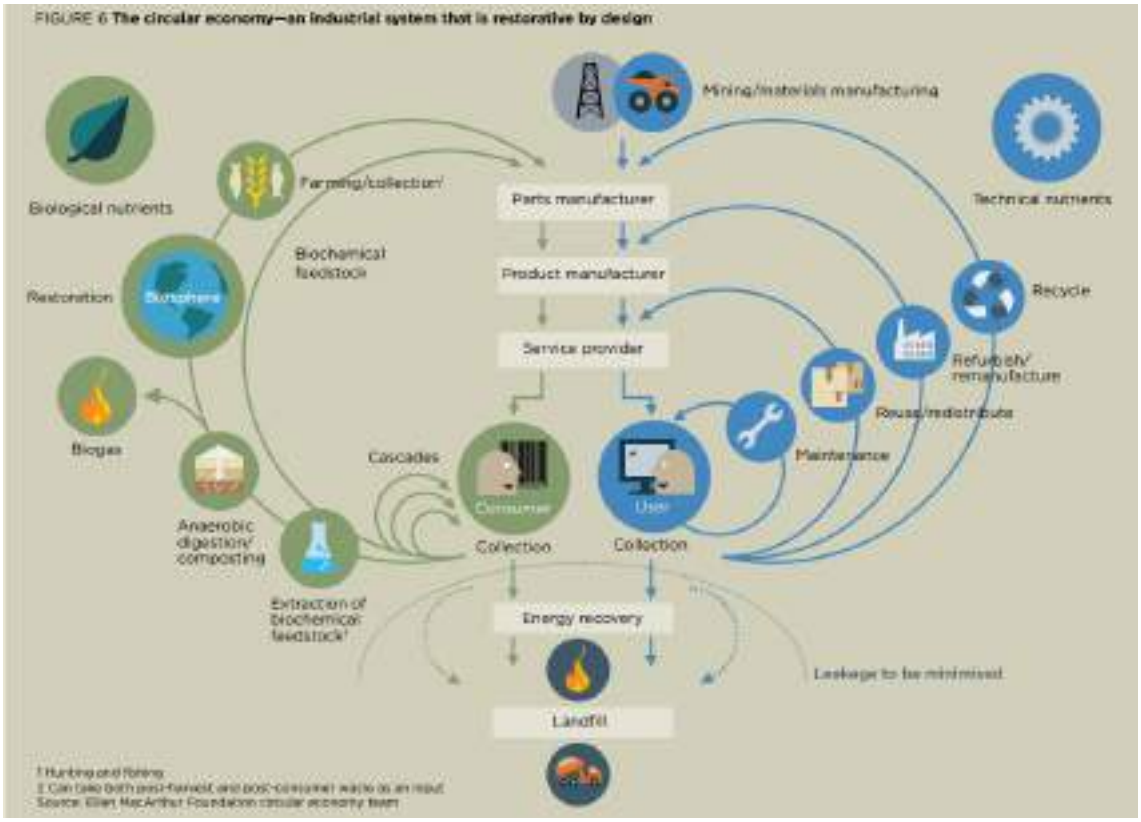

Figure 4. Source: Ellen MarArthur Foundation.

In order to understand how the circular economy is explained by the EMF, it is necessary to define the cycle:

- The **inner circle**: its principle lies in the fact that the tighter the circle is, the more valuable is the method applied. A product can be maintained and repaired and, if it's not possible anymore, its components can be reused or remanufactured;
- The principle of **circling longer**: its aim is to maximise the life of the products, thus extending the number of life-cycles or how many times an inner cycle can be repeated (for, example, the reuse of a product). Prolonging the number of cycles means that the production of a new product can be avoided;
- The principle of **cascaded use:** stands for the diversification of the reuse of a product;
- The principle of **pure inputs**: the use of pure, uncontaminated materials in the circular system means maintain the quality and extends the product's life and its reuse.

These principles can be translated into what the EMF calls "Resolve Framework" (V. Tab 1).

Regenerate	Share	Optimise	Loop	Virtualise	Exchange
Regenerate and restore natural capital	Keep product loop speed low and maximise product utilisation	Optimise system performance	Keep components and materials in closed loops and prioritise inner loops	Deliver utility virtually	Select resource input wisely
• Retain and restore natural capital; • Power by renewable energy; • Return recovered resources to renewables production system	• Share; • Reuse; • Prolong	• Increase efficiency/ remove waste; • Intelligise/big data	• Remanufacture; • Cascade; • -Biochemical extraction and anaerobic digestion	• Virtualise value chains, e.g. online shopping	• Substitute resources directly; • Substitute resources indirectly e.g. dietary and process shifts

Table 1. Source: Growth Within: A Circular Economy Vision For A Competitive Europe, Ellen MacArthur Foundation, 2015, https://www.ellenmacarthurfoundation.org/assets/downloads/publications/EllenMacArthurFoundation_Growth-Within_July15.pdf

1.3 Problems in the food system

The actual food systems are still predominantly following the lineal model: nutrients flows are not created, aggravating the soil degradation and there is no recovery from food waste and waste water, thus leading to further use of incineration and landfills methods. Moreover, the externality costs are not included in the final price of products, maintaining a food system that use in an unsustainable way the resources.

The 31% of food produced is lost or wasted: 11% at consumer level, 9% during the agricultural production stage, 4% at post-harvest and storage step, 5% at processing level and 3% during the distribution[10].

The current agricultural production:

- is responsible for a quarter of the eater withdrawals in Europe[11];

[10] Ellen MacArthur Foundation (EMF), *Growth Within: a Circular Economy Vision for a Competitive Europe*, 2015, https://www.ellenmacarthurfoundation.org/assets/downloads/publications/EllenMacArthur-Foundation_Growth-Within_July15.pdf

[11] Food and Agriculture Organization (FAO), AQUASTAT website, 2015.

- with the heavy use of fertilisers, causes GHG emissions, water pollution and eutrophication, thus damaging the marine ecosystem; their use is also poorly absorbed by crops[12];
- is responsible for soil degradation and biodiversity destruction;
- produces food that is less nutrient than the one produced in the past, contains chemicals and plastics and the production of cheap food (junk food) leads to health issues such as obesity.

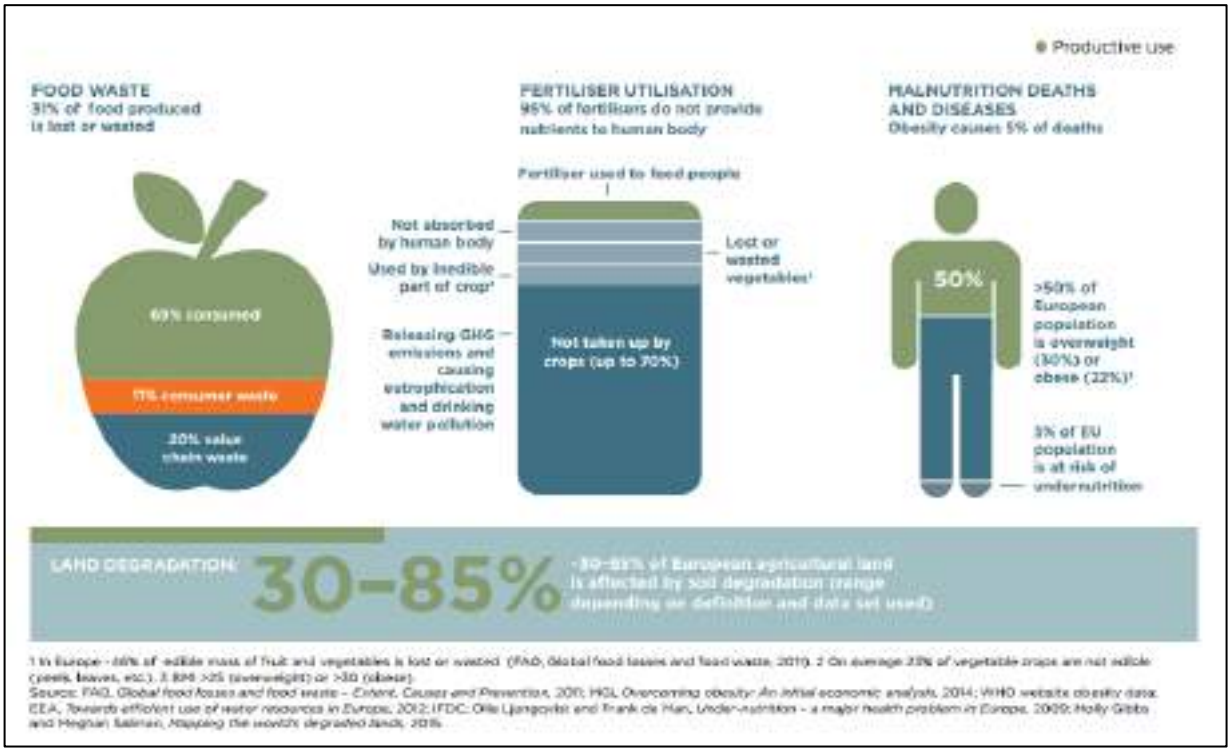

Figure 5. Source: Growth Within: a Circular Economy Vision for a Competitive Europe, Ellen MacArthur Foundation, 2015, https://www.ellenmacarthurfoundation.org/assets/downloads/publications/EllenMacArthurFoundation_Growth-Within_July15.pdf

1.4 How to promote circular economy solutions

The application of new methods of sustainable and regenerative agriculture, such as precision agriculture and organic agriculture, can preserve and enhance the natural capital: establishing closed loop for nutrient flows, thus minimizing the use of pesticides and synthetic fertilizers, promote the recovery of valuable material such as nutrients, energy from the waste streams, sustain the urban- (such as, urban gardens, aquaponic and

[12] IFDC, 2015, http://www.ifdc.org/Technologies/Fertiliser/Fertiliser_Deep_Placement_(UDP).

hydroponic agriculture) and peri-urban farming that provide healthy local food and foster short supply chains, thus promoting healthier diets.

This would mean cost reductions for resource inputs (land, water use as well as fuel, energy), waste generation, reduced GHG emissions while enhancing resource productivity through healthier soil and higher yields and the recirculation of nutrients.

Moreover, the introduction of technology would improve the water, irrigation and fertilizers use, would optimize the inventory management, sale forecasts and replenishment system.

An example is the precision agriculture, defined as "a whole-farm management approach using information technology, satellite positioning (GNSS) data, remote sensing and proximal data gathering. These technologies have the goal of optimising returns on inputs whilst potentially reducing environmental impacts"[13]. An efficient food value chain that designs out waste, enhance agricultural efficiency and optimize resources' use.

However, in this food value chain still remains some issues: the lack of inclusion of externality costs in the food products' prices, the absence of establishing closed loops, the lack of support to local initiatives and organic farming and of a policy framework that would encourage these practices, the recovery and recirculation of nutrients and material and the methods of separate collection of waste.

It is necessary to include these measures and strategies into the food value chain, in order to reach a system that is "regenerative, closing nutrient loops with minimal leakage and maximum long-term value extraction from each loop in short, local supply chains with almost zero waste. The system would offer accessible, fresh, and healthy food that would encourage consumers to embrace a healthier and/or less resource-intensive diet"[14].

This system would also reduce the societal and healthcare's costs, which account up to the 3% of GDP and it would create employment since organic farming and waste management are labor-intensive.

A policy framework that would price externalities would make organic farming more competitive, shift taxes from labour to finite resources and place incentives on recovered nutrients and materials.

[13] Precision Agriculture: An Opportunity For Eu Farmers - Potential Support With The Cap 2014-2020, Directorate-General For Internal Policies, 2014, https://www.europarl.europa.eu/RegData/etudes/note/join/2014/529049/IPOL-AGRI_NT%282014%29529049_EN.pdf

[14] Ellen MacArthur Foundation (EMF), *Growth Within: a Circular Economy Vision for a Competitive Europe*, 2015, https://www.ellenmacarthurfoundation.org/assets/downloads/publications/EllenMacArthur-Foundation_Growth-Within_July15.pdf

1.5 European framework for circular economy

The Directive 2006/12/EC[15] on waste laid the foundation for the legislative framework for handling waste and for the actions that must be undertaken by Member States such as: "the prevention or reduction of waste production and its harmfulness" (Art 3.1 (a)) "the recovery of waste by means of recycling, re-use or reclamation or any other process with a view to extracting secondary raw materials" (Art 3.1 (b) (i)) and "the use of waste as a source of energy" (Art 3.1 (b) (ii)), "without endangering human health and without using processes or methods which could harm the environment" (art 4).

Moreover, it encourages the making of waste management plans and the harmonization of Member States' legislation.

In 2008, the Directive 2008/98/EC[16] revised and the legal framework for waste management by reassuring principles laid out in the 2006 Directive, such as the waste handling must not harm nor human health nor environment, by defining several concepts, but mostly by establishing a "waste hierarchy", a priority order of actions in the waste prevention and management legislation and policy of Member States.

Figure 6. Source: Directive 2008/98/EC, https://ec.europa.eu/environment/waste/framework/

[15] Directive 2006/12/Ec of the European Parliament and of the Council of 5 April 2006 on Waste, https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006: 114:0009: 0021:en:PDF

[16] Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri= CELEX: 32008L 0098

The art. 3 gives the definitions of the actions:

1. **Waste** means any substance or object which the holder discards or intends or is required to discard[17;]
2. **Prevention** means measures taken before a substance, material or product has become waste, that reduce: (a) the quantity of waste, including through the re-use of products or the extension of the life span of products; (b) the adverse impacts of the generated waste on the environment and human health; (c) the content of harmful substances in materials and products[18;]
3. **Preparing for re-use** means checking, cleaning or repairing recovery operations, by which products or components of products that have become waste are prepared so that they can be re-used without any other pre-processing[19;]
4. **Re-use** means any operation by which products or components that are not waste are used again for the same purpose for which they were conceived[20;]
5. **Recycling** means any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes. It includes the reprocessing of organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations[21;]
6. **Disposal** means any operation which is not recovery even where the operation has as a secondary consequence the reclamation of substances or energy[22.]

The Directive also sets out what are:

- by-products (Art. 5), which is a "substance or object, resulting from a production process, the primary aim of which is not the production of that item, may be regarded as not being waste" if it fulfills some conditions: (a) certain use of its further use, (b) can be used directly without any other processing, (c) it's an integral part of the production process and (d) it's lawful[23;]
- end-of-waste status (art. 6) is the status given to certain specified waste "when it has undergone a recovery, including recycling, operation and complies with specific criteria": (a) it's commonly used for specific purposes, (b) market demand

[17] Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri= CELEX: 32008L 0098

[18] Ibidem.

[19] Ibidem.

[20] Ibidem.

[21] Ibidem.

[22] Ibidem.

[23] Ibidem.

exists for it, (c) meets specific legislation and standards and (d) does not have negative impacts on human health and environment[24.]

The Communication COM (2011)21[25] final is the flagship initiative under the Europe 2020, "A resource-efficient Europe".

"This flagship initiative aims to create a framework for policies to support the shift towards a resource-efficient and low-carbon economy which will help us to:

- boost economic performance while reducing resource use;
- identify and create new opportunities for economic growth and greater innovation and boost the EU's competitiveness;
- ensure security of supply of essential resources;
- fight against climate change and limit the environmental impacts of resource use[26]"

In the long-term framework (by 2050), the main measures are:

- creating a low-carbon economy, cutting greenhouse gas emissions by 80-95%;
- creating low-carbon, resource-efficient, secure and competitive energy and transport system;
- decoupling economic growth from resource use and its environmental impact.

While medium-term measures are:

- A strategy to make the EU a 'circular economy', based on a recycling society with the aim of reducing waste generation and using waste as a resource;
- Early action on adaptation to climate change to minimise threats to ecosystems and human health, support economic development and help adjust our infrastructures to cope with unavoidable climate change;
- A water policy that makes water saving measures and increasing water efficiency a priority, in order to ensure that water is available in sufficient quantities, is of appropriate quality, is used sustainably and with minimum resource input, and is ultimately returned to the environment with acceptable quality[27]".

[24] Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri= CELEX: 32008L 0098

[25] Communication From The Commission To The European Parliament, The Council, The European Economic And Social Committee And The Committee Of The Regions A resource-efficient Europe – Flagship initiative under the Europe 2020 Strategy, https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0021:FIN:EN:PDF

[26] Ibidem.

[27] Communication From The Commission To The European Parliament, The Council, The European Economic And Social Committee And The Committee Of The Regions A resource-efficient Europe – Flagship initiative under the Europe 2020 Strategy, https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0021:FIN:EN:PDF

By improving the products' design and increasing recycling rates, the pressure on demand for primary raw materials will be reduced as well as energy consumption and greenhouse gas emissions from extraction and processing, but also making those products more durable and easier to recycle. By aiming to turn Europe into a resource-efficient entity, the reliance on limited raw materials would be reduced, increasing the materials' supply making the Europe's economy more resilient to price raises in global energy and commodities but also create business opportunities.

The communication COM(2015) 614 final[28], called "closing the loop - An EU action plan for the Circular Economy**"**, sets out a concrete and ambitious plan to support the transition towards a circular economy in order to create a sustainable, low-carbon and resource-efficient and competitive economy.

The Commission propose different type of interventions in several areas:

- the production process,
- the consumption,
- the waste management,
- the secondary raw materials' market and the water reuse,
- the innovation in the industry,
- the priority areas: plastics, food waste, critical raw materials, construction and demolition and biomass and bio-based products.

Regarding the production process, the action plan aims to better the design phase and the production process in order to make products more durable or easier to repair, upgrade or recycle. In this way, the products will be easier to disassemble in order to recover valuable materials and components, reducing the impact on sourcing, resource use and waste generation.

The design phase will reflect the Ecodesign Directive's (Directive 2009/125/EC[29]) requirements in order to improve the efficiency and environmental performance of energy-related products.

Economic incentives will be given to design products that can be more easily recycled or reused through provisions on extended producer responsibility.

[28] Communication From The Commission To The European Parliament, The Council, The European Economic And Social Committee And The Committee Of The Regions Closing The Loop - An EU Action Plan For The Circular Economy, https://eur-lex.europa.eu/resource.html?uri=cellar:8a8ef5e8-99a0-11e5-b3b7-01aa75ed71a1.0012.02/DOC_1&format=PDF

[29] Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products, https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32009L0125

The Commission will promote the BREFs (best available technique reference documents) in order to share the best practices on resource use, waste generation and management, to which Member States have to align when issuing permit requirements for industrial installations.

In addition, the Commission will promote the use of renewable products, included by-products to become inputs of one industry to another.

The action plan stresses the importance of the citizens' awareness of the impacts of the products they consume. The lines of action foreseen in this direction mainly concern information on products, including: reliability of the product's information; an improved labelling system regarding information concerning the contribution to the circular economy (such as durability and reparability); the support to the development of a methodological standard for measuring the environmental performance of the product through the environmental footprint.

The action plan also aims to contrast planned obsolescence and encourage the Green Public Procurement (GPP), by including circular economy principles in the criteria used by public procurements, which accounts for circa the 20% of European GDP.

Regarding the waste management, the action plan underline the importance of the waste hierarchy, with the aim of increasing the quality of recovered materials (also through voluntary certification) as well as the return back to the economy of valuable materials and, at the same time, the reduction of landfills and inefficient waste management practices which may have harmful impacts on environment and relevant economic losses.

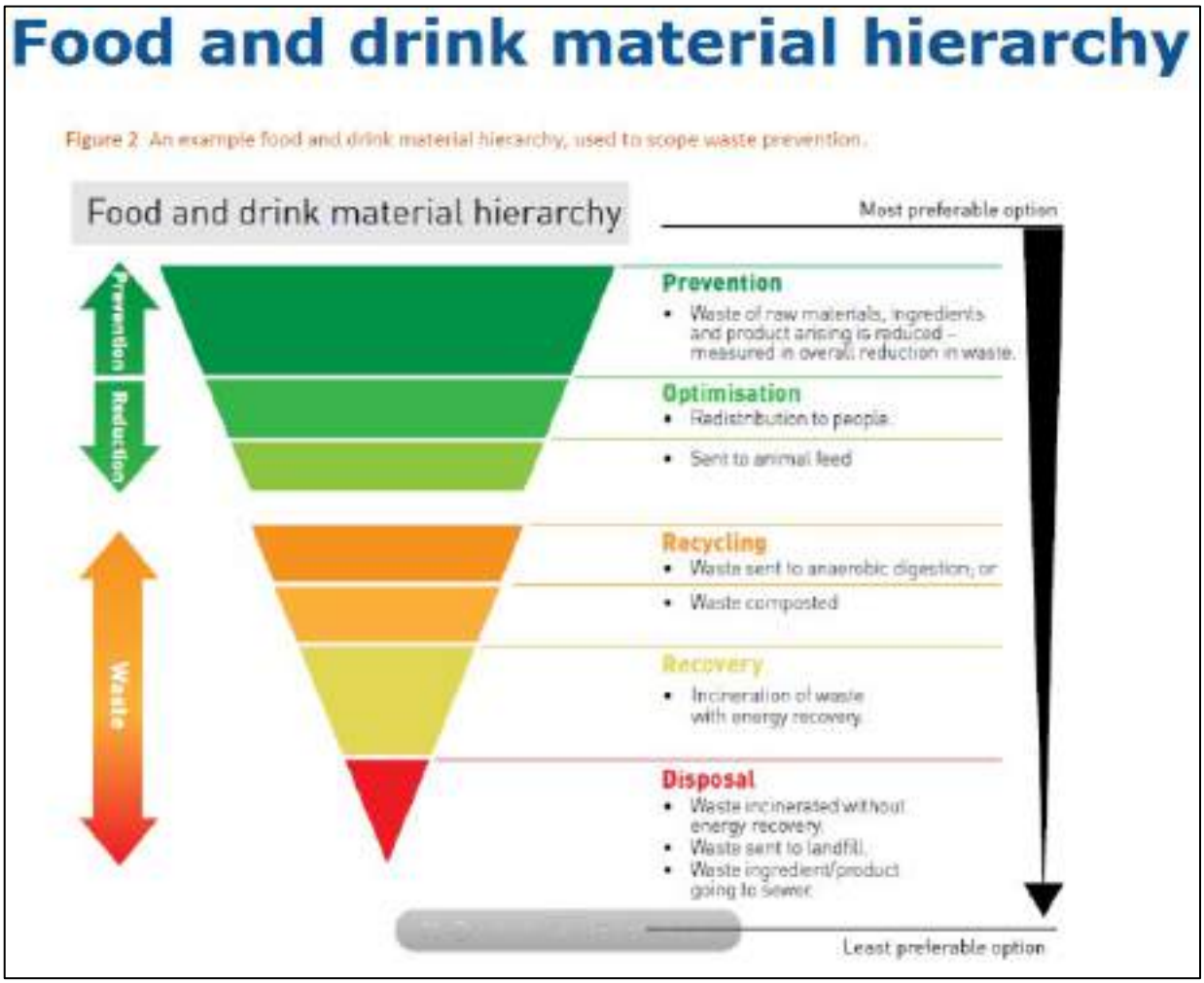

Figure 7. Source: UNEP/Think-Eat-Save, FAO, WRAP, 2014

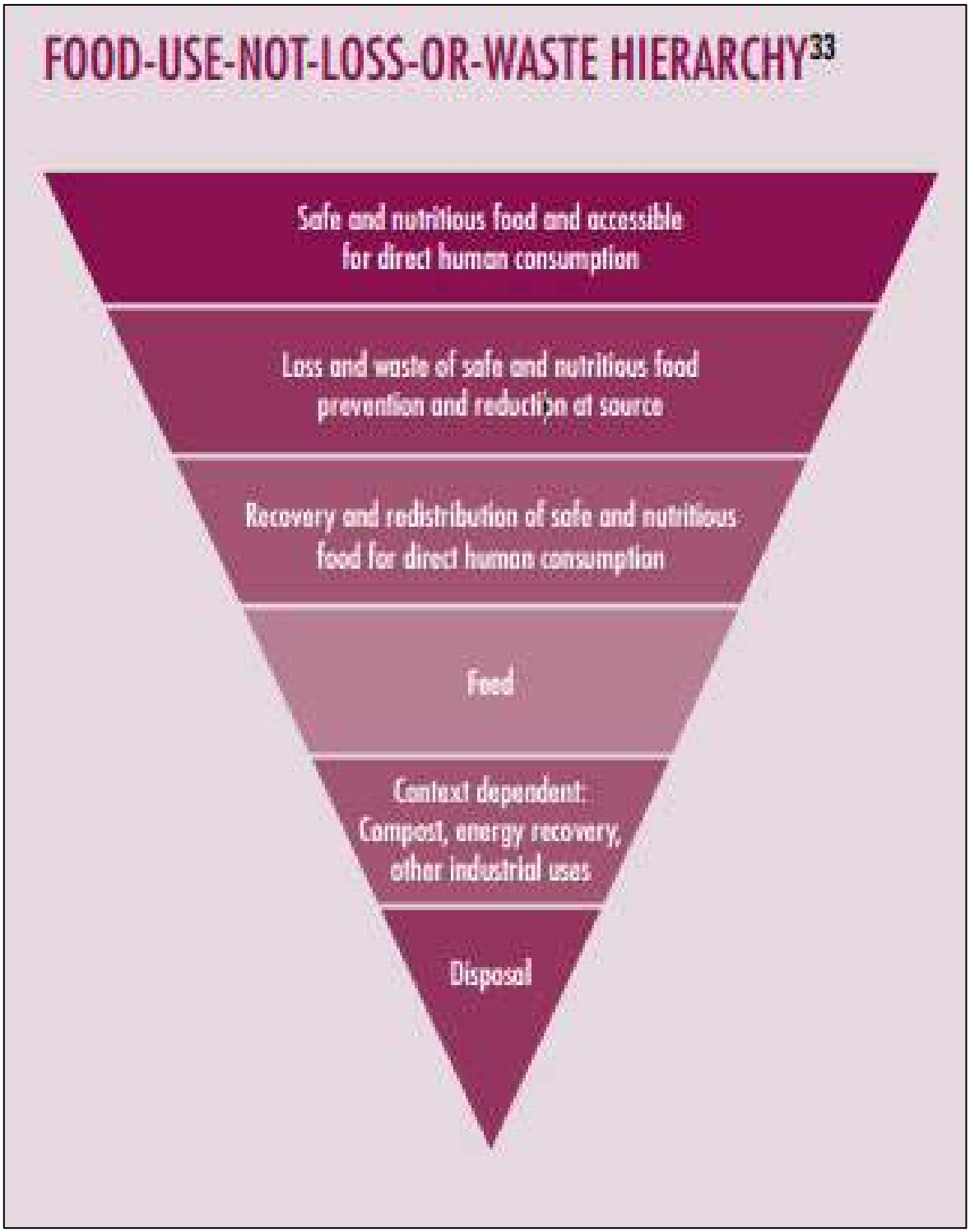

Figure 8 - Source: FAO

Only circa 40% of waste produces by EU household is recycled, however there's a big difference between Member States, with rates going from 5% to 80%. Therefore, the Commission stresses the key role of the EU Cohesion policy, supporting the Member States to comply with the EU's waste legislation, in particular with the waste hierarchy. To this end, statistics regarding the recycling rates will be collected in order to ensure comparable statistics across the EU.

Great importance is also given to secondary raw materials, which are "materials that can be recycled are injected back into the economy as new raw materials". Example of these materials are usable waste of ferrous and nonferrous materials as well as precious metals, but also waste paper. They increase the security of supply, reduce the material needed, the energy used for the production as well as the impacts on the environment.

However, there are several barriers to the use of secondary raw materials: alongside the absence of EU-wide standards of quality, the need to develop traceability and risk management methods of chemicals of concern in recycled materials in order to improve the uptake of secondary raw materials as well as preserve the protection of human health and of the environment. Moreover, there are several difficulties linked to the trade of these materials: a dynamic market needs to be created in order to stimulate the demand of recycled products and facilitate the cross-border circulation of the secondary raw materials.

The Commission will also intervene by revising the legislation regarding the "end-of-waste" materials and the EU regulations on fertilisers. Instead of mineral-based fertilizers, new measures will be taken in order to promote the use of organic and waste-based fertilisers.

In addition, the action plan focuses on 5 priority areas: plastics, food waste, critical raw materials, construction and demolition and biomass and bio-based products, given to "the specificities of their products or value-chains, their environmental footprint or dependency on material from outside Europe".

Regarding the plastics, the "*Commission will adopt a strategy on plastics in the circular economy, addressing issues such as recyclability, biodegradability, the presence of hazardous substances of concern in certain plastics, and marine litter*". The strategy will intervene throughout the value chain and the entire life cycle of plastics, preventing the use of landfills and negative impacts on the environment.

About the food waste, which is an increasing concern in Europe, the Commission, with Member States and stakeholders, will develop a methodology to measure food waste generated throughout the entire value chain (production, distribution, conservation and

consumption) and define significant indicators. To this end, a dedicated platform will be created to share best practices and the evaluation of progresses in order to achieve the SDGs' targets on food waste.

Regarding the critical raw materials, which are the materials of high economic importance for the EU and are vulnerable to supply disruption, the EU aims to the betterment of recycling these valuable materials, such as electronic waste, by intervening on the product design, by creating recycling standards of these materials and the sharing of best practices on these issues.

For what concerns the construction and demolition sector, which is among the biggest sources of waste, the Commission will take several measures to ensure the recovery, the recycle and the reuse of the materials. To this aim, guidelines on how to collect and sort materials on construction and demolition sites will be created and indicators to assess the environmental performance a building will be developed.

For biomass and bio-based materials, such as wood, the Action Plan includes measures to encourage cascade use of renewable resources, which can go through several reuse and recycling cycles, through the dissemination of guidelines and good practices, as well as a possible update of the bioeconomy strategy within the framework of the circular economy.

At the end, the Communication speaks about the importance of innovation, to which the EU will provide funds for over €650 million, and the need to develop a monitoring framework to measure the progress towards a circular economy.

Figure 9. Source: COM/2018/029 final, https://eur-lex.europa.eu/legalcontent/EN/TXT/?uri=COM%3A2018%3A29%3AFIN

DIMENSION	INDICATOR	SUB-INDICATOR
Production and consumption	1. EU self-efficiency for raw materials 2. Green public procurement 3. Waste generation 4. Food waste	3a. Generation of municipal waste per capita 3b. Generation of waste excluding major mineral wastes per GPD 3c. Generation of waste excluding major mineral wastes per domestic material consumption
Waste Management	5. Recycling rates 6. Recycling/Recovery for specific waste streams	5a. Recycling rate of municipal waste (percentage) 5b. Recycling rate of all waste excluding major mineral waste 6a. Recycling rate of overall packaging 6b. Recycling rate of plastic packaging 6c. Recycling rate of wooden packaging 6d. Recycling rate of e-waste 6e. Recycling of biowaste 6f. Recovery rate of construction and demolition waste
Secondary Raw Materials	7. Contribution of recycled materials to raw materials demand 8. Trade in recyclable raw materials	7a. End-of-life recycling input rates (EOL-RIR) 7b. Circular material use rate 8a. Imports from non-EU countries 8b. Exports to non-EU countries 8c. Intra EU trade
Competitiveness and innovation	9. Private investment, jobs and gross value added related to circular economy sectors 10. Number of patents related to recycling and secondary raw materials	9a. Gross investment in tangible goods 9b. Persons employed 9c. Value added at factor cost

Table 2. Source: Rielaboration made on EUROSTAT's Circular economy indicators, https://ec.europa.eu/eurostat/web/circular-economy/indicators/monitoring-framework

The Communication COM(2018) 29 final[30,] "on a monitoring framework for the circular economy" sets a monitoring framework for measuring the progress of Member States towards circular. economy through 4 main dimensions, 10 indicators with sub-indicators.

[30] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on a monitoring framework for the circular economy, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2018%3A29%3AFIN

2. Food Policy

According to the United Nations' Revision of World Urbanization Prospects (2018), the 55% of the world's population lives in urban areas, and it is expected to increase to 68% by 2050[1]. This process of urbanization – to which poverty and insecurity are increasingly becoming associated with – necessarily needs to be regulated by a solid framework of sustainable urban development. In particular, the food systems are being challenged "by inter alia, unbalanced distribution and access, environmental degradation, resource scarcity and climate change, unsustainable production and consumption patterns, and food loss and waste"[2]. Thus, it is essential to create "more sustainable food systems and mainstreaming the critical need for a socially inclusive and a rights-based approach in urban food policy". In fact, food insecurity in the cities is closely associated to inequitable distribution of resources[3].

The food policies not only affect food-related issues but they can also affect the various dimensions of sustainable development (economic, environmental and social): for example, it is estimated that the 30% of the total emission of greenhouse gas (GHG) are produced by food systems.

The global food system can be divided in the upstream sector, which is agricultural areas (prevalently rural) and the downstream sector, which regards the consumption centres, mainly urban. The focus here will be on the downstream sector.

Cities accounts for the 70% of global food supply (represented by urban food markets)[4], 75% of natural resources are consumed[5], the production of the 50% of global

[1] Milan Urban Food Policy Pact Monitoring Framework, 2019, http://www.milanurbanfoodpolicypact.org/wp-content/uploads/2019/11/CA6144EN.pdf

[2] Milan Urban Food Policy Pact, 2015, http://www.milanurbanfoodpolicypact.org/wp-content/uploads/2016/06/Milan-Urban-Food-Policy-Pact-EN.pdf

[3] UN Habitat. 2010. *The State of the World Cities 2010/2011. Bridging the Urban Divide. State of the World's Cities Reports*, Nairobi, Kenya, 244, (also available at: https://sustainabledevelopment.un.org/content/documents/11143016_alt.pdf).

[4] WB. 2015. *Investing in Urban Resilience. Protecting and Promoting Development in a Changing World* [online]. Washington DC. [Cited 25/09/2019]. https://www.gfdrr.org/sites/default/files/publication/Investing%20in%20Urban%20Resilience%20Final.pdf

[5] Ellen MacArthur Foundation (EMF), *Cities and the circular economy for food*, 2018.

waste[6] and the generation of the emission of 60-80% of GHG[7]. Thus cities represent ideal place where to test and develop food policies.

2.1 Definitions and Concepts

Tim Lang defines, in a reductive way the food policies, as those policies that deal with "who eat what, when, and how, whether people (and animals) eat and with what consequences"[8].

A well more defined definition of the concept is given by IPES Food:

> «An urban food policy is a concerted action on the part of city government to address food-related challenges […] through significant involvement of civil society and other actors […]. Integrated urban food policies refer to policies seeking to address multiple food systems challenges, and typically require multiple government departments and policy areas to be bridged and novel governance bodies to be established. The process of developing integrated urban food policies often starts with an assessment of all the food-related challenges faced by the city, and the whole range of policy levers the city has at its disposal to deal with them (Bricas, 2017). However, most urban food policies consist of targeted actions with specific goals, […] (e.g. obesity, food waste). Such actions can pave the way for – and be incorporated into – integrated food policies at a later stage and may also have benefits in other policy areas. […] Many problems associated with the food system are contingent on imperatives at the national and international levels, e.g. trade, economic, agriculture and public health policies, and cannot be fully addressed at the city level»[9].

Therefore, in the circular economy and in the food policies, it is essential to develop a governance system that includes multiple levels of power (local national, and international) and multiple actors (citizens, governments bodies, NGOs, experts and private businesses).

> «Only a participatory, collaborative, inclusive, diversified governance of this kind would facilitate the development of an economy that functions in the long term as regenerative»[10].

[6] Ellen MacArthur Foundation (EMF), *Cities and the circular economy for food*, 2018.

[7] Ibid.

[8] Lang, T., Barling, D., Caraher, M., *Food Policy: Integrating Health, Environment and Society*; OUP Oxford: Oxford, UK, 2009

[9] IPES-Food, *What makes urban food policy happen?*, International Panel of experts on sustainable food system, 2017..

[10] Fassio F., Minotti B., *Circular Economy for Food Policy: The Case of the RePoPP Project in The City of Turin (Italy)*, MDPI, 2019.

2.2 Milan Urban Food Policy Pact (MUFFP)

This is the context in which the Milan Urban Food Policy Pact (MUFPP) was signed, in 2015, by city delegations (163 in 2018[11,] of which 84 in Europe[12)] from all the world.

The cities will adopt a food policy that aim to:

- develop "sustainable food systems that are inclusive, resilient, safe and diverse, that provide healthy and affordable food to all people in a human rights-based framework, that minimise waste and conserve biodiversity while adapting to and mitigating impacts of climate change[13]";
- the coordination of actions at city level (municipal and community levels as well as between city departments and agencies) and with regional and national food-related policies;
- the creation of programmes and initiatives regarding the entire food supply chain (thus including the production, the distribution, the safety) as well as social protection, education and waste reduction.

The MUFPP was accompanied by an Urban Food Policy Framework for Action, which lists 44 indicators and a series of 37 recommended actions that should be taken in: ensuring an enabling environment for effective action, sustainable diets and nutrition, social and economy equity, food production, supply and distribution as well as food waste. The Framework is built "upon the direct experience of participating cities and takes into account relevant diverse commitments, goals and targets[14]" and the guidelines and the actions can be adjust to fit the particular situation of every city that will voluntarily decide to comply with the MUFPP.

2.3 Indicators[15]

Among the recommended actions, the MUFPP suggests to:

- Develop or revise urban food policies and plans, ensuring a food system that is more sustainable and equitable, taking into account both urban and rural interests;

[11] Milan Urban Food Policy Pact, 3rd Annual Gathering and Mayor Summit, 2017, http://www.milanurbanfoodpolicypact.org/wp-content/uploads/2018/02/3rd-MUFPP-Annual-Gathering-REPORT.pdf

[12] Ibid.

[13] Milan Urban Food Policy Pact, 2015, http://www.milanurbanfoodpolicypact.org/wp-content/uploads/2016/06/Milan-Urban-Food-Policy-Pact-EN.pdf

[14] Ibid.

[15] Milan Urban Food Policy Pact Monitoring Framework Indicators, http://www.milanurbanfoodpolicypact.org/milan-urban-food-policy-pact-monitoring-framework/

- Facilitate collaboration across actors and institutions involved, enhance stakeholder participation
- Develop information systems where data can be gathered and the progresses of the food policies and plans assessed as well as where the best practices can be shared;
- Creation of "sustainable dietary guidelines to inform consumers, city planners[16]" in order to "promote sustainable diets (healthy, safe, culturally appropriate, environmentally friendly and rights-based)[17]" and communication of the diseases related with poor diets and obesity;
- Provide access to healthy food to vulnerable individuals through the creation of social protection systems, such as food banks and community food kitchens;
- "increase social and economic equity, promote rights-based approaches, alleviate poverty and facilitate access to adequate and nutritious foods[18]" through education (in particular in school feeding programmes), supporting workers' rights (such as fair wages and improved labour conditions in the agricultural sector), promoting full inclusion of women, creating social and solidarity economy activities that aim to "create social inclusion and provide food to marginalized individuals[19]";
- Promote the integration of urban and peri-urban agriculture into the city's food policies plans and strategies and strengthen its food production;
- Provide access to municipal land to farmers in order to develop and increase local agricultural production, especially urban and peri-urban land. Municipal land would include land useful for the promotion of community gardeners and urban gardens;
- Provide services to food producers in urban and peri-urban areas, though consulting, technical training and grants in order to promote also sustainable food systems where compost and energy can be made by food waste, the re-use of grey water;
- Create, develop and support short food chains, linking urban and rural areas;
- Ensure that in low-income or underserved areas, the access to healthy and affordable food is given, also through sustainable strategies of transportation and logistics;
- Create and improve a monitoring system that allow food supply chain agents and city planners to monitor and asses food losses and waste throughout the food supply chain;
- "Raise awareness of food loss and waste through targeted events and campaigns[20]";

[16] Milan Urban Food Policy Pact Monitoring Framework Indicators, http://www.milanurbanfoodpolicypact.org/milan-urban-food-policy-pact-monitoring-framework/

[17] Ibid.

[18] Ibid.

[19] Ibid.

[20] Ibid.

- Facilitate "recovery and redistribution for human consumption of safe and nutritious foods[21]".

2.4 Barriers and constraints to the promotion of urban food policies

According to the Brief Report (2017) of the 3rd Annual Gathering and Mayor Summit, cities pointed out some persistent constraints and challenges in integrate food policies into their plans: "lack of specific responsibilities on health issues; constraints on the possibilities for cities to promote local products through public procurement and lack of collaboration across city departments, lack of alignment of policies and programs that impact the food system[22]" as well as the nonexistent or weak governance structures, the absence of resources and the poor professional experience in addressing these obstacles in the food system[23].

[21] Milan Urban Food Policy Pact Monitoring Framework Indicators, http://www.milanurbanfoodpolicypact.org/milan-urban-food-policy-pact-monitoring-framework/

[22] Milan Urban Food Policy Pact, 3rd Annual Gathering and Mayor Summit, 2017, http://www.milanurbanfoodpolicypact.org/wp-content/uploads/2018/02/3rd-MUFPP-Annual-Gathering-REPORT.pdf

[23] The Role of Cities in the Transformation of Food Systems: Sharing Lessons from Milan Pact Cities, Fao, 2018 http://www.milanurbanfoodpolicypact.org/wp-content/uploads/2018/10/CA0912EN.pdf

3. Food Loss and Waste (FLW): concepts and definitions

In order to understand when food losses and waste take place, it's necessary to define what is food, its parts and what is considered food waste and what is food loss.

> **Food**
> «Any substance—whether processed, semi-processed, or raw—that is intended for human consumption. "Food" includes drink, and any substance that has been used in the manufacture, preparation, or treatment of food. "Food" also includes material that has spoiled and is therefore no longer fit for human consumption»[1].
> **Inedible parts**
> «Components associated with a food that, in a particular food supply chain, are not intended to be consumed (under normal circumstances) by humans. Examples of inedible parts associated with food could include bones[2].
> The inedible parts of food may be re-used, recovered, recycled or used for non-food uses, such as energy recovery».

In the STREFOWA Project, it is further defined what **avoidable food waste** is. It is originally edible parts (es: whole unused food, partly consumed food, consumption residues)[3].

3.1 FAO definitions

FAO defines **Food waste (FW)** as food appropriate for human consumption being discarded or left to spoil *at consumer level* – regardless of the cause[4]. Often this is because food has spoiled but it can be for other reasons such as oversupply due to markets, or individual consumer shopping/eating habits.[5]

Therefore, food losses occur before consumption, while food waste occurs at the consumption level.

[1] C. Hanson et al., *The Food Loss and Waste Accounting and Reporting Standard (or FLW Standard)*, 2016.
[2] Ibid.
[3] Report On Status Quo Of Food Waste Prevention and Management, Interreg Central Europe, 2016
[4] Ibid.
[5] Food and Agriculture Organization (FAO), *Food wastage footprint; impacts on natural resources.* Summary Report. Rome, 2013.

3.2 FUSIONS definitions

FUSIONS defines *Food waste* *as* any food, and inedible parts of food, removed from the food, supply chain to be recovered or disposed, including the following destinations: composting, crops ploughed in/not harvested, anaerobic digestion, bio-energy production, cogeneration, incineration, disposal to sewer, landfill or discarded to sea but not including food or inedible parts of food removed from the food supply chain sent to animal feed or used for the production of bio-based material/biochemical processing[6.]

3.3 HLPE definitions

Food losses and waste (FLW) is defined as "a decrease, at all stages of the food chain from harvest to consumption, in mass, of food (and inedible parts of food[7)] that was originally intended for human consumption, regardless of the cause"[8.]

Food losses (FL) refers to a decrease, at all stages of the food chain prior to the consumer level, in mass, of food that was originally intended for human consumption, regardless of the cause[9.] These losses are mainly caused by inefficiencies in the food supply chains, such as poor infrastructure and logistics, lack of technology, insufficient skills, knowledge and management capacity of supply chain actors, and lack of access to markets. In addition, natural disasters play a role.[10]

Food quality loss or waste (FQLW) refers to the decrease of a quality attribute of food (nutrition, aspect, etc.), linked to the degradation of the product, at all stages of the food chain from harvest to consumption[11.] Food quality loss is difficult to measure: fresh products loses nutritional (such as macro- and micronutrients, vitamins and minerals), economic qualities (such as aspect, shape, color) over time. THE FQLW leads to a loss of economic value: when food has lost most of its quality, it is often discarded.

Regarding FLW, there are two different approaches:

[6] EU FUSIONS, *Recommendations and guidelines for a common European food waste policy framework*, 2016.

[7] Food and Agriculture Organization (FAO), *Food wastage footprint; impacts on natural resources.* Summary Report. Rome, 2013.

[8] *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, June 2014.

[9] Ibid.

[10] Food and Agriculture Organization (FAO), *Food wastage footprint; impacts on natural resources.* Summary Report. Rome, 2013.

[11] Ibid.

- The *waste-focused* approach aims to reducing waste production and the negative impacts and costs of the treatment of waste; [12.]
- The *food-focused* approach considers the food and food losses and waste along the food chain, thus it aims to the improvement of the food system.[13]

3.4 Food Waste and Loss in the European Union's legal Framework

For the European Communities, the definition of food is given by the Regulation (EC) no. 178/2002:

> «[…] 'food' (or 'foodstuff') means any substance or product, whether processed, partially processed or unprocessed, intended to be, or reasonably expected to be ingested by humans. 'Food' includes drink, chewing gum and any substance, including water, intentionally incorporated into the food during its manufacture, preparation or treatment. […]»[14.]

Food' shall not include:

- feed;
- live animals unless they are prepared for placing on the market for human consumption;
- plants prior to harvesting.

However, the regulation does not speak yet of the food waste and loss.

In 2008, the Directive 2008/98/EC gave the definition of waste in article 3:

"Waste" means any substance or object which the holder discards or intends or is required to discard"[15.]

Excluded by the scope of the Directive are:

> «[…] agricultural or forestry material used in farming, forestry or for the production of energy from such biomass […][16"] and "animal by-products […], except those which are destined for incineration, landfilling or use in a biogas or composting plant[17»].

[12] *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, June 2014.

[13] *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, June 2014.

[14] Regulation (Ec) No 178/2002 of the European Parliament and of the Council of 28 January 2002, Official Journal of the European Communities.

[15] Directive 2008/98/EC Article 3.

[16] Directive 2008/98/EC Article 2.

[17] Directive 2008/98/EC Article 2.

The Directive also established the waste hierarchy (will be seen in more depth in the circular economy paragraph), in which food was included in the waste definition but not yet of food waste nor food losses.

In 2015, there's a proposal to amend the above-mentioned Directive, with the COM (2015) 595.

At the article 9, the measures that should reduce the waste, shall also "reduce the generation of food waste in primary production, in processing and manufacturing, in retail and other distribution of food, in restaurants and food services as well as in households"[18].

Moreover:

1. "Member States shall monitor and assess the implementation of the waste prevention measures. For that purpose, they shall use appropriate qualitative or quantitative indicators and targets, notably on the per capita quantity of municipal waste that is disposed of or subject to energy recovery"[19].
2. "Member States shall monitor and assess the implementation of their food waste prevention measures […]"[20].
3. "[…] In order to ensure uniform measurement of the levels of food waste, the Commission shall adopt an implementing act to establish a common methodology, including minimum quality requirements. […]"[21].

In the Communication, a broad definition of food waste was given:

> «Food waste means food lost at retail and consumer levels and food losses along production and supply chains, including post-harvest losses»[22].

It also proposed several goals:

1. By 2030, reduce food waste and food losses by 50%;
2. By 2017, Adopt a common methodology to measure food waste;
3. National Waste Prevention Programmes shall reflect the EU food waste reduction targets.

Moreover, it was proposed to exclude feed materials from the Directive in order to facilitate the use of former food products in feed, however the precondition is to ensure

[18] Proposal to amend Directive 2008/98/EC (COM(2015) 595), European Commission, 2015, https://ec.europa.eu/food/sites/food/files/safety/docs/fw_eu-actions_ms_20160622_p02.pdf

[19] Ibid.

[20] Ibid.

[21] Ibid.

[22] Ibid.

the food and feed safety: the prevention of food waste cannot damage human or animal health[23.]

3.4.1 *A common methodology to measure food waste*

In 2018, the Commission delegates an Expert Group on Food Losses and Food Waste to establish a common methodology to measure food waste.

The group presents a new proposal to amend Directive 2008/98/EC on waste, on the base of the COM (2015) 595.

Among the measure to reduce the waste generation, the EU Member States shall take measures to at least:

- reduce the generation of food waste in primary production, in processing and manufacturing, in retail and other distribution of food, in restaurants and food services as well as in households as a contribution to the United Nations Sustainable Development Goal to reduce by 50 % the per capita global food waste at the retail and consumer levels and to reduce food losses along production and supply chains by 2030[24] (article 9);
- encourage food donation and other redistribution for human consumption, prioritizing human use over animal feed and the reprocessing into non-food products"[25] (article 9);
- Member States shall adopt specific food waste prevention programs within their waste prevention programs […][26] (article 22.2a).

Other obligation for the Member States are:

- the monitoring and then assessment of the implementation of their food waste prevention measures (article 9);
- shall report their results every year (art 37).

[23] , A. Nikolakopoulou, *Food waste prevention in Circular Economy Action Plan*, European Commission, DG Health and Food Safety Head of Unit (E1), 2016, https://ec.europa.eu/food/sites/food/files/safety/docs/fw_eu-actions_ms_20160622_p01.pdf

[24] Delegation for the Commission to establish a common methodology to measure food waste – legal provisions and planning of work, Dr Tim Gumbel, Deputy Head of Unit, DG SANTE Unit E1, 2018, https://ec.europa.eu/food/sites/food/files/safety/docs/fw_eu-actions_ms_20180316_p01.pdf

[25] Ibid.

[26] Ibid.

While the Commission has to establish "a common methodology and minimum quality requirements for the uniform measurement of level of food waste[27]".

The Expert Group on Food Losses and Food Waste reports the development of 2 indicators in order to monitor the SDG 12.3: the FLI and the FWI.

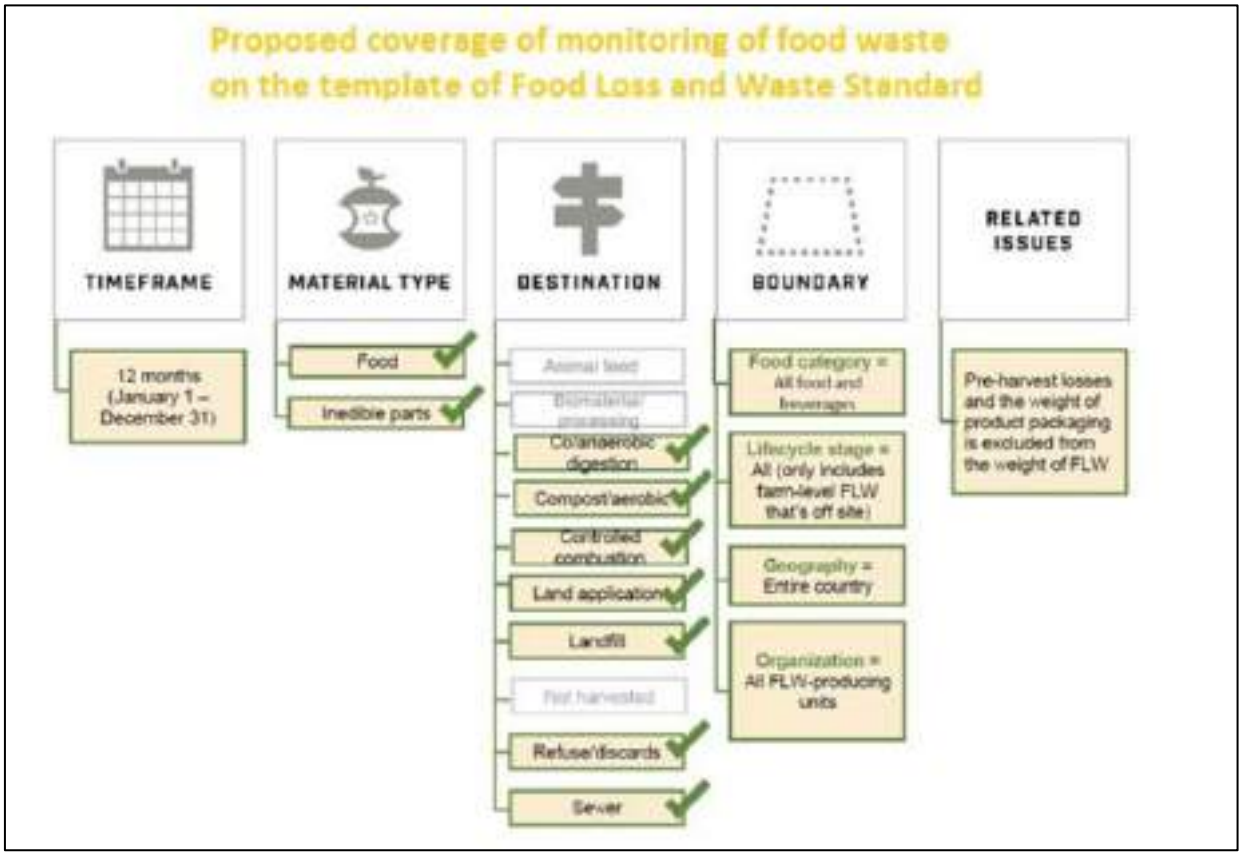

Figure 10. Source: https://ec.europa.eu/food/sites/food/files/safety/docs/fw_eu-actions_ms_20180316_p03.pdf

[27] Delegation for the Commission to establish a common methodology to measure food waste – legal provisions and planning of work, Dr Tim Gumbel, Deputy Head of Unit, DG SANTE Unit E1, 2018, https://ec.europa.eu/food/sites/food/files/safety/docs/fw_eu-actions_ms_20180316_p01.pdf

The monitoring, however, excludes:

- due to definition of food, pre-harvest losses;
- due to scope of waste legislation, agriculture biomass (including harvest losses), by-products (as not being a waste) and animal by-products (until disposed as a waste)[28.]

Later, based on food definition:

- water, other than intentionally found in food, is excluded[29;]
- packaging, as non-food material, is excluded[30.]

The Expert Group proposed a monitoring system for all the 5 stages of the food supply chain and reported them separately[31.]

Moreover, a separate monitoring is proposed for:

- food waste to waste treatment, such as composting, bio-gas, incineration, land-filling;
- for food waste to sewer.

The former can be monitored with existing waste reporting, the latter requires the setup of a new system to measure it.

The obligation of the monitoring is upon the Member States, which will have to provide explanations concerning the methods used to monitor food.

Member States are also obliged to a periodical reporting:

> «Every year, a report of estimated amounts of food waste must be presented and it's based on collected socio-economic data and general waste data. It "would require analysis of the links between amounts of waste generation and economic activity – like production volume or turnover – of the companies or production sectors (e.g. oils, meat, dairy, bakery etc.)[32"]. Estimations could be produced using data on municipal/household waste generation.
> Every 4 years a detailed analysis of the amounts of food waste must be presented. It "would require analysis of the food processing industry in order to identify its structure (sectors, products, typical waste, number of companies, size, production

[28] Summary of preparatory work within EU Platform of Food Losses and Food Waste, Bartosz Zambrzycki, European Commission, DG Health and Food Safety Unit E1, 2018, https://ec.europa.eu/food/sites/food/files/safety/docs/fw_eu-actions_ms_20180316_p03.pdf

[29] Main elements of the delegated act Bartosz Zambrzycki European Commission, DG Health and Food Safety Unit E1, 2018, https://ec.europa.eu/food/sites/food/files/safety/docs/fw_eu-actions_ms_20180316_p02.pdf

[30] Ibid.

[31] Ibid.

[32] Ibid.

volume turnover). Information obtained from the companies (or representative sample of them)[33]". Data would be produced through a compositional analysis of the bin, while the food waste discarded via the sewer through kitchen diaries».

Several methods to measure food waste are presented[34:]

- Direct measurement: whether it is based on weighing or volumetric assessment;
- Scanning: counting the number of items that compose food waste and determine the weight;
- Waste composition analysis –separating physically food waste from other waste and assess the weight;
- Diaries –keep a log of the food waste in a consistent manner.
- Mass balance –calculate the mass of food waste as result of the inputs and of the outputs of food into and out of the food system;
- Coefficients, Establishing food wastage coefficients or percentages representative through sampling, based on data provided by food business operators.

Re-use of food waste –in our view it is legally impossible. Once food becomes food waste, it can only be recycled, not re-used[35.]

[33] Detailed analysis and its recommended methods, Bartosz Zambrzycki, European Commission, DG Health and Food Safety Unit E1, 2018, https://ec.europa.eu/food/sites/food/files/safety/docs/fw_eu-actions_ms_20180604_p02.pdf

[34] Ibid.

[35] Delegated act on food waste measurement – discussion on 3rd draft and comments received Bartosz Zambrzycki European Commission, DG Health and Food Safety Unit E1, 2018, https://ec.europa.eu/food/sites/food/files/safety/docs/fw_eu-actions_ms_20180709_pres-01.pdf

In the draft meeting of July 8th, it was proposed this table[36:]

Stage of the food supply chain	Food wasted destined to waste treatment operations (composting, biogas, land application, incineration, landfilling)		Food waste removed to sewer/wastewater		Food sent for redistribution (food donation)
	Total	Edible fraction	Total	Edible fraction	
1. Primary Production					
2. Processing and manufacturing					
3. Distribution (including retail)					
4. Restaurants and food services					
5. households					

Table 3

Grey cells mark the data which are to be reported on voluntary basis.

There's still needed to clarify what it's included in the voluntary basis, such as food redistribution.

[36] Format to report amounts of food waste - concept Bartosz Zambrzycki European Commission, DG Health and Food Safety Unit E1, 2018, https://ec.europa.eu/food/sites/food/files/safety/docs/fw_eu-actions_ms_20180709_pres-02.pdf

4. Food systems and sustainable food systems (SFS)

> «A *food system* gathers all the elements (environment, people, inputs, processes, infrastructures, institutions, etc.) and activities that relate to the production, processing, distribution, preparation and consumption of food, and the outputs of these activities, including socio-economic and environmental outcomes»[1].

What makes a food system sustainable? According to the Bruntland Report (1987), sustainable development was defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs[2]". The sustainable development is based upon three pillars: economic, social and environmental.

Therefore, if we apply these concepts to the food system's definition, a sustainable food system (SFS) would be "a food system that ensures food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition of future generations are not compromised[3]".

4.1 Impacts of FLW

4.1.1 *Impacts of FLW on SFS*

FLW affects SFS economically, socially and environmentally at three different levels: at household level (micro-level), at food production chain (meso level) and the society (macro level).

Regarding the economic dimension, consumers will ultimately play a higher price due to the inefficiency and economic losses in the food production chain. At the meso-level, the agents may see their profits reduced and imbalances in the production flows. At the general level of society, the negative effects would be a higher use of public resources for agricultural programs and infrastructures, taking away said resources for other investment plans.

[1] Food and Agriculture Organization (FAO), *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, June 2014.

[2] World Commission on Environment and Development (WCED), Report of the World Commission on Environment and Development, *Our Common Future*, 1987.

[3] Food and Agriculture Organization (FAO), *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, June 2014.

Regarding the social impacts, "the high volume of losses in agriculture in developing countries ends up impacting also on labour productivity (marketable output per worker) and therefore on wages, which in turn can slow down the expansion of the consumer market, which would have boosted the producers for the acquisition of new technologies"[4].

With regards to environmental impacts, FLW means a needless pressure on natural resources and ecosystems as well as a higher production of garbage and waste which ultimately leads to the multiplication of landfills.

According to FAO, a reduction of consumer food waste in developed countries by 30% would save roughly 40 million hectares of cropland[5].

Level / Dimension	Economic	Social	Environmental
Micro (household or individual enterprise)	• Businesses and consumers spend a larger portion of their budget on foods that will not be sold or consumed	• Lower wages • Consumers with fewer resources for purchase • Lack of products	• Amount of garbage and waste • Contamination of individuals in rural and urban areas
Meso (food chain)	• Imbalance in production flows and need for more investments such as construction of silos and warehouses for intermediate stocks • Profit reduction • Inefficiencies in supply chain • Costs of disposal and treatment of waste	• Low labour productivity • Difficulties for companies to make their planning	• Multiplication of landfills
Macro (food system and beyond)	• Unrealized economic effort • Public investment in agriculture and infrastructure being less productive and turning into an opportunity cost • Reduction in financial resources for investment in other areas	• Higher level of food prices and difficulties in access to food • Larger number of people below the poverty line	• Pressure on natural resources: water and soil • Emission of greenhouse gases • Occupation of forests and conservation areas • Depletion of fishery resources; • Pressure on wildlife • Greater spending on non-renewable energy

Table 4

[4] Food and Agriculture Organization (FAO), *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, June 2014.

[5] Food and Agriculture Organization (FAO), *Toolkit: reducing the food wastage footprint*, Rome, 2013a.

4.1.2 *FLW and food security*

As already stated, FLW is the product of an inefficient and inequal food systems.

In 1996, the World Food Summit stated that "food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life[6]".

The food security is based on 4 pillars: food availability, access (both physically and economically), utilization of food (diet, safety, quality), stability of food (food at all times).

The FLW affects these 4 dimensions of food security by:

- reducing food that instead of being consumed, is lost or wasted;
- affecting negatively the access to food due to increasing food prices, leading to profit reduction and economic losses for actors along the food chain and for consumers, who have to spend more of their budget on food;
- reflecting the unsustainable use of natural resources, since more resources are needed in order to produce the food that has to balance the food that is lost and wasted.

Food availability

As reported by FAO, 1.3 billion tons of food is lost or wasted annually. This huge amount of food could feed the 842 million people (12% of world population) that were estimated to be suffering from hunger in 2011–2013[7].

The food availability stands for the guarantee at the local level of sufficient quantities of safety and good quality food.

At micro-level, FLW and food availability are inversely proportional: if the FLW is high, then the food security is less guaranteed and viceversa.

Access to food

The access to food is characterized by two dimensions:

- economic: it refers to both the capabilities of Nations and families to generate, respectively, the foreign currency needed to pay for imports and the income needed to purchase food;

[6] Food and Agriculture Organization (FAO), *Food Security*, Policy Brief, 2006.
[7] Food and Agriculture Organization (FAO), *The State of Food Insecurity in the World.* Rome, 2013b.

- physical: it is related to the state of infrastructure, storage facilities and marketing, political stability and the distribution of household income.

In developing countries, the cost of food represents an important portion of the household income's expenditure. Since FLW leads to higher food prices, FLW can have huge negative impact on these countries. While in developed countries, the food budget is circa the 15% of total household income.

Nutrition/utilization

The aim of utilization of food, through an adequate diet, clean water, sanitation and health care, is to reach a state of nutritional wellbeing where all physiological needs are met. The foods must be sufficient in quantity, quality and variety according to the needs expressed in individual energy requirements.

From the nutritional perspective, it is fundamental to minimize loss or waste in order to reduce micronutrients deficiencies and related diseases. Food such as fruits and vegetables are important sources of macro- and micronutrients, vitamins, but account for the highest quantitative food losses and waste.

Food losses and waste take place due to food-safety concerns: the need to discard unsafe food contributes to ensure food safety but has a negative impact not only on the food availability but also on the access to it, leading ultimately to higher prices.

Stability

Food stability means that food must be available at all times. This also means that the risk of losing access to food as a consequence of natural or economic events must be minimized.

It is important then to adjust the production, manage the surplus, but mostly the storage and distribution capacities in order to ensure food stability with minimum food losses and waste.

4.1.3 *FLW and the Sustainable Development Goals (SDGs)*

The goal of reducing food losses and waste (FLW) as well as its prevention and management, contributes to reach several SDGs. The main one is the SDG 12 (ensure sustainable consumption and production patterns**)**, which aims to:

- achieve the sustainable management and efficient use of natural resources by 2030 (12.2);

- halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses by 2030 (12.3);
- achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, […] and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment by 2020 (12.4);
- substantially reduce waste generation through prevention, reduction, recycling and reuse by 2030 (12.5);
- ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature by 2030 (12.8);
- move towards more sustainable patterns of consumption and production (12.a) and develop and implement tools to monitor sustainable development impacts (12.b).

In order to measure the progress towards SDG Target 12.3, an indicator was created: The Global Food Loss Index (GFLI)[8.] However, this index was categorized as Tier III, meaning that it still needs to be fully developed, tested and adopted.

It was decided then to split the SDG Target 12.3 in two components: (1) aiming to halve the global food waste and (2) reduce food losses, leading FAO and UNEP to develop two separates indicators:

- Food Loss Index (FLI), which "focuses on food losses that occur from production up to (and not including) the retail level. It measures the changes in percentage losses for a basket of 10 main commodities by country in comparison with a base period"[9;]
- Food Waste Index (FWI), which is still under development and it would measure the food waste at retail and consumption levels.

Other SDGs that can be directly or indirectly be reached by reducing food loss and waste include the SDG 2, which aims to end hunger, achieve food security and improved nutrition and promote sustainable agriculture[10,] but also SDG 6, regarding the sustainable management of water, SDG 13, which is about the climate change and its impacts, SDG 14, which aims to the sustainable use of oceans, seas and marine resources, SDG 15 that aims to the protection and promotion of the sustainable use of terrestrial ecosystems,

[8] Gennari Pietro, Food and Agriculture Organization (FAO), *SDG target 12.3, Indicator 12.3.1 - Global Food Loss Index,* https://unstats.un.org/sdgs/files/meetings/iaeg-sdgs-meeting-03/3rd-IAEG-SDGs-presentation-FAO--12.3.1.pdf

[9] Food and Agriculture Organization (FAO), *SDG target 12,* http://www.fao.org/sustainable-development-goals/indicators/1231/en/

[10] Sustainable Development Goals Knowledge Platform, *SDG 2*, https://sustainabledevelopment.un.org/sdg2

forests, and halting land degradation and biodiversity loss, showing that the reduction of food losses and waste may have positive environmental impacts on different dimensions.

4.1.4 *FLW impacts on environment*

1.3 billion tonnes of food waste and loss is the equivalent of 1.4 billion hectares of agricultural land[11] or 30% of the world's agricultural land area[12;] a global water footprint of 250 km3 in 2007 or 20% of freshwater consumption[13;] 8% of global anthropogenic greenhouse gas (GHG) emissions[14;] and circa 38% of the total energetic consumption of the food supply chain[15.] Only considering CO2 emissions, if FLW were a country, it would be the third major emitter on Earth[16.]

In 2012, in Europe, it was estimated that the food waste generated is 88 million tonnes[17.] This equates to 173 kilograms of food waste per person in the EU-28. The total amounts of food produced in EU for 2011 were around 865 kg / person[18,] this would mean that in total we are wasting 20 % of the total food produced.[19]

4.1.5 *Agri-food system and food supply chain*

Food Supply Chain

The food supply chain is defined as the connected series of activities used to produce, process, distribute and consume food.

[11] Food and Agriculture Organization (FAO), *Food Wastage Footprint & Climate Change*, Rome, 2015.

[12] Food and Agriculture Organization (FAO), *Food wastage footprint; impacts on natural resources*, Summary Report, Rome, 2013.

[13] Food and Agriculture Organization (FAO), *Food wastage footprint; impacts on natural resources*, Summary Report, Rome, 2013.

[14] Food and Agriculture Organization (FAO), *Food Wastage Footprint & Climate Change*, Rome, 2015.

[15] Food and Agriculture Organization (FAO), *Energy-smart food for people and climate*, Rome, 2011.

[16] Food and Agriculture Organization (FAO), *Food wastage footprint; impacts on natural resources.* Summary Report. Rome, 2013.

[17] EU FUSIONS Project, *Estimates of European food waste levels*, 2016.

[18] http://faostat3.fao.org/download/FB/FBS/E

[19] EU FUSIONS Project, *Estimates of European food waste levels*, 2016.

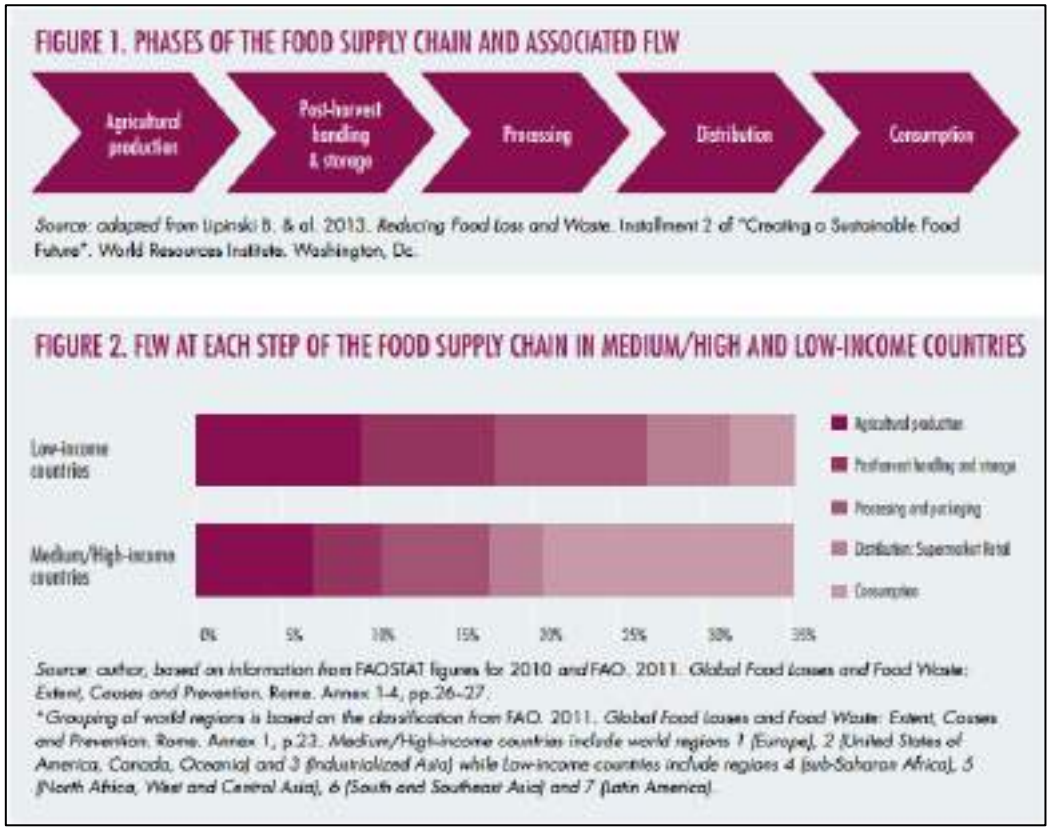

Figure 11. Source: Food loss and waste and the right to adequate food: Making the connection, FAO, 2018

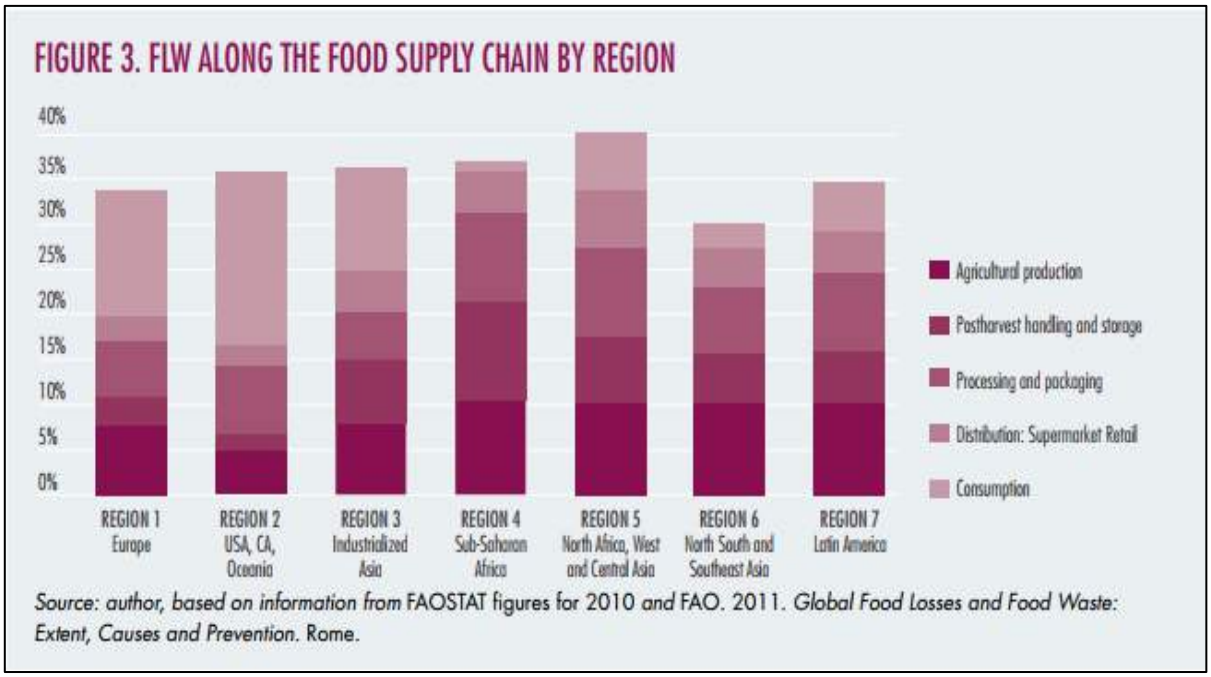

Figure 13. Source: Food loss and waste and the right to adequate food: Making the connection, FAO, 2018

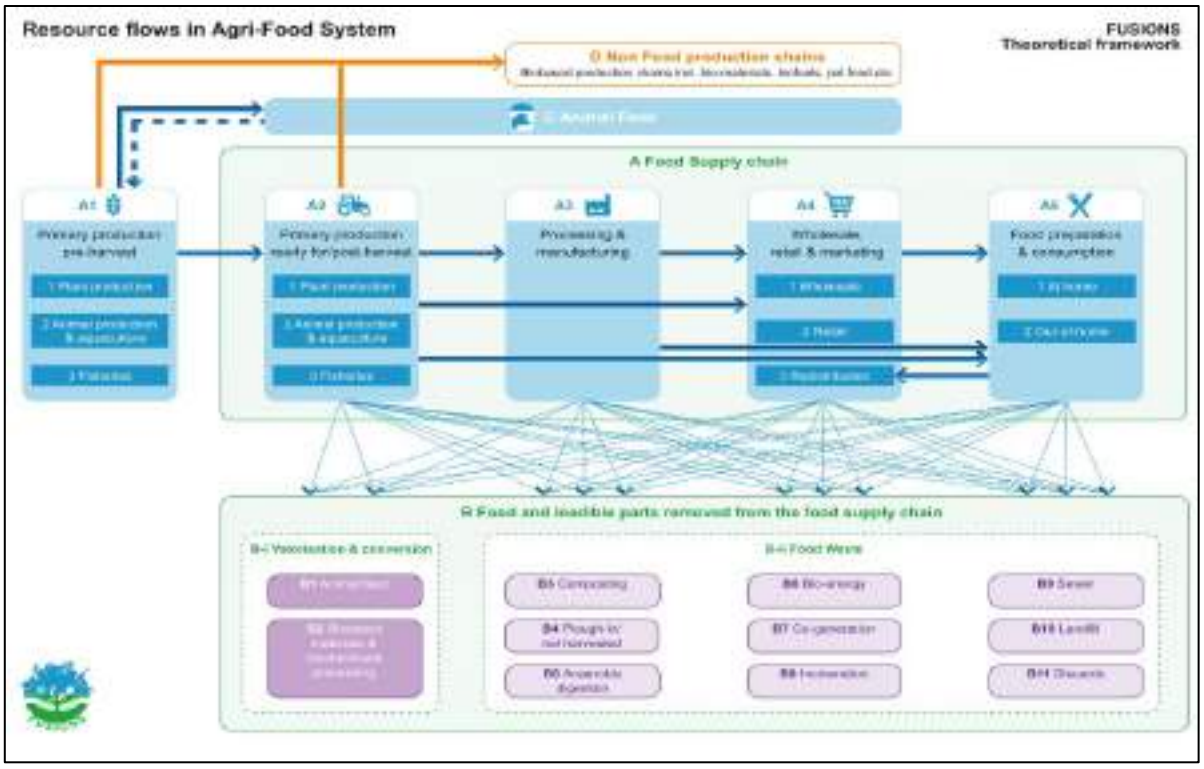

Figure 12. Source: FUSIONS Definitional Framework for Food Waste, Full Report, EU FUSIONS, 2014

FUSIONS's authors divided the agri-food system in four main sections:

- Section A covers the major steps of the food supply chain: primary production, processing, wholesale and logistics and the food consumption;
- Section B shows the different routes for the re-use, the recycling, the recovery and the disposal of edible food and inedible parts associated to food;
- Section C covers the crop production aimed to animal feed;
- Section D refers to the crop production intended specifically for non-food uses, such as biobased production.

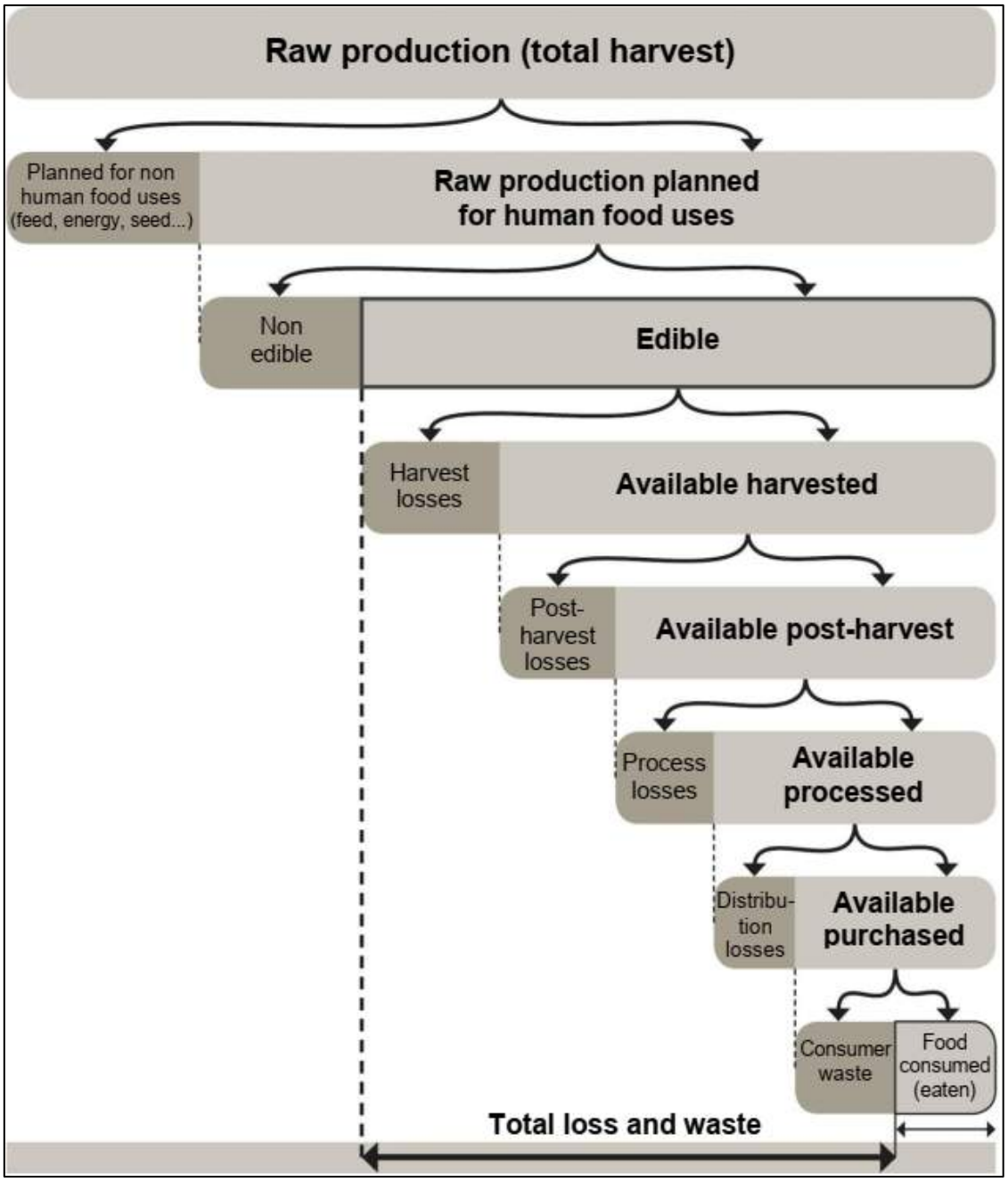

Figure 14. Source: *Food losses and waste in the context of sustainable food systems*, A report by The High-Level Panel of Experts on Food Security and Nutrition, June 2014

5. Food supply chain

The food supply chain is a process composed by several steps. The article 9 of the Directive (EU) 2018/851, which amends the Waste Directive Framework (Directive 2008/98/EC), divides the process in sectors:

1. Primary production, which "encompasses agricultural activities, aquaculture, fisheries and similar processes resulting in raw food materials. This first stage in the chain includes all activities related to the harvest, handling and storage of food products before they move to either processing or distribution[1]".
2. Processing and manufacturing, which "encompasses all processes intended to transform raw food materials into products suitable for consumption, cooking or sale[2]" and it also "includes packaging of processed goods[3]";
3. Distribution and wholesale, which "ensure that food products make it to market and consumers[4]", through for example wholesalers and retailers.
4. Food services, which "includes all institutions that serve prepared food intended for final consumption[5]", such as restaurants.
5. Households, which "encompasses all food preparation and consumption in the home[6]".

5.1 Causes of FLW during the food supply chain's stages

As it will be analysed more in-depth in the next paragraph, there could be several causes of FLW throughout the food supply chain. During the primary production, inappropriate practices of harvesting and of handling as well as the inadequate storage conditions could lead to important losses.

[1] Commission for Environmental Cooperation, http://www3.cec.org/flwm/sector/primary-production/

[2] Commission for Environmental Cooperation, http://www3.cec.org/flwm/sector/processing-and-manufacturing/

[3] Commission for Environmental Cooperation, http://www3.cec.org/flwm/sector/processing-and-manufacturing/

[4] Commission for Environmental Cooperation, http://www3.cec.org/flwm/sector/distribution-and-wholesale/

[5] Commission for Environmental Cooperation, http://www3.cec.org/flwm/sector/food-service-institutions/

[6] Commission for Environmental Cooperation, http://www3.cec.org/flwm/sector/household/

During transportation there could be losses too if the raw food is not handled carefully or the cold chain is interrupted. Inadequate packaging can also shorter food's shelf life.

At the food service's level, causes of food losses could be the high aesthetic standards the food products must meet in order to be sold.

At household sector, instead, losses are usually due to poor meal purchase, planning and storing as well as the risk of overbuying food products in order to save money and confusion regarding the expiring date's labels.

5.2 Causes and enablers of FLW

Causes of FLW can happen along the whole food chain. What happens at a certain stage, however, can have its cause at another stage. The food chain can be divided in pre-harvest/production, harvest, post-harvest, storage, transformation, distribution and retail and, eventually, consumption.

Causes of FLW are often interrelated and can be divided in three different levels:

1. micro-level causes, which take place at each given stage. They take place due to action or non-actions of actors of the same stage, in response or not to external factors;
2. meso-level causes, which include structural causes of FLW, therefore concerning the food chain, such as how actors are organized or the state of infrastructures. At this level, what happens in a stage can affect the chain at another stage. Meso-level causes can affect micro-level causes;
3. macro-level causes, which concern the systemic issues of the entire food system, including unfavorable institutional and policy conditions, lack of investments and inefficient practices. Macro-level causes can have impacts both on meso- and micro-level causes.

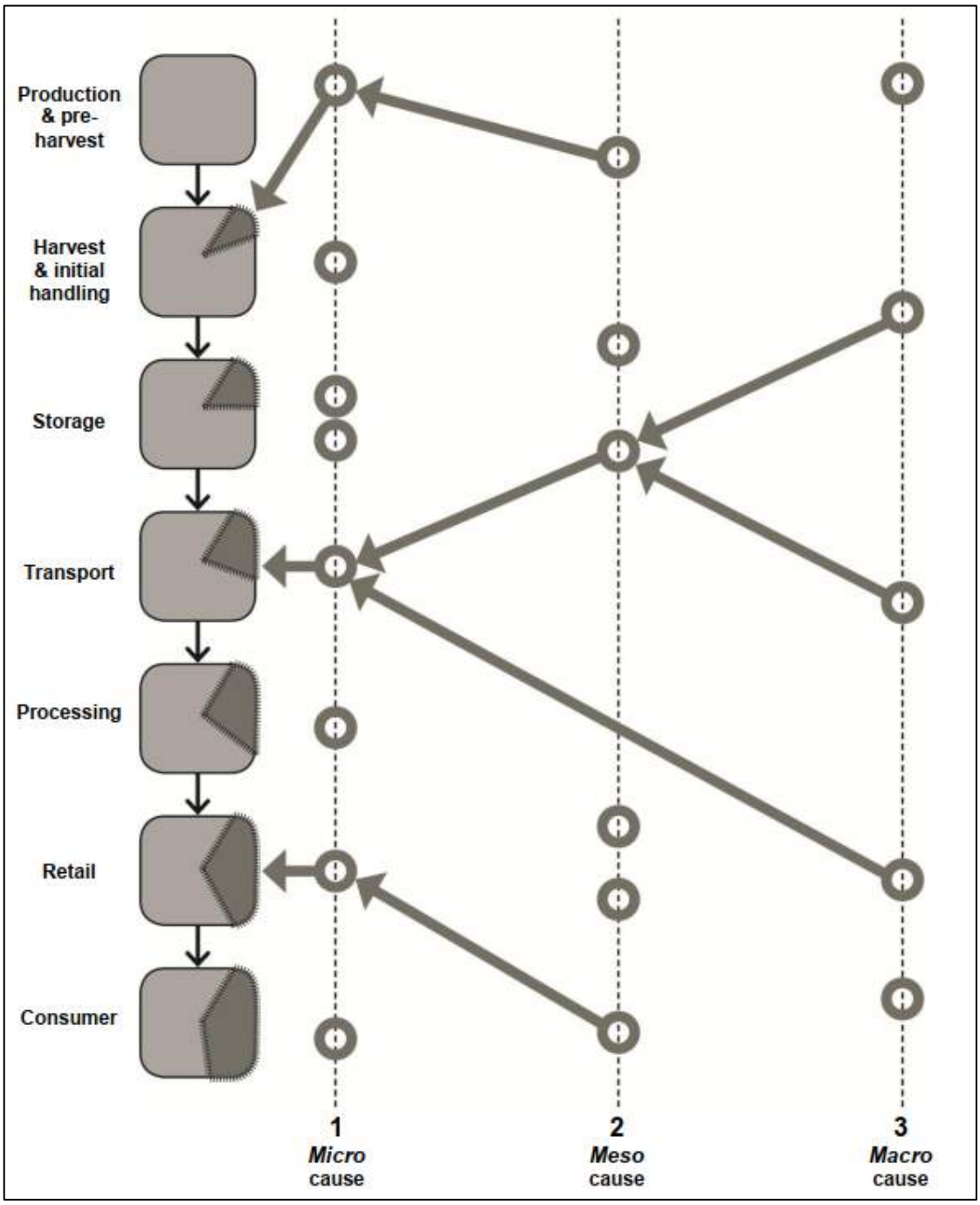

Figure 15. How the food chain is affected by micro-, meso- and macro-level causes.

Source: *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, June 2014

5.3 Micro-level causes

As stated above, micro-level causes can affect each stage.

5.3.1 *Pre-harvest and production stage*

The factors that can lead to food losses, both quantitatively and qualitatively, along the chain in this stage can be divided in groups:

- the choice of crops for the production site and for the market of reference;
- agronomic practices, such as the use and what type of fertilizers, the nutrient management, the water management, the disease management as well ass pruning, staking, bagging etc.;
- biological factors;
- environmental factors.

First, it is fundamental to choose the right variety of the crop given the production site. The wrong choice would result in produce of lower quality that eventually would lead to high losses, due also to the fact that crops have to meet the requirements of the target market, therefore must satisfy certain quality specifications.

Second, wrong agronomic practices as well as poor water and nutrient management contribute to poor quality produce. For example, for fruits and vegetables, these practices greatly contribute to the product's quality, both visually and nutritionally.

Moreover, some of the produce is left unharvested or thrown away because it fails to meet certain quality standards that are imposed by other actors in the supply chain, such as retailers.

There could be other reasons to not to harvest the produce:

- due to economic reasons such as low market price at a given time and the labour cost is high;
- the demand is low related to the production, thus the cost of harvesting and transport are higher than the returns and the crop is left in the field.

Conversely, sometimes growers aim to the overproduction of the crop and it may be due to uncertainties of retailers' demand, uncertainty of the weather or to reach the quantity established in the contract with the buyers. It also happens that the excess is left unharvested or sold at a lower price to processors or feed industries. However, this leads to lowering the prices and thus in more produce left in the field.

5.3.2 *Harvesting and initial handling*

Poor harvest scheduling and timing, as well as rough, careless handling of the produce, are key contributors to FLW along the chain.

Highly perishable food, such as fruits and vegetables, are sometimes harvested prematurely due to economic reasons, however they are more prone to mechanical damage and have inferior eating qualities, or even result not suitable for consumption. Instead when fruits are overmature, they have a short shelf-life.

Harvesting techniques, multiple handlings as well as poor temperature management lead to speed up the deteriorative process, leading to economic losses, qualitative losses, potential growth of pathogens.

These causes reduce the quantity of food that has the high appearance standards suitable for selling, and therefore for human consumptions. Thus it is important to handle food with care and storage it with the proper temperature, otherwise the percentage of unsellable or unwanted food will increase. However, this kind of food could be used for feed, reducing losses.

5.3.3 *Storage*

The storage management is essential to conserve food and its qualities. However, it is also important that the shelf-life basely depends on the initial quality and storage decided at the previous stages.

Suboptimal storage conditions could lead to biochemical reactions that would result in unwanted changes in color, flavor, microbial growth or even rotting. This would ultimately lead to food and economic losses for all the actors in the food supply chain.

5.3.4 *Transport and logistics*

Transport can be a major cause of food losses and waste: the longer the time of transport there is between the production stage and the consumption stage, the higher are the risks that fresh products are subject to mechanical risks or a decrease of nutritional contents.

In fact, poorly packing/packaging expose food products to deteriorative processes.

If the cooling system has malfunction, fruits and vegetables perish faster.

One of the main problems at this stage is the rejection of shipments: imported food products go through phytosanitary, veterinary and food safety regulations checks. In some

cases there could be delays, leading to a reduction of shelf-life of perishable products. If products fail to meet the safety standards, the entire shipment could be destroyed.

5.3.5 *Processing and packaging*

At this stage, it may happen errors could take place during processing, leading to defects in the finished product, such as damaged packaging or appearance. This does not affect negatively the safety or the quality of the product itself, but it could be discarded for not satisfying selling standards.

For animal products, if the units are not properly cleaned, it may affect the whole batch.

In order to prevent food losses waste, is essential to pack food products in the proper way. While reducing packaging would be advisable, it would lead to unwanted consequence of increasing food waste.

5.3.6 *Retail*

The retailers dictate the quality standards of food products that must be met in order to order them and display them. However, they must assure that proper conditions of conserving food products are assured, such as temperature, humidity control and reduce the handling by buyers, in order to avoid to affect negatively the shelf-life, the quality and the acceptability of the food products.

By displaying the best food products by piling them up, leading to damage the products at the bottom of the pile. Moreover, if food of different expiry dates is mixed together, some will have shorter shelf-life and consumers will buy fresher products instead of close-by expiry dates.

Higher food losses and waste happen when food is cooked or ready-made or when fruits and vegetables are fresh-cut. It is an opportunity to valorize food that does not meet high standards of appearance, but it is also true that food prepared in this way is more prone do spoilage and to a faster deteriorative process.

Moreover, retailers place strict orders to growers, who, in order to ensure they fulfill the contract’s obligations, overplant and often the extra produce is discarded or sold at a lower price.

Another cause of food loss is connected to the so-called “rule of the one-third”, according to which food products must reach retailers in up to one-third of their shelf-life in order to provide consumers with a wide variety of fresh products. However, if this rule

is not respected by growers, retailers will reject the delivery, leading to an increase of the amount of food discarded.

5.3.7 *Consumption*

With the increasing of income, demographic changes as well as eating habits, food waste at this stage is a huge issue. Therefore, the one of the main causes of FLW at this stage is the consumer's behavior, including the buying, the preparation of food and its consumption as well as the planning's skills.

There are several causes of FLW:

- poor planning of purchases: people buy more than they need or buy impulsively;
- confusion regarding the "best-before" and the "use-by" dates, leading to discard of food products that could actually be still eaten;
- poor storage's condition management at home;
- preparation of excessive portion that will not be eaten;
- poor food preparation techniques will lead to less food being eaten, inefficient use of leftovers or a degradation of food quality.

Moreover, consumers are influenced by marketing strategies that tempt them to buy larger packs due to retailers' offers, such as three-for-two, leading to a larger percentage of food left to spoil or discarded.

5.4 Meso-level causes of FLW

Meso-level causes include structural causes and secondary ones of FLW. The origin of these causes could be:

- how the several actors in the food chain are organized together, therefore inadequate coordination, communication between them;
- lack of proper infrastructures, equipment;
- lack of support to actors for investment and good practices;
- maladapted economic conditions.

Between growers and retailers there is an important relationship that can have a determinant role for FLW:

- the contract's obligations can be strict, regarding for example the appearance and the acceptability of food product;
- there are high penalties if the delivery is not respected;

- product take-back clauses if the whole delivery has not been fully sold;
- poor demand forecasting, leading growers to overproduce in case of short-noticed orders.

Adequate infrastructure is essential to reduce the time span between the primary production and the consumption stage. In the first stages a high capacity processing infrastructure that satisfies the demand of food will lead to less food left to spoil or discarded.

While in the final stages careful handling procedures and proper storage conditions are crucial to reduce FLW. The cold chain affects significantly FLW: an inefficient cold chain could increase up to 3 times the rate of deterioration of perishables products.

Another main issue is the food date labelling, which still confuses consumers. Several date labels exist, some for the management of the stock, some others for the consumers, including the expiring date.

This misunderstanding leads to FLW by consumers because of the lack of knowledge and confusion of the date labels and represents an economic loss for retailers because they often anticipate dates to preserve their reputation.

The main labels for consumers are:

- 'Best-before', which "indicates the date until when the food retains its expected quality"[7]. After this date, food is still safe if well conserved, but it might lose some flavor or the texture.
- "Use By", which "indicates the date until when the food can be eaten safely"[8]. This is applied to highly perishable food, such as fresh fish. If not well conserved, there's the risk of food poisoning. You can extend the "use by" date by freezing properly the food products.

5.5 Macro-level causes of FLW

These causes concern the policy and the regulatory environment as well as systemic causes.

FLW can be affected by some regulations that may hinder or reduce the surplus food by promoting the redistribution or the use for animal feeding, but also clearer food labelling, more efficient waste policies.

[7] European Commission, https://ec.europa.eu/food/sites/food/files/safety/docs/fw_lib_best_before_en.pdf
[8] European Commission, https://ec.europa.eu/food/sites/food/files/safety/docs/fw_lib_best_before_en.pdf

The safety of food must be guaranteed by everyone involved in the food chain:

- control at the source;
- controls on the whole process;
- proper hygienic practices and policies during each stage of the food chain;
- preventive approach.

The Hazard Analysis and Critical Control Point (HACCP) checks the biological, chemical and the physical hazards during the production process.

Well-designed regulation can reduce FLW, but they could also cause it: food-safety regulations could forbid, for example, the import of food products if they do not meet the safety standards adopted by the importing country.

In EU, with the animal by-product regulation, bans have been placed on feeding animals with catering discards that have been in contact with animal by-products, even though it's very difficult to sort out what food products have been in contact with them and which has not been. This regulation poses constraints on the usage and the valorization of discarded food products.

In the waste policy area, the EU is aiming to separate the food waste from the mixed waste, and keep it under monitoring, in order to use for example for composting or for anaerobic digestion.

A systemic cause is the low value given to food-related to other goods in the household management. A sign of wealth is the abundance of food, which increase the risk of waste.

6. How to measure FLW and FQLW

There are still few methods to assess both FLW and FQLW.

6.1 Food Mass

The usual approach for measuring FLW is through its mass, measured in tonnes. It is easy to collect data and can be easily compared. However, this approach does not take into account the economic values of different commodities and low-value food could be attributed a higher weight in the measurement just because of its higher specific weight.

6.2 Food Calories

Another approach is to report FLW in calories. This approach gives a higher weight to the food which has a high caloric content.

6.3 Nutritional value (FQLW)

Regarding FQLW, therefore the nutritional value of food, there's another approach. Since food quantity, and therefore low FLW levels, might be preserved, this doesn't mean the nutrients are preserved.

Macro- and micronutrients, vitamins and minerals are at their peak right after the harvest, especially of fruits and vegetables. However, they begin to degrade right after it and continue to decline during storage, transportation and distribution. The process can be slowed for example through refrigeration but it can't be stopped.

The loss of nutrients or nutritious by-products can also happen during industrial processing, fractioning or refining of foods.

6.4 Monetary (FLW and FQLW)

The food losses and waste also translate into economic losses. Supply chains actors could see their profits reduced and consumers would pay higher prices.

Moreover, the degradation of the quality of food (FQLW) can happen in all the phases of the food supply chain, making foods less “sellable” due to their flaws.

In fact food chain actors (such as agents, processors, retailers and market operators), in order to mitigate the economic loss due to food quality loss (whether it is freshness, shape, colour, consistency, taste), for example redirect food products that have almost loss their quality to non-food uses or to feed or sell products near the “best-before” date at discounted rates.

6.5 Difficulties to measure FLW

The EU is still working to develop and establish a standardised methodology for data collection at national level in accordance with a common data collection, definitions and metrics adopted at european level.

Following the same standards and methods will make the data more consistent and comparing countries easier. In fact, the available data sets are of insufficient quality or the data are not reported on a regular basis.

Food waste quantification is essential to have a better understanding of how spread and how cocnerning is the food waste, allowing the European Union and the Member States to better define and prioritize the most critical areas.

7. State and trends of FLW

Regarding the type of food that are being wasted or lost, there are wide differences based on what method is used.

On a caloric basis, the 53% of the global FLW is comprised of cereals, then roots and tubers (14%), fruits and vegetables (13%), then meat (7%)[12].

On a weight basis, instead, fruits and vegetables represent the 44%, while tubers and root 20%[3].

Considering the rate of FLW over these food products' production: 20–22% of total produced cereals are lost, while up to 39–44% fruits and vegetables, 33% of roots and tubers[4].

In middle and high income countries a great share of the food losses and waste occur at distribution and consumption level.

In 2011, Eurostat and other national data and estimates have been used and the study estimated EU27 annual FLW at 89 million tonnes, or 179 kg per capita[5].

In 2012, the estimate of generated food waste in Europe (EU28) was 88 million tonnes, which equates to 173 kg of food waste per person[6]. The total amounts of food produced in EU for 2011 were around 865 kg / person[7], this would mean that in total we are wasting 20 % of the total food produced.

[1] Maria Virginia Vilariño, Carol Franco and Caitlin Quarrington, *Food loss and Waste Reduction as an Integral Part of a Circular Economy*, Frontiers in environmental sciences, 2017.

[2] Food and Agriculture Organization (FAO), *Global Food Losses and Food Waste– Extent, Causes and Prevention*, 2011.

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[4] Kummu, M., de Moel, H., Porkka, M., Siebert, S., Varis, O., and Ward, P. J., *Lost food, Wasted Resources: Global Food Supply Chain Losses and Their Impacts on Freshwater*, Cropland, and Fertiliser Use. *Sci. Total Environ*, 438, 477–489, 2012.

[5] Bill Pritchard, Rodomiro Ortiz, Meera Shekar, *Routledge Handbook of Food and Nutrition Security*, Routledge, 2016.

[6] EU FUSIONS Project, *Estimates of European food waste levels*, 2016.

[7] Food and Agriculture Organization (FAO), FAOSTAT, *New food Balances*, http://faostat3.fao.org/download/FB/FBS/E.

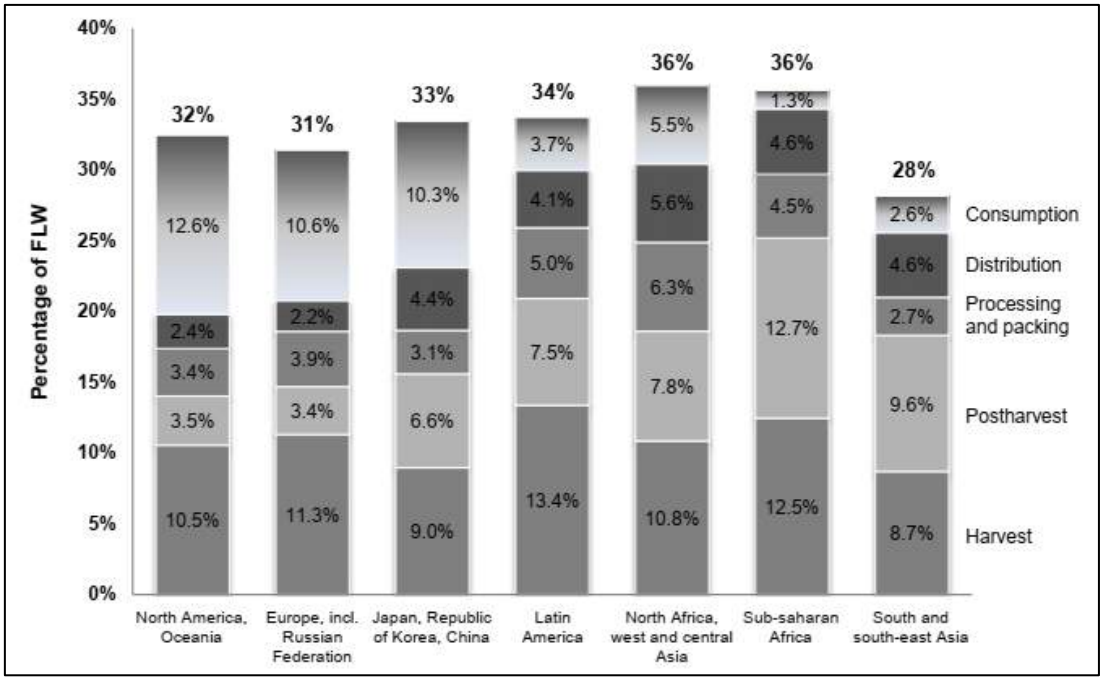

Figure 16. Source: elaborated from Gustavsson et al. (FAO, 2011a)

Estimates of food waste (food and inedible parts associated to food) in EU-28 in 2012, divided by sector of food chain. (Tab. 3)

Sector	Food waste (million tonnes) with 95% CI*	Food waste (kg per person) with 95% CI*	Food waste in %
Primary production	9.1 ± 1.5	18 ± 3	11
Processing	16.9± 12.7	33 ± 25	19
Wholesale and retail	4.6 ± 1.2	9 ± 2	5
Food service	10.5 ± 1.5	21 ± 3	12
Households	46.5 ±4.4	92 ± 9	53
Total food waste	87.6 ± 13.7	173 ± 27	100

Table 5

What strikes the most is that the two sectors of processing and households alone account for the 72% of the total EU food waste's estimates. In particular, the household's sector's total food waste of circa 46.5 billion tonnes is further divided into (Tab. 2).

Destination for food waste	Weight of food waste (tonnes)
Households	34 998 327
Sewer	7 780 727
Home Composting	3 754 141
Total	46 533 195

Table 6. Source: made by the autor based on data[8]

It is also interesting to know the costs related to the food waste (only edible food), divided by each sector (Tab. 5).

Sector	Food waste (million tonnes)	Food waste (kg per person)	Food waste in %	Costs (billion of Euro)
Primary production	9.1 ± 1.5	18 ± 3	11	1.8
Processing	16.9± 12.7	33 ± 25	19	13
Wholesale and retail	4.6 ± 1.2	9 ± 2	5	10
Food service	10.5 ± 1.5	21 ± 3	12	20
Households	46.5 ±4.4	92 ± 9	53	98
Total food waste	87.6 ± 13.7	173 ± 27	100	142.8

Table 7. Source: made by the autor based on data[9]

The costs are related to the value of edible food that has been wasted in each sector.

[8] EU FUSIONS Project, *Estimates of European food waste levels*, 2016.
[9] Ibid.

8. Towards Common Food Policy

The increasing need of a Common Food Policy shows that the current main food systems (industrialized, standardized, profit-driven and export-oriented) are unsustainable and the European Union has the tools to change the trajectory but, even if the latest reforms of the Common Agricultural Policy (CAP) showed some progress, there is the lack of substantial reforms to the CAP's Pillars, the lack of coherence and coordination among policy areas, policy makers (especially the policy Directorate-Generals (DGs)) and the several levels of governance to apply a holistic approach to the problem as well as the non-involvement of citizens, territorial initiatives and the intromission of the powerful interests of the food industry.

The iPES Food's report defines the Common Food policy as

> «a policy setting a direction of travel for the whole food system, bringing together the various sectoral policies that affect food production, processing, distribution, and consumption, and refocusing all actions on the transition to sustainability»[1].

This would mean that the externalities (or hidden costs) generated from the food production (such as biodiversity undermining, soil degradation, water contamination, GHG emissions) would finally be reflected in food prices and that citizens can have access to diets that are both healthy and sustainable

8.1 Impacts of the main current food systems

> «Europe loses 970 million tonnes of soil every year, with more than 11% of the EU's territory affected by moderate to high soil erosion[2]. Pesticides and nitrogen-based fertilizers are driving unprecedented impacts on plant and insect life»[3].

[1] IPES-Food, *Towards a Common Food Policy for the EU - The policy reform and realignment that is required to build sustainable food systems in Europe*, 2019.

[2] P. Panagos, P. Borrelli, J. Poesen, C. Ballabio, E. Lugato, K. Meusburger, L. Montanarella, and C. Alewell, "The new assessment of soil loss bywater erosion in Europe," *Environmental Science & Policy*, 438-447, 2015.

[3] IPES-Food, *Towards a Common Food Policy for the EU - The policy reform and realignment that is required to build sustainable food systems in Europe*, 2019.

Soil erosion affects 25% of agricultural land in the EU[4] and 83% of EU soils contain one or more pesticides residues[5.]

Furthermore, the European agricultural sector is responsible for over 90% of ammonia emissions, which contribute to acid deposition and eutrophication, as well as air pollution"[6.]

While the animal production in the EU is estimated that in 2030 will account for the 72% of the emissions of methane and nitrous oxide (GHGs)[7.]

The EU food demand obliges to source from outside Europe: 31% of the land required to produce food is located outside of it[8,] more than the half of the EU fish and seafood consumption is satisfied by extra-Europe production[9] and the EU imports account for "almost one quarter of the global trade in soy, beef, leather, and palm oil[1011]".

Moreover, approximately 20% of the food produced in Eu is lost wasted, which equals to a loss of 143 billions per year in terms of resources wasted and impacts on the environment.

One of the consequences of the current food systems is the unhealthy diet, a leading cause of disease and mortality in Europe, such as of cardiovascular disease, which is main cause of death in Europe[12] and that accounts for the 70-80% of EU healthcare costs[13.]

[4] IPBES, *Summary for Policymakers of the Regional Assessment Report on Biodiversity and Ecosystem Services for Europe and Central Asia*, M. Rounsevell, M. Fischer, A. Torre-Marin Rando, and A. Mader (eds.), 2018.

[5] V. Silva, H. G.J. Mol, P. Zomer, M. Tienstra, C.J. Ritsema, V. Geissen, *Pesticide residues in European agricultural soils – A hidden reality unfolded*, Science of the Total Environment, 2018.

[6] EEA, *Ammonia (NH3) emissions*, 2015.

[7] European Commission, "EU agricultural outlook: For the Agricultural Markets and Income 2017-2030", 2017.

[8] European Commission, "Science for Environment Policy, thematic issue: Global Environmental Impacts of EU Trade in Commodities", 2013.

[9] WWF, "Europe runs out of fish," 2018, https://www.fishforward.eu/en/europe-runs-out-of-fish/.

[10] IPES-Food, *Towards a Common Food Policy for the EU - The policy reform and realignment that is required to build sustainable food systems in Europe*, 2019.

[11] FERN, *EU consumption and illegal deforestation*, 2015.

[12] EHN, *Transforming European food and drink policies for cardiovascular health*, 2017.

[13] M. Seychell, "Towards better prevention and management of chronic diseases," *Health-EU newsletter* 169, 2016.

Moreover, “one in four Europeans are at risk of poverty or social exclusion[14][15]”, thus excluding them from the access to healthy and sufficient diets.

At socio-economical level, major imbalances of power and poor working conditions are still occurring.

> In 2011, the five largest food retailers in thirteen EU Member States had a combined market share of over 60%”[16][17], thus having the strength to affect food supply agents, to drive down prices and lower working conditions, leading eventually to the disappearance of many smallholder farms (“from 2003 to 2013, more than 1 in 4 farms disappeared from the European landscape[18][19]).

Moreover, “3% of farms now account for 52% of EU farmland[20,] and 20% of farms receive 80% of payments under the CAP[21][22]".

The agricultural area has declined over the decades[23,] used for urban development, driving up land prices and diminishing the opportunities of young farmers to access land.

The need of a new approach to the food system: reforms and declarations

In 2016, the European Economic and Social Committee (EESC), published an own-initiative opinion “Civil society’s contribution to the development of a comprehensive food policy in the EU”.

[14] IPES-Food, *Towards a Common Food Policy for the EU - The policy reform and realignment that is required to build sustainable food systems in Europe*, 2019.

[15] Eurostat, “Europe 2020 indicators - poverty and social exclusion,” 2017

[16] European Commission, “The economic impact of modern retail on choice and innovation in the EU food sector,” 2017

[17] IPES-Food, *Towards a Common Food Policy for the EU - The policy reform and realignment that is required to build sustainable food systems in Europe*, 2019.

[18] Eurostat, “EU Farm Structure Survey 2013,” 2013

[19] IPES-Food, *Towards a Common Food Policy for the EU - The policy reform and realignment that is required to build sustainable food systems in Europe*, 2019.

[20] TNI, “Land for the few: The state of land concentration in Europe – Database for all EU member states,” 2016

[21] European Commission, *The Future of Food and Farming*, COM(2017)713 final, 2017,

[22] IPES-Food, *Towards a Common Food Policy for the EU - The policy reform and realignment that is required to build sustainable food systems in Europe*, 2019.

[23] European Commission, “EU agricultural outlook: For The Agricultural Markets And Income 2017-2030,” 2017

It states that "current EU policy framework is not suited to making the transition to more sustainable food systems[24]", that "EESC reiterates its call for the development of a comprehensive food policy in the EU, with the aim of providing healthy diets from sustainable food systems, linking agriculture to nutrition and ecosystem services, and ensuring supply chains which safeguard public health for all sections of European society[25]", that a "comprehensive EU food policy should improve coherence across food-related policy areas, restore the value of food and promote a long-term shift from food productivism and consumerism to food citizenship[26]" and that the food policy "should be complementary to […] a reshaped CAP[27]".

The food policy should be based on common governance at all levels (from local, to European levels) and should involve all the stakeholders across the food supply chain also with the aim to achieve a fair distribution along the chain.

Moreover, "EESC encourages the Commission to explore the feasibility of creating a dedicated DG for Food, which would provide a clear centre for EU responsibilities on all food-related policies and be the source of regulation, legislation and enforcement as appropriate[28]".

In 2017, also the European Committee of the Regions called for "a comprehensive, sustainable EU food policy which is democratically shaped, designed with a common and long-term vision, based on the latest scientific insights and in line with a multilevel governance approach that addresses food production and nutrition in a more comprehensive manner, promoting more sustainable production and consumption patterns, establishing a link across different policy areas, including, among others, food production, agriculture, environment, health, consumer policy, employment and rural development, and creating jobs and growth in Europe's Regions and Cities[29]". The Committee also stated to take into account the ecosystems, since "[e]nvironmental costs are currently externalised in food production, leading to a situation where food produced in a more

[24] Civil society's contribution to the development of a comprehensive food policy in the EU (own-initiative opinion), EESC, 2017.

[25] Ibid.

[26] Ibid.

[27] Ibid.

[28] Ibid.

[29] Opinion of the European Committee of the Regions — Towards a sustainable EU food policy that creates jobs and growth in Europe's Regions and Cities, ECR, 2017.

sustainable manner seems to be more expensive, mainly due to higher manufacturing costs[30]", which are not reflected in the final price of the food product.

In the opinion, it is emphasized the key role of cities and regions in addressing the challenges of the food system as well as involving them in the design of the EU food policy.

It is also suggested the revision of the CAP "in order to incentivise not only farmers, but also food manufacturers to produce sustainably, i.e. by guaranteeing consistent implementation of the EU's cross compliance mechanism that sets income support for producers that follow environmental and animal welfare standards"[31.]

Moreover, ECR promotes the sustainment and development of small-scale farming systems, especially the ones in urban and peri-urban areas, since these systems address several issues: social inequality and exclusion, lack of access to healthy and sufficient food, limits impacts on environment through sustainable production practices as well as reduced emissions since short supply chains require less transport.

The ECR also promotes several other actions that cover several areas:

- healthy ecosystem that supports agricultural productivity: safeguarding biodiversity, diversification of cultures, short supply chains, resource-efficient production, organic farming;
- access to healthy diets, in particular for low-income families: promotion of local, fresh and seasonal food, programmes addressing obesity;
- standardizes definitions, methodologies, monitoring and vigilance: harmonization and coordination ad EU level with the Commission surveilling;
- promote green public procurement (GPP): ensuring and fostering sustainable food supply;
- multilevel governance.

[30] Opinion of the European Committee of the Regions — Towards a sustainable EU food policy that creates jobs and growth in Europe's Regions and Cities, ECR, 2017.

[31] Ibid.

8.2 Initiatives taken at institutional level by the EU

In 2018, the European Parliament decided to associate to the Agricultural Committee the Environment Committee, allowing to address the environmental components of the post-2020 CAP.

In the CAP, the EU School Fruit, Vegetable and Milk Scheme is one of the measures that connect agricultural policy to dietary goals. However, the CAP's reforms say little about how the policies that could affect the later stages of the food supply chain (distribution, retail and consumption) and food waste developed by the Member States can meet the "societal demands on food and health" if the policy instruments are limited to the agriculture policy.

According to IPES FOOD's report, the"[m]arket competitiveness has taken precedence over sustainability goals in the EU's agri-trade policies; it has been the main justification for the market support measures deployed for decades under the CAP and subsequently for direct payments to farmers,56 as well as underpinning EU competition law[32]", Moreover, private set their own food safety and market standards in the production, processing and trade stage along the food chain[33,] leaving the public sector lagging behind. Examples are the negotiations over the TTIP agreement with the US and the renewal of the glyphosate-based pesticides, where the negotiations were taking place in secret and where the economic interests prevailed on the public health concerns.

Social and environmental factors have been left out, or as far as they are aligned with the economic interests, and the power remained de facto in the hands of the agro- and food industry. In fact, "20% of farms receive 80% of payments[34] under the CAP[35]".

In this context, moreover, the small-scale, especially urban and peri-urban, farms and local initiatives are usually ineligible for CAP funding; and where tools, measures and

[32] IPES-Food, *Towards a Common Food Policy for the EU - The policy reform and realignment that is required to build sustainable food systems in Europe*, 2019.

[33] F. Mittermayer, *Does Europe need a Food policy? A Food system approach to Public policy for Food in the European Union,* Paper prepared for presentation at the 148th seminar of the EAAE, Brussels, Belgium, 30 November – 1 December, 2015.

[34] European Commission, *The Future of Food and Farming*, 2017.

[35] IPES-Food, *Towards a Common Food Policy for the EU - The policy reform and realignment that is required to build sustainable food systems in Europe*, 2019.

funds are available, they are often under-communicated or implemented in an ineffective way[36].

Rather than focusing primarily on regulating markets and supporting farmers through standardized EU-wide policy tools, the EU must find ways to encourage local food initiatives, which are increasingly circumventing conventional markets and supply chains. Supporting experimentation in all of its diverse forms, through complementary actions at EU, national, and local levels, would be a priority of a Common Food Policy.

By shifting the focus from agriculture (and other sectoral policy areas) to *food*, a wider range of stakeholders can be meaningfully involved in designing and assessing policies.

8.3 The need of a new governance

It would be essential the adoption of the Common Food Policy (such as the Circular Economy package), thus being able to harmonize the policies of the several sectors involved and set the objectives of the policy.

At governance level, it would be necessary to create an intergroup on Food between the various Directorate-Generals (such as Agriculture, Environment, Health, Development) with a Head of Food in each of them, thus breaking down the so-called sectoral silos.

In order to involve all the stakeholders, especially the civil society, it would be created an European Food Policy Council, which develops and monitors the progresses of the Common Food Policy (through benchmarks and progress indicators). This would also draw attention onto local initiatives, urban and peri-urban food policies, thus establishing a bottom-up approach.

8.4 Objectives of the Common Food Policy

8.4.1 *Ensuring Access to Land, Water and Healthy Soils*

CAP's incentives are:

[36] European Commission, *The role of family farming, key challenges and priorities for the future*, Public consultation, 2013.

- based on farm size (per hectare), benefiting then "large-commodity producers, driving up land prices, encouraging land concentration & making it harder for new entrants to access land"[37;]
- commodity-linked ("coupled"): to crops like cereals and oilseeds.

This kind of policies undermine the implementation of EU environmental policies (such as the Water Framework Directive and the Nitrates Directive), aggravated by the absence of a "Soil Directive", which would recognize the value of the soils and regulate its management.

Moreover, "Europe's freshwaters are under threat from water pollution, water abstractions, droughts, and floods[38]".

In order to establish sustainable food production, it is necessary to have access to land, clean water and healthy soils. This would also not be essential to the food production but also for safeguarding of the ecosystem.

What the IPES FOOD's expert suggests is to reform the CAP's Pillar 1's direct payments mechanism in order to adjust it to better target the income support to farmers.

The first step would be moving from a logic based on farm size (hectare) to criteria including also labor intensity and regional specificities, with redistributive payment (for example, the 30% of the first pillar funds[39)] to small-scale farms; ii) putting caps on individual farms; iii) pro viding positive definition of active farmer at EU level; iv) introducing minimum % (instead of ceiling) for payments to young farmers.

It is also proposed to protect farmland from urban development and where urban infrastructures are built, the EU policies must include provisions for a sustainable urbanization.

Make access to EU Structural Funds conditional on sustainable land use under integrated territorial food system planning.

[37] IPES-Food, *Towards a Common Food Policy for the EU - The policy reform and realignment that is required to build sustainable food systems in Europe*, 2019.

[38] IPES-Food, *Towards a Common Food Policy for the EU - The policy reform and realignment that is required to build sustainable food systems in Europe*, 2019.

[39] Committee of Regions, *Opinion CAP reform – 132nd plenary session*, NAT-VI/034, 2018

8.4.2 *Rebuilding Climate-Resilient, Healthy Agro-Ecosystems*

According to IPES FOOD's experts, keeping the CAP in the way it is means that "highly-polluting forms of agriculture continue to be subsidized (incl. intensive livestock […]), while CAP environmental schemes & conditionalities are widely seen as ineffective. The latest CAP reform proposals risk exacerbating these problems & launching a race to the bottom by granting Member States the freedom to design their CAP interventions, while failing to establish clear EU wide sustainability indicators"[40].

In order to facilitate the inclusion and the implementation of sustainable practices, in the 2018 CAP reform, the Commission reiterated to the Member States to set up a FAS, a Farm Advisory System.

A list of new baseline requirements (or conditionalities) were proposed in order to have access to CAP payments such as:

- crop rotation;
- links to Directives on the sustainable use of pesticides and the Water framework Directive;
- nutrient management plans;
- eco-schemes that would aim to maximization of the benefits for the environment and for the climate;
- the CAP Strategic Plans that would be drew up by the Member States, indicating the measures that will be taken in order to meet nine objectives (of economic, social and environmental kind), including protection of biodiversity, resource-efficiency management, measures with reduced impact on climate;
- 30% of the Rural development Pillar (Pillar 2) are reserved for environmental and climate-related measures.

In 2013, there were introduced green direct payments to which farmers could get access to whether they implemented certain practices set at EU level. With the 2018 reform, the introduction of eco-schemes gave the Member States more flexibility to define

[40] IPES-Food, *Towards a Common Food Policy for the EU - The policy reform and realignment that is required to build sustainable food systems in Europe*, 2019.

these actions as well as the funds for the eco-schemes. However, the EU failed to stablish clear objectives the Member States would aim to[41][42], increasing the problems.

Regarding the funds connected to the environmental and climate-related measures, only the 16.8% has been used out of 30% that has been earmarked[43,] while Member States still rely on the coupled payments linked to meat and dairy sectors[44.]

Regarding the meat sector, the intensive production of livestock causes several negative impact both to environment and to health (from GHG emission, deforestation, pollution to antimicrobial resistance), making necessary the diversification of the production and the reduction of the number of animal per hectare as well as of the import of protein feed.

Moreover, the funds for the digitization of the farm life and the precision agriculture reinforced the trend to use capital-intensive inputs (such as expensive equipment) leading to sustain the intensive and large monoculture productions, putting aside the environmental and the socio-economic interests (such as the biodiversity loss, lack of diversification, barriers to small-scale farmers and social land, reduced employment).

It would be needed then a shift towards agroecology, which can be defined as "the application of ecological science to the study, design, and management of food system[45]", thus encompassing practices and measures such as "diversifying farms and farming landscapes, replacing chemical inputs with organic materials and processes, optimizing biodiversity, and stimulating interactions between different species, as part of a holistic strategy to build long-term soil fertility, healthy agroecosystems, and secure and just livelihoods"[46][47].

[41] ECA, *Opinion No 7/2018 (pursuant to Article 322(1)(a) TFEU) concerning Commission proposals for regulations relating to the Common Agricultural Policy for the post-2020 period*, COM(2018) 392, 393 and 394 final, 2018

[42] IPES-Food, *Towards a Common Food Policy for the EU - The policy reform and realignment that is required to build sustainable food systems in Europe*, 2019.

[43] European Commission, *Food, Farming, Fisheries*, https://ec.europa.eu/agriculture/events/2016/rural-development/fact-sheet.pdf

[44] European Commission, "Voluntary Coupled Support - Notification of the revised decisions taken by Member States by 1 August 2016,

[45] IPES-Food, *Towards a Common Food Policy for the EU - The policy reform and realignment that is required to build sustainable food systems in Europe*, 2019.

[46] Ibid.

[47] IPES-Food, *From uniformity to diversity*, 2016.

The agroecology is already incorporated into the CAP, but it needs to be incentivatized, for example through the allocation of the 50% of the CAP Pillar 2's funds to Agroecology premium that should be based on: (a) going beyond the CAP's Pillar 1's conditionality (crop rotation and diversification, replacement of synthetic pesticides with organic ones), (b) the creation of advisory services for the implementation of agroecological strategies and bottom-up initiatives and schemes such as the community supporter agriculture, where the organic production is led by farmers who are also consumers.

It would also be necessary the creation of output indicators, based onto production requirements and standards, thus aiming to implement a holistic approach.

The implementation of the agroecology would help to redesign the farming methods and the food production systems as well as to foster the development of "sustainable" technologies. However, farmers cannot make this shift on their own: in order to change the system, all the actors (including consumers) of the food supply chain must be involved.

8.4.3 *Promoting Sufficient, Healthy And Sustainable Diets For All*

The aim is the creation of healthy food environment: increasing the availability and physical proximity of healthy food can affect the diets. In order to promote healthy diets, it is then necessary the reshape of public spaces and make consumers aware of the choices.

Lifestyle changes, consuming patterns, longer working hours and less spare time, along the production of cheap food, lead to the rise of pre-prepared and processed meals as well as obesity issues. Moreover, private companies, through marketing campaigns, promoted a shift in the eating behaviours and consumption, while the public (in this case the EU) failed to efficiently promote healthier lifestyle and consuming patterns.

To address these issues, urban food policies should be developed and incentivized in order to make easier the access to healthy food options, especially in poorer neighbourhoods, and include locally-produced and seasonal fruits and vegetables in the public procurement's expenditure for public canteens, such as schools.

Poverty and social exclusion (23,7% of EU citizens in 2015[48)] tackle the access to healthy food, leading poor consumers to get mass produced foods. In fact, in low-income contexts, other expenses (such as housing) take priority, leaving less expenditure budget for healthy food. Moreover, in 2011, 8.7% of Europeans was affected by food insecurity[49] and food banks' food distribution reached over 6 million people[5051].

At institutional level, there is the European Social Fund (ESF) that is used for supporting social inclusion, education, employment as well as public services in the Member States. The 2013 reform introduced also the intervention in rural areas, tackling poverty, social exclusion and promoting economic development, sustaining bottom-up local strategies.

It should be created a food policy framework where educational campaigns are made in order to change lifestyle and consuming patterns, where food poverty and food insecurity are monitored, assessed and addressed by food and social policies, where healthy food options are targeted by fiscal reduction policies and where the healthy and sustainable food products are included in the public procurement's expenditure.

At industry level, cheap food is produced through mass production with the aim of lowering prices leading ultimately to shrink working conditions of farmers as well as of the production system. In the meantime, the production of vegetables and fruits is not incentivized enough.

[48] Eurostat, *People at risk of poverty or social exclusion*; EPRS, "Poverty in the European Union: The Crisis and its aftermath", PE 579.099, 2016.

[49] O. Davis and B.B. Geiger, "Did Food Insecurity rise across Europe after the 2008 Crisis? An analysis across welfare regimes," *Social Policy and Society* 16, no.3 (2017).

[50] U. Gentilini, "Banking on food: The state of food banks in high-income countries," *IDS Working Papers* 415, 2013.

[51] EBA, Homepage, 2017.

8.4.4 *Building Fairer, Shorter And Cleaner Supply Chains*

"Agriculture has recently been estimated to receive only 21% of the share of value in EU food chains […] and in stark contrast to the 51% of value going to the food retail and food services sector"[52][53][54].

The food companies usually have the power in the negotiation for the agreements and also produce new standards of production, leaving the producers obliged to accept the changes in order to continue to sell. Moreover, wholesalers prefer to source from large-scale farms rather than small-scale ones in order to be sure to have a wider variety of foods, lower prices and higher volumes.[55][56]

Moreover, the centralization of operations in the production led to the disappearance for example of small-scale processors. In fact, the agricultural workforce decreased by 25%[57] from 2005 to 2017 and it is expected to drop by a further 28%[58] by 2030. This also led to depopulation of rural areas and thus the gradual increase of poverty, social exclusion as well as the reduction of services[59].

Another huge concern is the unfair trading practices (UTPs): selling below the cost of production means poorer working conditions for farm-workers and lower revenues for farmers. This goes against the EU competition law, but the working rights of farmer are "deemed to have little impact on the (economic) welfare of consumers"[60].

[52] IPES-Food, *Towards a Common Food Policy for the EU - The policy reform and realignment that is required to build sustainable food systems in Europe*, 2019.

[53] European Parliament, Parliamentary questions - Answer given by Mr. Hogan on behalf of the Commission.

[54] European Parliament, *Report on fair revenues for farmers: A better functioning food supply chain in Europe.*

[55] European Commission, *Commission staff working document on various aspects of short food supply chains*, 2013.

[56] K.M. Reardon, "An experiential approach to creating an effective community- university partnership: The East St. Louis Action Research Project," *Cityscape: A Journal of Policy Development and Research* 5, no.1 (2000): 59-74.

[57] European Court of Auditors, "Future of the CAP," *Briefing Paper*, March 2018.

[58] European Commission, "EU agricultural outlook: European agricultural labour and total income expected to decrease by 2030," 2017.

[59] Eurostat, "Statistics on rural areas in the EU," 2017.

[60] IPES-Food, *a Common Food Policy for the EU - The policy reform and realignment that is required to build sustainable food systems in Europe*, 2019.

On the other hand, approximately 75% of Europeans live in cities[61]. It's in the cities that the most of sustainability issues occur. Even though food waste happens along the whole food supply chain, most of it occurs at consumer level.

Moreover, it is estimated that circa the 20% of the food produced in the EU is wasted or lost every year[62], which equals to circa 180 kg per person and it is estimated that, in terms of impact on environment and resources used, costs 143 billion-euros[63]. This is due also to the rise of throwaway culture.

It was highlighted the need to reinforce the negotiation power of farmers leading with the 2017 CAP adjustment to add new provisions regarding the production and supply contracts[64]. Under the Green Public Procurement (GPP), there are provisions to foster public bodies to source goods and services from small-scale producers, especially for local/organic foods or satisfying higher standards such as of animal welfare or reduced use of plastics. It could be also included a mandatory percentage of buying from small and medium farmers or the buying of local varieties of vegetables and fruits.

While, under the Rural Development Programme 2014-2020, it was included the support for alternative food systems, such as short supply chains and local markets[65].

The Alternative Food Systems (AFS) are systems where all actors are actively involved in shaping the system itself. The AFS aim to "improve environmental impacts (e.g. by promoting on-farm biodiversity, natural resource conservation, diminishing the need for cold storage, or reducing packaging)[66]; economic impacts (e.g. by generating employment, increasing farm- and food-worker revenues)[67]; and social impacts (e.g. by promoting greater consumer awareness on the origins and quality of their food, encouraging food citizenship through local democracy and new governance models;

[61] Eurostat, *Share of urban population*, 2014.

[62] Fusions, *Estimates of European food waste levels*, Stockholm, 2016.

[63] Fusions, *Estimates of European food waste levels*, Stockholm, 2016.

[64] Commissioner *Phil Hogan, Building the Future of EU Food & Farming*, 2017.

[65] European Parliament and Council of the European Union, *Measure 16.4, Art.35.2 of Regulation (EU) No 1305/2013 of the European Parliament and of the Council of 17 December 2013 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD) and repealing Council Regulation (EC) No 1698/2005*, OJ L 347, 20.12.2013, 2013).

[66] J.-P. Schweitzer, S. Gionfra, M. Pantzar, D. Mottershead, E. Watkins, F. Petsinaris, P. ten Brink, E. Ptak, C. Lacey and C. Janssens, *Unwrapped: How throwaway plastic is failing to solve Europe's food waste problem (and what we need to do instead)*, a study by Zero Waste Europe and Friends of the Earth Europe for the Rethink Plastic Alliance (Brussels: Institute for European Environmental Policy (IEEP), 2018).

[67] OECD, *Towards green growth: A summary for policy makers*, 2011.

bridging the gap between urban and rural areas and different supply chain actors)[68]. They also often aim to improve food security by promoting access to fresh foods for consumers while supporting small producers and local econoies"[69].

Example of AFS are community gardens, short food supply chains (for example the farmers' market), certifications as urban and peri-urban agriculture.

According to the report, the 15% of EU farms sells directly to consumers and Community Supporter Agriculture reach a population between 500,000 and 1 million of Europeans.

Not only, at municipal level, the number of AFS's initiatives is growing: from urban gardens to the establishment of food policy councils. These initiatives can address sustainability and social issues (such as being a source of employment) as well as introducing democracy into the food systems.

However, these initiatives are not supported: inadequate framework, lack of integration and coordination among the various initiatives' actors but also the EU support tools fall behind: local-led action are often too small to be eligible to access to CAP Pillar 1 funding, and, since they are usually urban-based they are not eligible for the funding under the Rural Development Pillar. Moreover, due to their small-scale nature, they struggle to compete with larger farmers in terms of prices, volume etc, thus facing exclusion from contracts for example with the public bodies.

It is necessary then to create, for example, city regions policies and strategies, establishing collaboration a at various level of governance between several actors: from citizens to local authorities to private sector. However, "few opportunities exist for EU policy-makers to learn from these initiatives and shape EU-level policies and programmes accordingly[70]" and local actors are poorly aware of funds and policy tools [71] made available the EU as well as the fact that these actors do not see the links between these

[68] M. Kneafsey et al., *Short food supply chains and local food systems in the EU: A state of play of their socio-economic characteristics*, JRC Scientific and Policy Report (Brussels: European Commission, 2013).

[69] IPES-Food, *Towards a Common Food Policy for the EU - The policy reform and realignment that is required to build sustainable food systems in Europe*, 2019.

[70] Ibid.

[71] Ibid.

initiatives' aims and the goals and objectives (such as strengthening the urban-rural linkage or rural development or job creation) of EU programmes.

To this aim, it would be necessary a reform to the CAP Pillar 2 earmarking funds for strengthening the linkages between the rural and urban system and develop a common framework to sustain, develop and monitor the alternative food systems across the Member States (for example, a measure could be the creation of exemptions for small-scale actors).

Another proposal could be the creation of food hubs, which are "are local or regional facilities that aggregate, store, process, distribute, and/or market locally-produced foods[72]", thus re-territorializing food systems. They would support small-scale and medium-scale farmers by making easier the selling of their products to consumers, for example through the processing and warehouse facilities as well as supporting farmers throughout the distribution. Food hubs would create jobs, would facilitate the access to healthy food, support small-scale farmers and also create networks with farmers' market, food banks and other social realities.

8.4.5 *Putting Trade in the Service of Sustainable Development"*

"The EU is the world's biggest food exporter and importer, the biggest aid donor, and the largest source of foreign direct investment"[73], thus making the EU an actor that can significant negative impacts on the global market, especially on developing countries. It is necessary then to introduce new measures that regulate trade by taking into account the developments goals of developing countries and reduce the CAP promotion of exports of high-emitting sectors such as dairy and meat.

This is also due to the fac that the EU has a significant bargaining power, thus it can take advantages during the agreements' negotiation, especially when with developing countries.

An example is the royalty-free access to raw materials in developing countries, thus mining the resources for the local government to develop[74].

[72] IPES-Food, *Towards a Common Food Policy for the EU - The policy reform and realignment that is required to build sustainable food systems in Europe*, 2019.

[73] European Union, "Trade," 2018, https://europa.eu/european-union/topics/trade_en.

[74] IPES-Food, *Towards a Common Food Policy for the EU - The policy reform and realignment that is required to build sustainable food systems in Europe*, 2019.

Notwithstanding, some tools were created, such as the EU Generalised Scheme of Preferences (GSP) and the GSP+, which provide preferential access to the market for those countries that sign and implement the international conventions based on the safeguard of the environment or recognition of labour rights.

However, the exports of EU agricultural products are still heavy subsidized, making impossible for small countries to compete.

A proposal would be to implement in the agreements' negotiations the SDGs, assessment before and after the signature of Free Trade Agreements (FTA) regarding both the sustainability and the human rights.

The introduction of economic (such as economic development), environmental (such as biodiversity) and social clauses (such as right to food) in the negotiation would ensure that no measures would negatively affect the other countries' people.

Moreover, it is proposed to create and implement a "complaint mechanism" in order to protect the citizens, that could be applied to all EU's agreements[75].

[75] IPES-Food, *Towards a Common Food Policy for the EU - The policy reform and realignment that is required to build sustainable food systems in Europe*, 2019.

9. Circular economy applied to food policy

The application of circular economy's principles to the food supply system is new research area, in particular the urban food policies.

The concept of circular economy, seen from a production-consumption point of view, can be defined as:

> «[…] a sustainable development initiative with the objective of reducing the societal production-consumption systems' linear material and energy throughput flows by applying materials cycles, renewable and cascade-type energy flows to the linear system. CE promotes high value material cycles alongside more traditional recycling and develops systems approaches to the cooperation of producers, consumers and other societal actors in sustainable development work»[1.]

In this definition, the circular economy approach would involve all three aspects of sustainable development (economic, environmental and social) by departing from a linear economy by introducing the circular economy's principles (such as reusing, recycling, cascade use) and limits the production accordingly to the level that nature tolerates and respecting its reproduction rate.

The systemic approach of the circular economy, which could be expressed as 3R (Reduce, Reuse, Recycle) as well as 9R (Refuse, Rethink, Reduce, Reuse, Repair, Refurbish, Remanufacture, Repurpose, Recyle and Recover) or, as Fassio and Minotti (2019)[2:]

> «[…] responsibility, react, reduce, reuse, re-design, repair, recover, recycle, and rot"[3,] would benefit the food system through, for example, "regenerative agriculture, valorisation of by-products and waste, closing nutrient loops, protein substitution[4.] as well as the value recovery from food waste and the potential of urban and peri-urban farms».

[1] Korhonen, J., Nuur, C., Feldmann, A., Birkie, E.S., *Circular Economy as an essential contested concept*, J. Clean. Prod, 2017.

[2] Fassio F., Minotti B., *Circular Economy for Food Policy: The Case of the RePoPP Project in The City of Turin (Italy)*, MDPI, 2019.

[3] Ibid.

[4] Ellen MacArthur Foundation (EMF), *Cities and the circular economy for food*, 2018.

The contribution given by the application of circular economy to food system would also benefit other systems: an increased food supply and wider choice of food products (thus a healthier diet and an alternative to fast food products), reduced GHG emissions, better water management, social benefits (such as inclusion of disadvantages groups) and, overall, a better quality of the life in the city.

The Ellen MacArthur Foundation's "Cities and the circular economy for food" report states that, the current food system, over being wasteful as already explained, is:

- leading to the clearing of land: to grow crops and rear livestock, lands of the area equivalent to, respectively, South America and Africa have been cleared[5;]
- consuming excessive energy: the equivalent of 2 000 litres of oil is used to bring food on the table of an average American[6;]
- contributing to environmental degradation: "For every $1 spent on food, $2.27 is required to clean up the damage (KPMG)"[7] and that "[i]ndustrialised farming practices cost the environment some USD 3 trillion per year (more than UK annual GDP) in negative environmental externalities across the value chain (FAO)[8"];
- disrupting nutrient flows and degrading soul: "[m]odern agricultural practices, such as excessive tillage and the use of heavy machinery, accelerate erosion and water runoff, carrying nutrients out of the soil and into water systems. As crops are harvested, nutrients and organic matter are removed; if they are not replaced, soil fertility decreases"[9] as well as the heavy use of synthetic fertilizers and pesticides increase toxicity levels of the soil, involves use of finite resources and generates GHG emissions;
- impacting on social dimension: "heavily subsidised rich country farms lower global food prices, flooding cheap exports into poor, unsubsidised farmers who can no longer compete[10.]

According to Fassio and Minotti, the current food system feeds "the economy itself rather than responding to real needs of humanity"[11,] leading to an irrational waste and loss of food (in particular at the consumption level).

The MacArthur Foundation suggests some actions and strategies that should be taken into consideration:

[5] Ellen MacArthur Foundation (EMF), *Cities and the circular economy for food*, 2018.
[6] Ibid.
[7] Ibid.
[8] Ibid.
[9] Ibid.
[10] Ibid.
[11] Fassio F., Minotti B., *Circular Economy for Food Policy: The Case of the RePoPP Project in The City of Turin (Italy)*, MDPI, 2019.

- Implement regenerative agriculture: return "organic matter to the soil in the form of composted by-products, food waste or digestates from treatment plants, organic content in topsoil increases and soil structure improves, protecting it from erosion[12]";
- Recover value and biogas from organic nutrients: organic matter, if left to rot, releases methane (which releases 28% of overall global GHG emissions), which can be controlled "through engineered anaerobic digestions (AD) systems[13]", transformed in carbon-neutral energy, the biogas, and later "injected into the natural gas network or converted to electricity[14]";
- Supporting urban and peri-urban agriculture: it would create new jobs, increase social inclusion, foster short chain food supply, thus reducing transport costs, lowering emissions of GHG and at the same time, facilitate the return of organic matter to soil (inverse logistic).

9.1 Examples of Circular Economy applied to Urban Food Policies

As reported above, the MUFFP considers 6 categories (social and economic equity; governance; food waste; food supply; food production; sustainable diets and nutrition) and highlights the main impacts every practice adopted have on them.

I will report some of best practices gathered across European cities.

9.1.1 *Sustainable diets and nutrition*

Copenhagen[15]

The aim of the Municipality of Copenhagen was to pursue sustainability goals in the city's public food system through two main aims: ensure the supply of quality organic food, aiming to achieve the 90% of organic ingredients in the entire public food system and training kitchen staff.

The results reported that an 88% was achieved, which equals to 141 thousands kilos of organic food that were served across approximately 900 kitchens, instead of processed food and semi-fabricated.

Moreover, the demand of organic food tripled throughout the years.

[12] Ellen MacArthur Foundation (EMF), *Cities and the circular economy for food*, 2018.
[13] Ibid.
[14] Ibid.
[15] Food and Agriculture Organization (FAO), Milan Urban Food Policy Pact (MUFPP), *Copenhagen*, 2018, http://www.milanurbanfoodpolicypact.org/wp-content/uploads/ 2018/07 /Brief-15-Copenhagen.pdf

Regarding the kitchen staff, the programme lead to the professionalization of the organic food supply lines (canteens, schools, hospital and nursing homes): the staff was trained in order to create sustainability friendly meal plans and the food offering was wider, including seasonal fruits and vegetables.

The programme's costs reported were circa 40 millions of euros for food, and circa 6 millions of euros for the training and counseling to kitchen staff.

Birmingham – United Kingdom[16]

The project aimed to tackle childhood obesity, in fact, according to recent studies, one in four children is obese after primary school.

Thus, with a budget of 400 000 GBP, all schools and cumminity centres have been supported not only to grow healthy food, but also to raise awareness and healthy diets and adopt an healthy lifestyle. The aim was to promote a cultural shift towards food preferences. In fact, this project took place in deprived areas, where the fast food behavior is stronger, thus fostering economic and social equity of the food system.

9.1.2 *Governance*

Ede – Netherlands[17]

It's the first integrated food strategy adopted by a city in Netherlands.

The city council allocated a large budget for the strategy, created through a bottom-up approach, thus involving several stakeholders from local society. The aim is the healthy and sustainable supply of food for the citizens. It was also included the key figure of the municipal food councilor.

The team has to develop an integrated food strategy with social actors, raise awareness about food issues, involve other structures and public institutions.

The strategy would cover not only the food-related policies (such as short food chains, sustainable food production) and issues (such as food waste), but also public health and integrated governance.

[16] Food and Agriculture Organization (FAO), Milan Urban Food Policy Pact (MUFPP), *Birmingham*, 2018, http://www.milanurbanfoodpolicypact.org/wp-content/uploads/2018/07/Brief-14-Birmingham.pdf

[17] Food and Agriculture Organization (FAO), Milan Urban Food Policy Pact (MUFPP), *Ede*, 2018, http://www.milanurbanfoodpolicypact.org/wp-content/uploads/ 2018/ 07/Brief-4-Ede.pdf

An example of initiative taken under this strategy is to include citizens in gathering ideas and allocate subsidies to winning ideas, thus generating commitment and responsibility in citizens as well as public organisms involved.

9.1.3 *Food waste*

Riga – Latvia

About 50% of all waste produced in Latvia (circa 300 000 tonnes per year) is brought to a given waste landfill. Of this 50%, over 40% is biomass, which could be exploited in order to mitigate the negative impacts to the environment and the soil. The Municipality of Riga turned this waste landfill into an environmentally friendly, innovative and ecological waste management site.

The "food waste is deposited in environmentally safe biodegradable cells. The landfill gas that forms in the cells is channelled to the […] power unit and transformed into energy. The impact of waste on the environment is reduced to a minimum: the […] ecological landfill is one of the largest producers of green energy in Latvia (31 to 33 gWh annually). The side-product of energy production is heat (20 gWh in 2015) used for greenhouses that are located in the vicinity of the landfill […][18]".

> "The greenhouses provide off-season tomatoes to the citizens of Riga, distributed through the primary supermarket chains. The company has developed a "one-touch" method in gathering, pack - ing and distributing products to the wholesaler. This method allows food harvesting to occur as late as possible to keep products safe and unspoiled, while also enabling them to grow to full maturity for maximum nutrition value. […] only organic practices and natural organisms are used to grow healthy tomatoes. During the off-season period, the greenhouse produces 390 tonnes of high-quality tomatoes, whose nutrition value is high compared to imported tomatoes during the winter months[19]".

Along tomatoes, also cucumbers are now cultivated using LED lighting as sole source.

Alongside the cultivation, an educational programme has been established in order to increase awareness regarding food-related issues as well as field trips for schools, students and experts.

[18] Food and Agriculture Organization (FAO), Milan Urban Food Policy Pact (MUFPP), *Riga*, 2018, http://www.milanurbanfoodpolicypact.org/wp-content/uploads/2018/07/ Brief-6-Riga.pdf

[19] Food and Agriculture Organization (FAO), Milan Urban Food Policy Pact (MUFPP), *Riga*, 2018, http://www.milanurbanfoodpolicypact.org/wp-content/uploads/2018/07/ Brief-6-Riga.pdf

As a result, the citizens of Riga are provided of healthy off-season vegetable and where the waste landfill is located, it gives work to 17% of the neighborhood. Moreover, the atmosphere is protected from 2000 meters cubic meters per hour of environmentally harmful gases.

Ghent – Belgium

Due to large volumes of excess food, the Municipality created a logistic and information platform in order to balance volume and demand for excess food between wholesale markets, retailers and social organizations. So far, in 10 months, the platforms achieved: **"**• 300.34 tonnes of food redistributed composed of 64 395 items; • 24 retailers, one wholesale market, two distribution centers of retailers, one organic farm and one company provided food products; • 58 local charity organisations and social restaurants based in Ghent distributed food to people in need; • 18 971 people in need received products or food baskets. • 68% of fresh fruit and vegetables on total amount of products redistributed; • reduction of 762 tonnes of CO2; and • employment of 19 people coming from long-term unemployment[20]".

Therefore, the platform manages to tackle food waste, provides work to unemployed citizens and fights poverty by ensuring access to healthy food to disadvantaged groups.

Milan – Italy[21]

The Municipality of Milan took several measures to tackle food waste:

- discount on the waste tax (20% to food businesses, such as supermarkets and restaurants, that donate their excess food to social organizations, such as charities. It is estimated it would involve circa 10 000 food businesses with an impact of 1.8 million euros[22;]
- - 106 canteens (out of a total of 418) were affiliated to a food bank through which 150 tonnes of fruits and bread were recovered and redistributed;
- - Pilot project at neighborhood level in order to redistribute food losses at local level. The project involves 35 "local food waste hub" and each of them, according to estimates given my preliminary analysis, would be able to redistribute circa 70 tonnes of food per year;

[20] Food and Agriculture Organization (FAO), Milan Urban Food Policy Pact (MUFPP), *Ghent*, 2018, http://www.milanurbanfoodpolicypact.org/wp-content/uploads/2018/07/ Brief-22-Ghent.pdf

[21] [21] Food and Agriculture Organization (FAO), Milan Urban Food Policy Pact (MUFPP), *Milan*, 2018, http://www.milanurbanfoodpolicypact.org/wp-content/uploads/2018/10/ Milan-Ago.-2018-def.pdf

[22] Food and Agriculture Organization (FAO), Milan Urban Food Policy Pact (MUFPP), *Milan*, 2018, http://www.milanurbanfoodpolicypact.org/wp-content/uploads/2018/10/ Milan-Ago.-2018-def.pdf

- a project involving open street markets;
- the hiring of a food policy officer at municipal level.

The aim is to achieve a 50% of waste reduction by 2030.

Bruges - Belgium[23]

The project to tackle food waste involved healthcare institutions, since, according to analysis, food waste in the healthcare sector could reach up to 40% of the city total waste[24.] Thus, the city of Bruges involved actively 19 healthcare institutions.

The first step was to measure food waste and its economic impact, then develop and disseminate good practices to reduce food waste. This was also made by training the institutions' personnel and handing out questionnaires to personnel and patients to gather informations about quality, quantity, choice and timing of served food.

According to the results produced, a reduction of 27 652 kg of food waste per year is possible, which means a saving of 27 652 euros per year as well as a reduction of 88 487 kg of CO2[25].

9.1.4 *Food production*

Nantes – France[26]

Revitalization of wastelands and brownfields (areas affected by real or perceived environmental contamination) where agriculture could be relocated through a land clearing process. The area identified covers 1900 hectares (ha) and 137 sites.

Through a joint coordination group of the Nantes municipality and the Chamber of Agriculture, along the involvement of several stakeholders, the strategy led to the clearing and re-cultivation of circa 450 ha on 51 different sites. New farm facilities were created and others are being built or under study at cleared sites.

The project also led to the creation of jobs in the agricultural sector, the emergence of short food chains and thus the diversification of the territorial food system.

[23] Food and Agriculture Organization (FAO), Milan Urban Food Policy Pact (MUFPP), *Bruges*, 2018, http://www.milanurbanfoodpolicypact.org/wp-content/uploads/2018/07/ Brief-7-Bruges.pdf

[24] Food and Agriculture Organization (FAO), Milan Urban Food Policy Pact (MUFPP), *Bruges*, 2018, http://www.milanurbanfoodpolicypact.org/wp-content/uploads/2018/07/ Brief-7-Bruges.pdf

[25] Food and Agriculture Organization (FAO), Milan Urban Food Policy Pact (MUFPP), *Bruges*, 2018, http://www.milanurbanfoodpolicypact.org/wp-content/uploads/2018/07/ Brief-7-Bruges.pdf

[26] Food and Agriculture Organization (FAO), Milan Urban Food Policy Pact (MUFPP), *Nantes*, 2018, http://www.milanurbanfoodpolicypact.org/wp-content/uploads/2018/07/ Brief-29-Nantes.pdf

Bordeaux – France[27]

The Municipality of Bordeaux created the Food Policy Council, which is run by four elected representatives, with groups of stakeholders (in total 170 stakeholders) that compose 4 working groups that work on: 1. Access to sustainable and quality food supply 2. Reduction of food waste 3. Increase the agricultural and food capacity of production in the territory 4. Support short food supply chains.

Moreover, the Council is currently creating benchmark indicators to assess progresses.

9.1.5 *Food supply and distribution*

Vienna – Austria[28]

The public food procurement in Vienna provides food every day to circa 100 000 people through: day cares centers, schools and after-school centres, hospitals, nursing-homes, retirement homes etc.

A Food Working group has been created with the aim of creating a sustainable food supply that provides high quality food meeting also eco-friendly criterias. Therefore, several criteria have been added along the food quality and the sustainability criteria:

- organic food products must compose at least the 30% of the total food procurement, but also "seasonality and freshness;
- no-GMO products;
- minimisation of waste;
- reduction of animal products e.g. meat used in dishes;
- animal rights (ethical handling of animals);
- high social standards in production and trade;
- minimal food processing[29]".

[27] Food and Agriculture Organization (FAO), Milan Urban Food Policy Pact (MUFPP), *Bordeaux*, 2018, http://www.milanurbanfoodpolicypact.org/wp-content/uploads/2018/ 07/Brief-19-Bordeaux.pdf

[28] Food and Agriculture Organization (FAO), Milan Urban Food Policy Pact (MUFPP), *Vienna*, 2018, http://www.milanurbanfoodpolicypact.org/wp-content/uploads/2018/07/ Brief-10-Vienna.pdf

[29] Food and Agriculture Organization (FAO), Milan Urban Food Policy Pact (MUFPP), *Vienna*, 2018, http://www.milanurbanfoodpolicypact.org/wp-content/uploads/2018/07/ Brief-10-Vienna.pdf

70% of food products are sourced from Austria	100% organic eggs	66% organic fruits
33% of food products are from organic agriculture	100% organic milk	62% organic vegetables
1440 tonnes of organic fruits and vegetables are bought every year	100% organic coffee	38% organic meat

Table 8. Source: http://www.milanurbanfoodpolicypact.org/wp-content/uploads/2018/07/Brief-10-Vienna.pdf

Ljubjana – Slovenia[30]

In the Rural Development Strategy, one of the targets was the creation of allotment gardens spread across the city. On an area of approximately 65 000 m3 (65 292 m3), there were created 705 allotment gardens with an average dimension of 60 m3 and to be rented for 3 to 5 years.

> **"**Recent research shows that urban gardening can now ensure a self-employment condition with an average income of EUR 200 to 400 per month for each occupied person, that is around 20 to 30% of the total monthly income. Considering an average gross margin for food production of about EUR 2.42/m 2, the expected economic impact of urban gardening on the vegetable supply chain in the urban areas currently dedicated for allotments is about EUR 1.1 million per year[31]".

It is also highlighted that over the 50% of vegetables needs are covered by the 50% of the gardeners' activities, that 80% of the gardeners use the production for their own needs and 70% of them also donate surpluses.

9.1.6 *Social and economic equity*

Almere – Netherlands[32]

In Almere, it's possible to rent plots of land by individuals or families to grow their own food. Every plot is minimum 12 m2 (3x4m2) with a cost of 23 euros per month and the possibility of renting several plots.

The allotments also give the possibility to grow out of season fruits, vegetables and flowers.

[30] Food and Agriculture Organization (FAO), Milan Urban Food Policy Pact (MUFPP), *Ljubjana*, 2018, http://www.milanurbanfoodpolicypact.org/wp-content/uploads/2018/07/ Brief-5-Liubiana.pdf

[31] Food and Agriculture Organization (FAO), Milan Urban Food Policy Pact (MUFPP), *Ljubjana*, 2018, http://www.milanurbanfoodpolicypact.org/wp-content/uploads/2018/07/ Brief-5-Liubiana.pdf

[32] Food and Agriculture Organization (FAO), Milan Urban Food Policy Pact (MUFPP), *Almere*, 2018, http://www.milanurbanfoodpolicypact.org/wp-content/uploads/2018/07/ Brief-16-Almere.pdf

> «The aim is to produce 20% of the total demand for food (vegetables, fruits, milk and eggs) within a radius of 20km from the city centre»[33].

Moreover, training courses to raise awareness and spread knowledge are organized every season, providing guidelines to novices.

As reported in the Utrecht's report:

> «Social restaurants and urban gardens provide employment to young residents, raising their incomes and helping them develop skills to increase their chances of future employment. At the same time, these places foster the inclusion of marginalized actors, providing a meeting point where people of all ages can work together or share a meal. Urban agriculture also reduces stress levels and improves the knowledge of urban gardeners, who become better informed about sustainable food production and consumption. All of these co-benefits contribute indirectly to diminishing health inequalities across the city»[34.]

[33] Food and Agriculture Organization (FAO), Milan Urban Food Policy Pact (MUFPP), *Almere*, 2018, http://www.milanurbanfoodpolicypact.org/wp-content/uploads/ 2018/07/Brief-16-Almere.pdf

[34] Food and Agriculture Organization (FAO), Milan Urban Food Policy Pact (MUFPP), *Utrecht*, 2018, http://www.milanurbanfoodpolicypact.org/wp-content/uploads/2018/ 07/Brief41-Utrecht.pdf

10. Food waste treatments

«As population and urbanisation grows, more food is being produced and more food is being wasted»[1] and as the number of people that live in cities increases, the higher will be the pressure on cities' infrastructure and thus even on basic services. However, cities also provide opportunities. One of them is how food waste is treated and the several benefits deriving from its treatment.

The management starts with the methods of collecting food waste: food that cannot be sold anymore can be donated to social actors such as charities and household's and business' food waste can be collected separately. Food waste treatment can have several positive impacts on many fields: increase soil health, food security create jobs, generate digestate and compost and other high value products[2], promote sustainable development, reduce dependence on synthetic fertilisers and fossil fuels, GHG emissions and need of landfills, pathogens in the waste (if anaerobically digested) thus promoting higher hygiene and sanitation, increase renewable production of energy as well as serving for increasing the resilience of cities' basic services (transport fuel, biogas for household consumption, energy, light, electricity, heating and cooling).

The avoidable and undesirable impacts of untreated food waste are several.

Regarding the water footprint:

- water, extracted from groundwaters or surface water bodies, used in the food production is wasted;
- wastewater deriving from food production and leachate from landfills pollute water bodies;
- use of fertilisers and pesticides impact on water quality.

It is necessary then to:

- collect wastewater properly, in order to prevent leachate;
- anaerobically digest it, capturing the carbon coming out from it in the form of biogas will reduce the oxygen demand of wastewater and thus the pathogens in it;
- use digestate as biofertilisers, reducing the use synthetic fertilisers.

[1] World Biogas Association, *Global Food Waste Management: an Implementation Guide for Cities*, C40 cities, 2018.

[2] Ellen MacArthur Foundation (EMF), *Towards the Circular Economy*, 2013, https://www.ellenmacarthurfoundation.org/assets/downloads/publications/TCE_Report-2013.pdf

Regarding nutrient loss, unsustainable practices led to the depletion of nutrients (nitrogen, phosphorus and potassium) and organic matter in the soil;

It is necessary then to:

- apply digestate or compost to agricultural land in order to slow down soil degradation and return nutrients to it;
- keep in circulation nutrients to prevent eutrophication in surface water bodies;

Sanitation

The anaerobic digestion reduces the pathogens in the food waste, preventing the spread of diseases and odours that otherwise would happen if left in landfills and promoting sanitation and hygiene.

Ecological impacts

Unsustainable food production affect negatively the land (from agricultural land to forests), leads to loss of biodiversity and over exploitation of marine life.

It is necessary then to:

- use biogas as domestic fuel in order to reduce the use of fossil fuels but also natural resources such as woods;
- manage properly the leachate from landfills to avoid contamination of water bodies as well as the eutrophication process.

Methods of food waste management according to the Waste Hierarchy

Food and drink Material Hierarchy	
Prevention	Waste of raw materials, ingredients and product arising is reduced – measured in overall reduction in waste
Optimisation	Redistribution to people Sent to animal feed
Recycling	Waste sent to anaerobic digestion Waste composted
Recovery	Incineration of waste with energy recovery
Disposal	Waste incinerated without energy recovery Waste sent to landfill Waste ingredient/product going to sewer

Table 9

11. Food waste treatment technologies

11.1 Technologies based on waste separation

11.1.1 *Anaerobic Digestion (AD)*

The American Biogas Council defines the anaerobic digestion as "a series of biological processes [hydrolysis, acidification, methanogenesis] in which microorganisms break down biodegradable material in the absence of oxygen"[1], "converting livestock manure, municipal wastewater solids, food waste, high strength industrial wastewater and residuals, fats, oils and grease (FOG), and various other organic waste streams into biogas […].

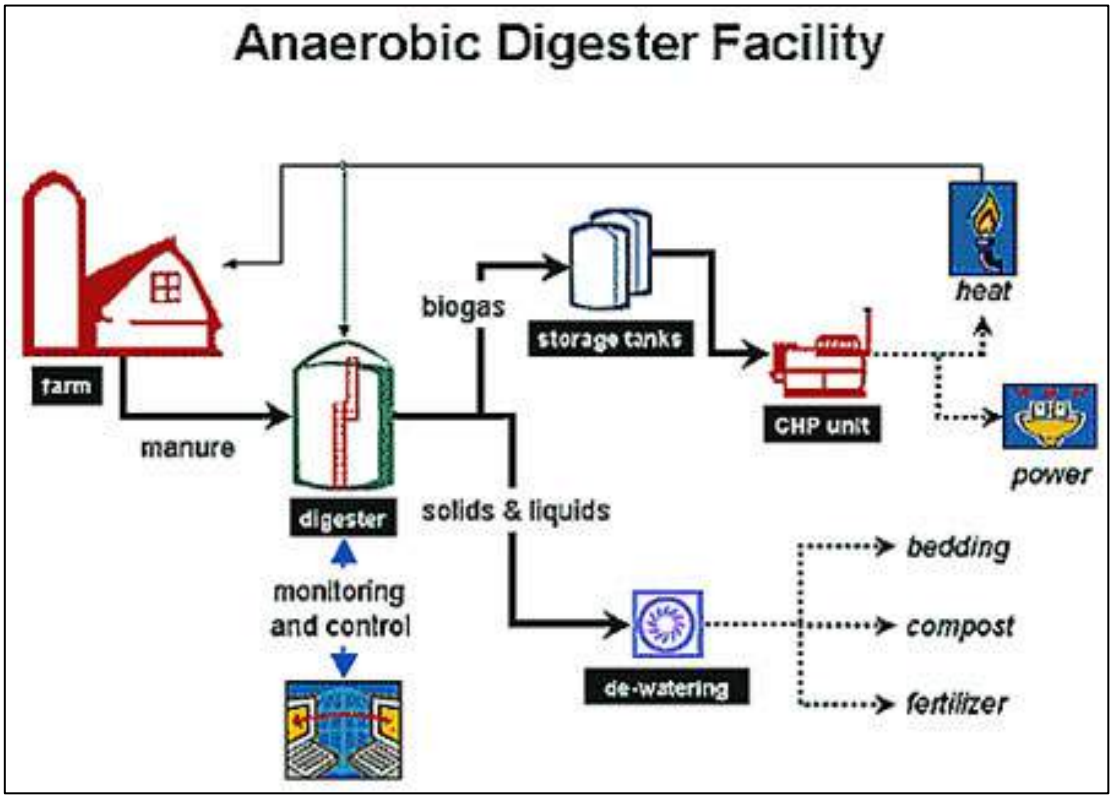

Figure 17. Source: https://archive.epa.gov/region9/organics/web/html/benefits.html

[1] American Biogas Council, *What is anaerobic digestion,* https://americanbiogascouncil.org/resources/what-is-anaerobic-digestion/

Separated digested solids [the organic matter left is known as digestate, rich in nutrients and organic matter] can be composted, utilized for dairy bedding, directly applied to cropland or converted into other products. Nutrients in the liquid stream are used in agriculture as fertilizer"[2].

More in depth, the anaerobic digestion of food waste produces:

Biogas	It can be: - directly used for domestic uses, combusted to produce electricity and generate heat; - upgraded into biomethane, thus used for transport fuel, for commercial and industrial use; - processed into high value products like bio-chemicals and bio-plastics.
Digestate	It's rich in nutrients and organic matter and can be: - used as bio-fertiliser; - pasteurized and then composted or separated of dry and wet solids in order to be applied to agricultural land.

Table 10

Therefore, the AD of food waste can be considered:

- as a renewable energy production site, thus reducing the reliance on fossil-fuel energy and increasing energy security (other than the already mentioned generation of biogas and thus biomethane, heat);
- environmental friendly: the reduced use of fossil fuels and the increased use of biogas and biomethane reduce the GHG emissions, the uncontrolled emissions of methane from rot food waste left in landfills, the use of synthetic fertilisers and, through the digestate, restore the soil health;
- a further step towards a circular economy: it increases the sustainability of industries through its products and the efficient use of resources as well as the recirculation of nutrients and organic matter to the soil through digestate;
- a way to improve food security: the use of digestate, rich of nutrients and organic matters, restore soil health and increase yields;
- a measure to promote hygiene and sanitation: through the proper solid waste management, thus preventing spread of diseases, creation of landfills and protect water bodies;
- a measure to generate economic development and employment: the construction, the maintenance of the AD plant require workforce as well as the collection, separation of solid waste and the selling of AD products.

[2] American Biogas Council, *What is anaerobic digestion,* ttps://americanbiogascouncil.org/resources/what-is-anaerobic-digestion/

11.1.2 *The process of Anaerobic Digestion (AD)*

It starts with a pre-treatment stage, where feedstock is screened, removing packaging, metal parts, grit, then macerated and pressed. Then the pre-treated food waste is put into the digester where it gets decomposed (by a combination of bacteria and microbes) in absence of oxygen, at a temperature range of 35-40°C (mesophilic). At these temperatures, the process runs in more stable conditions and requires less heat. However, other digesters can run also at 55-60°C (thermophilic), speeding up the process, creating more biogas and digestate with fewer pathogens, even though it requires more attention.

During the digesting process, biogas is released and is then collected in storage tanks, while the organic leftover is collected after the digestion.

There are several type of digestion process such as the wet, the dry and liquid digestion.

The most suitable digestion process for high solid waste, thus like food waste, is the dry digestion, in which to the new food waste that is starting the anaerobic digestion process is added digestate from the previous batch in order to provide the microorganism that begin the digestion process.

Other digestions processes are:

- wet digestion: mainly use for segregated food waste coming from residents, supermarkets and food-related plants and services, a small batch of new feedstock is put into the digester in order to generate an equal amount of digestate;
- liquid digestion, which fits better large volumes of wastewater with low solids, creates a microbial structure in order to keep elevate density of microbes;
- co-digestion, in which both food waste and wastewater are treated together, thus benefiting both processes since the wastewater treatment plants are energy-intensive which can be satisfied by the high energy output generated by the AD plant, while the food waste treatment plant can benefit from the surplus of the wastewater treatment. Example of co-digestion is the mixing of food waste with manure and agricultural leftover.

11.1.3 *Composting*

The United States Department of Agriculture defined composting as “the controlled aerobic biological decomposition of organic matter into a stable, humuslike product called compost. It is essentially the same process as natural decomposition except that it is enhanced and accelerated by mixing organic waste with other ingredients to optimize

microbial growth[3]", such as "bacteria, fungi, worms and other organisms[4]". The process runs in presence of oxygen, thus under aerobic conditions.

In vessel Composting

The process of composting begins with the shredding of mixed food and garden waste and then the loading into a chamber (called first 'barrier'). After 1-3 weeks the compound is transferred into a second chamber (the second 'barrier') for approximately the same time length.

The aim is to ensure that the whole composting compound reaches the required temperatures and begins the process of biodegradation. The whole process is constantly monitored in order to ensure require levels of oxygen, temperature and also the sanitization of the composting, which is possible keeping a given temperature, for circa 1-2 days, at circa 70°C. After that, there's a period of 10-14 weeks to ensure the stabilisation.

The compost is rich in nutrients (nitrogen, phosphorus and potassium) and organic matter, thus containing organic carbon, to help the restoring of soils and replenishing carbon storages. However, the quality of the compost depends on many factors, such as the quality of the inputs.

Moreover, the composting process allows to save up some costs, such as the separation of waste, since food waste is mixed with garden waste and the process itself is relatively simple and "natural".

However, there is no energy recovery.

Windrow Composting

This process, due to treating waste that contain both animal and catering waste, cannot be used due to the Animal By-products Regulations. In fact, as the regulation states at article 11, prohibits "the feeding of farmed animals other than fur animals with catering waste or feed material containing or derived from catering waste[5]" and "the feeding of farmed animals with herbage, either directly by grazing or by feeding with cut herbage,

[3] United States Department of Agriculture, *Natural Resources Conservation Service,* Chapter 2, https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_022229.pdf

[4] University of Florida, Institute of Food and Agricultural Studies, https://livinggreen.ifas.ufl.edu /waste /composting.html

[5] Regulation (EC) No 1069/2009 of the European Parliament and of the Council of 21 October 2009 laying down health rules as regards animal by-products and derived products not intended for human consumption and repealing Regulation (EC) No 1774/2002 (Animal by-products Regulation), https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32009R1069

from land to which organic fertilisers or soil improvers, other than manure, have been applied […][6]".

11.1.4 *Liquefaction*

It is the conversion of food waste into a liquid.

It starts with the shredding of food waste through a grinding mechanism and then waste is mixed with mixed with water and treated with the rest of the waste in the sewage. To accelerate process, it is possible to add microorganisms and this process takes the name of biological liquefaction.

As simple as it is and it can be incorporated into kitchen sinks' drainage system, thus saving up the cost of waste collection, it is not meant to used as a method to produce quality feedstock for the anaerobic digestion but only as a way to get disposed of food waste and the waste water systems may not be capable to treat also foodstuffs. However, if the waste water treatment plant an AD plant is added, it could both benefit both systems.

11.1.5 *Rendering*

The United States Environmental Protection Agency defines the meat rendering as a treatment that "process animal by-product materials for the production of tallow, grease, and high-protein meat and bone meal[7]". "The two types of animal rendering processes are edible and inedible rendering. Edible rendering plants process fatty animal tissue into edible fats and proteins. […] Inedible rendering plants […] produce inedible tallow and grease, which are used in livestock and poultry feed, soap, and production of fatty-acids"[8].

The process is relatively simple: animal products and by-products[9] heated in order to sterilize (killing dangerous microorganisms), stabilize the animal material (preventing further decomposition), remove water content. The heat separates the fat from the proteins and then the animal material is centrifuged. The outcome is ready to use, such as proteins for protein meals.

[6] Regulation (EC) No 1069/2009 of the European Parliament and of the Council of 21 October 2009 laying down health rules as regards animal by-products and derived products not intended for human consumption and repealing Regulation (EC) No 1774/2002 (Animal by-products Regulation), https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32009R1069

[7] United States Environmental Protection Agency, https://www3.epa.gov/ttn/chief/ap42/ch09/final/c9s05-3.pdf

[8] United States Environmental Protection Agency, https://www3.epa.gov/ttn/chief/ap42/ch09/final/c9s05-3.pdf

[9] The 3.1 of the animal by-products Regulation (Regulation (EC) No 1069/2009) states that: 'animal by-products' means entire bodies or parts of animals, products of animal origin or other products obtained from animals, which are not intended for human consumption, including oocytes, embryos and semen;

The rendering provides high value products but it requires strict regulation since it can transmit diseases.

11.2 Technologies based on unseparated waste

11.2.1 *Gasification*

It is a process that “converts organic materials (e.g. biomass, food wastes) or combinations of organics and inorganics into a combustible gas called syngas, by reacting the material at high temperatures (>700°C) with a controlled amount of oxygen and/or steam”.

Before being put in the reactor, called gasifier, the waste get first pre-treated, screened for undesirable materials, shredded and dried. In the first step, a temperature of 600°C is reached, producing ash and char, which is fixed carbon. In the second step, the former gets gasified reacting with oxygen and/or steam.

The main product of gasification, along char and tars, is the syngas. The quality of the products depends on many factors such as the quality of the feedstock as well as the operating conditions.

11.2.2 *Incineration with enery recovery*

It is a process where the solid waste, especially the non-recyclable, is burnt at extremely high temperature. At first it was meant only to get disposed of waste, thus reducing its volume, then thanks to the combustion process, it is possible to recoer energy in the form of heat or electricity as well as ash, from which some material can be extracted.

Incinerators, however, are large capital investments and if high amounts of waste are not generated they do gain profits, thus going against the increase of recycling, for example. Moreover, CO2 is released.

11.2.3 *Landfill without gas collection*

It is where the disposal of solid waste materials takes place. All type of waste is usually brough to landfills. When the waste reaches it, it gets compacted and then gets covered with soil or clay.

Even if it’s a cheaper method of waste disposal, it does not recovery energy or nutrients, it can create long lasting damage to environment and its maintenance can become expensive, such as preventing leachate and thus ground water contamination.

11.2.4 *Landfill with gas collection*

The waste in a landfill, in absence of oxygen, decomposes releasing landfill gas, which contains methane as well as CO2. This gas can be recovered, also to prevent air pollution and global warming, through a vacuum system that channel the landfill gas into a chamber for the combustion for energy recovery.

Even if this system is not environmental friendly as, for example the anaerobic digestion, it recovers energy through the combustion and the extraction of the methane, and destroy the CH4, which is way more harmful of CO2 for the atmosphere.

11.2.5 *Mechanical Biological Treatment (MBT)*

The Health and Safety Executive of the Government of United Kingdom defines the mechanical biological treatment as a "number of different residual waste treatment processes that involve both mechanical and biological treatment of municipal solid waste (MSW)[10]". It is "used to separate mixed waste streams, typically from MSW, into a range of dry products (typically ferrous and non-ferrous metals and glass), high calorific value refuse derived fuels (RDF) suitable for incineration, and wet biodegradable slurries suitable for either composting or anaerobic digestion (AD)[11]".

The mechanical process aims to separate the wet fraction from the dry part, thus separating materials like plastics and textiles, which can be recycled, from organic compound fraction and then shred them, screen them and/or further separation between the materials.

The biological treatment, which processes the organic materials. Include aerobic decomposition and/or anaerobic digestion. However, if the feedstock is composted of mixed MSW, the final product won't be of the appropriate quality, used mainly to cover landfills, for example.

11.2.6 *Pyrolysis*

It is "a thermochemical treatment, which can be applied to any organic (carbon-based) product. It can be done on pure products as well as mixtures. In this treatment, material is exposed to high temperature, and in the absence of oxygen goes through chemical and physical separation into different molecules. The decomposition takes place thanks to the limited thermal stability of chemical bonds of materials, which allows them

[10] Health and Safety Executive, UK, *Mechanical Bio* https://www.hse.gov.uk/waste/mechanical-bio.htm

[11] Health and Safety Executive, UK, *Mechanical Bio*, https://www.hse.gov.uk/waste/mechanical-bio.htm

to be disintegrated by using the heat"[12]. The resulting materials are gases and charcoal and liquids as well by varying material treated, the temperature or the heating rate, for example. It is a process that can transforms materials into higher value materials and also recover high value chemicals.

Food waste feedstock source	Biogas produced (m^3/wet tonne)	Distance travelled by different vehicles when running on biomethane produced from 1 tonne of feedstock (km)			Electricity generated (MWhe/ tonne)
		Car	Double-decker bus	Heavy goods vehicle	
Potatoes (18%-20% TS)	100-120	872	98	186	0.27
Bread	400-500	3,567	400	759	1.09
Cheese	>600	4,756	533	1,012	1.45
Vegetables	50-80	515	58	110	0.16
Mixed food (e.g. supermarket, restaurant)	75-140	852	96	181	0.26
Molasses (80-90% TS)	450-579	4,079	457	868	1.24
Brewery waste (20% TS)	60-100	634	71	135	0.19
Abattoir waste	120-160	1,110	124	236	0.34

Table 11. Table with several feedstock sources and the amount of biomethane they produce.
Source: Global Food Waste Management: an Implementation Guide for Cities, World Biogas Association, C40 cities, 2018

It is interesting to report another table along the above reported one, showcasing the reduction of GHG emissions when those sources of feedstock are used

[12] Biogreen, *What is pyrolysis*, http://www.biogreen-energy.com/what-is-pyrolysis/

Table showing the reduction of GHG emissions when food waste is used as feedstock source

Food waste feedstock source	Biogas produced (m^3/ wet tonne)	GHG emissions reduction if used in transport (kg CO_2e)	GHG emissions reduction if used in electricity (kg CO_2e)	GHG emissions reduction if used for heat (kg CO_2e)
Potatoes (18%-20% TS)	100-120	1,946	1,899	1,976
Bread	400-500	2,506	2,315	2,631
Cheese	>600	2,753	2,499	2,920
Vegetables	60-80	1,872	1,844	1,890
Mixed food (e.g. supermarket, restaurant)	75-140	1,942	1,896	1,972
Molasses (80-90% TS)	450-570	2,612	2,394	2,756
Brewery waste (20% TS)	60-100	1,896	1,862	1,919
Abbatoir waste	120-160	1,995	1,936	2,034

Table 12. Table showing the reduction of GHG emissions when food waste is used as feedstock source.
Source: Global Food Waste Management: an Implementation Guide for Cities, World Biogas Association, C40 cities, 2018

11.3 Digestate

> «For every tonne (1,000kg) of feedstock entering an AD plant, 900 to 950kg of digestate is produced, before any account is taken of water that may be added to the process […]»[13.]

Depending on the quality and on its end use, digestate can be used as end use product or separated into solid parts, thus producing compost for example, and into liquid parts, thus producing, among other products, liquid fertilizer.

The use of digestate reduces the need and the reliance on synthetic fertilisers, increase yields by returning nutrients and organic matter, thus fostering the restoration of soil health.

A peculiar aspect of digestate is the use of digestate specifically designed for certain areas, such as the one produced in Tuscany, which foster vine growth and, at the same time, repress potentially harmful fungi.

Moreover, in the EU it is run the European Compost Network-Quality Assurance Scheme (ECN-QAS), the certification scheme that establishes standards and certificate

[13] World Biogas Association, *Global Food Waste Management: an Implementation Guide for Cities*, C40 cities, 2018.

digestate. For example, in Italy the D. Lgs 75/2010 states the digestate standards, thus certificating that that compost is heavy metal, chemical compound free in order to protect human and animal health.

The certified compost can be sold up to 20$ in Italy[14].

11.4 Estimated costs of AD plants

«Based on data available from the USA, Denmark, the UK and Italy, the capital cost for a 30,000 tonne per year capacity plant may be $400-$600/ tonne of annual capacity. A larger 50,000 tonne plant may have a capital cost of $300-$400/ tonne»[15161718]. A 30,000 tonne annual capacity plant would therefore cost between USD 12 and 15 million.

While, "the operating cost may be $35-$55/tonne for a 30,000 tonne per year plant and $30 $45/tonne for a 50,000 tonne per year plant"[20212223].

11.4.1 *Income opportunities*

The income would be generated by the sale of biogas (and/or biomethane), electricity, heat, digestate (thus compost and fertilizers); while saving on operating costs using the electricity and the heat produced by the AD plant itself.

[14] CIC (2009). https://www.compost.it/attachments/617_Nota_Mercato_2010.pdf.

[15] Global Food Waste Management: an Implementation Guide for Cities, World Biogas Association, C40 cities, 2018

[16] Denmark Country report (2017) http://task37.ieabioenergy.com/country-reports.html

[17] Department of Energy and Climate Change (2014) RHI Biomethane Injection to Grid Tariff review https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/315608/Biomethane_Review_Final_-_FOR_PUBLICATION.pdf

[18] National Renewable Energy laboratory (2013) Feasibility study of anaerobic digestion of food waste in St. Bernard, Louisiana https://www.nrel.gov/docs/fy13osti/57082.pdf

[19] Dr Confaloneiri A and Dr Ricci M (2017) communication with Italian Composting and Biogas Association https://www.compost.it/

[20] Global Food Waste Management: An Implementation Guide for Cities, World Biogas Association, C40 cities, 2018

[21] Department of Energy and Climate Change (2014). RHI Biomethane Injection to Grid Tariff Review. https://www.gov.uk/government/uploads/system/uploads/
attachment_data/file/315608/Biomethane_Review_Final_-_FOR_PUBLICATION.pdf

[22] Denmark Country report (2017). http://task37.ieabioenergy.com/country-reports.html - EUR/GJ figure quoted, converted to $/tonne of feedstock based on assumption of 30,000 tonnes per annum average plant size.

[23] NREL (2013). Feasibility Study of Anaerobic Digestion of Food Waste in St. Bernard, Louisiana. https://www.nrel.gov/docs/fy13osti/57082.pdf.

In UK, for example, in 2017 the total landfill costs would exceed 120£/tonne of waste discharged (including taxes), while discharging separated waste at an AD plant could cost approximately 30£/tonne, thus saving circa 90£/tonne.

11.5 Current barriers to AD and measures to support it

Notwithstanding the several benefits and opportunities coming with the promotion and implementation of AD plants, there are still several barriers.

The alternative waste management systems have to compete with the traditional methods, such as landfill or illegal dumping. The competition also comes to the costs: the set-up and operating costs of AD plants, as outlined, are high, while the creation of landfills is much lower, or even null in case of illegal dumping. However, many externalities, such as the impacts on environment are not calculated into these costs.

It is therefore mandatory to promote the environmental-friendly waste treatment system and include, in the other methods the externality costs, thus making them more competitive.

The costs of creating a new system of food waste collection and treatment can be high for the municipality's budget as well as adjusting the existent collection system to the AD process. In both cases, it would be necessary to provide households and business the separate collection bins (or other methods) of their waste, making sure that it's properly separated. This would imply the need of organizing and planning awareness-campaigns and educational events.

A favorable political environment is also necessary: the development of a policy framework with clear objectives and monitoring system and the creation of a governance system where several stakeholders must be involved, such as public procurement's bodies and companies. It is essential highlight the benefits of the alternative waste management methods and incentivize public and private actors to shift towards them, also through tax cuts and funds.

Along the absence of a framework and the lack of incentive of these systems leads to issues that prevent the diffusion of AD plants, for example. In Germany and UK, the absence of proper collection and separation system of waste leads to feedstock shortages, thus preventing the AD plants to run at their maximum, creating concerns about the profitability of these systems.

11.6 European framework on landfill's waste

The landfills are the least preferred option among the waste treatment processes. The Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste, in order to prevent and reduce the negative impacts on environment, thus soil, air, water and human and animal health.

It established a standard procedure for the screening and the acceptance of the waste, among which, according to the article 6 of the Directive, "only waste that has been subject to treatment is landfilled. This provision may not apply to inert waste for which treatment is not technically feasible, nor to any other waste for which such treatment does not contribute to the objectives of this Directive, as set out in Article 1, by reducing the quantity of the waste or the hazards to human health or the environment"[24.]

The treatment, as laid out in the article 2, "means the physical, thermal, chemical or biological processes, including sorting, that change the characteristics of the waste in order to reduce its volume or hazardous nature, facilitate its handling or enhance recovery[25"].

This Directive gave the push towards those waste treatment systems that enhance the recycling and the recovery of waste material, since it "obliges Member States to reduce the amount of biodegradable municipal waste that they landfill to 35% of 1995 levels by 2016 (for some countries by 2020) which will significantly reduce this problem"[26.]

In 2017, the European Commission made several proposals, under the Circular Economy Package, regarding:

- "raising the ambition level of targets for municipal waste reuse and recycling (at least 70% by 2030, with a 5% sub-target for reuse); for municipal waste landfilling (maximum 5% by 2030); and for packaging waste, with separate targets for reuse (5% by 2025 and 10% by 2030) and recycling (70% by 2025 and 80% by 2030)[27;]

[24] Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31999L0031

[25] Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31999L0031

[26] European Commission, *Biodegradable Waste*, https://ec.europa.eu/environment/waste/compost/index.htm

[27]Circular economy package Four legislative proposals on waste, European parliament, February 2017, http://www.europarl.europa.eu/RegData/etudes/BRIE/2017/599288/EPRS_BRI(2017)599288_EN.pdf

- "introducing new targets for food waste and marine litter (30% reduction by 2025 and 50% reduction by 2030, compared with a 2014 baseline) as well as waste oils (85% regeneration by 2025), and introducing a specific food waste hierarchy[28].

In 2018, the proposals aimed to lower targets:

- regarding municipal waste: 65% for municipal waste reuse and recycling; 10% for the municipal waste landfilling and 65% for 2025 and 75% for 2030 for packaging waste prepared for reuse and recycling;
- regarding food waste: by end-2023, the possibility of introducing an EU food waste reduction target to be met by 2030[29].

Directive 2000/76/EC of the European Parliament and of the Council of 4 December 2000 on the incineration of waste

The EU Incineration Directive aims "to prevent or to limit as far as practicable negative effects on the environment, in particular pollution by emissions into air, soil, surface water and groundwater, and the resulting risks to human health, from the incineration and co-incineration of waste"[30].

11.7 Policies to foster Anaerobic Digestion as food waste treatment

As already outlined, the externality costs (such as the costs of negative impacts on environment) are not included in the price of landfilling or synthetic fertilisers, for example.

Several policies can be taken in consideration and applied:

- pricing GHG emissions whether through trading schemes (placing caps on total emission on businesses and/or citizens, then the allocations can be traded) or taxes (whether setting a price on carbon or setting the cost of amount per tonne of GHG emitted),
- incentivizing renewable energy sources: through direct cash payments (for example, government intervention in the payment of the fee due to the renewable energy generator in lieu of utility companies), quotas (utility companies must source a given percentage of energy through renewable energy production sources),

[28] European Parliament, *Circular economy package Four legislative proposals on waste*, February 2017, http://www.europarl.europa.eu/RegData/etudes/BRIE/2017/599288/EPRS_BRI(2017)599288_EN.pdf

[29] European Parliament, *Circular economy package Four legislative proposals on waste*, July 2018 http://www.europarl.europa.eu/RegData/etudes/BRIE/2018/625108/EPRS_BRI(2018)625108_EN.pdf

[30] Directive 2000/76/EC of the European Parliament and of the Council of 4 December 2000 on the incineration of waste https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32000L0076

procurement auctions (held by governments and where project developers bid "with the price per unit of electricity that they are able to deliver[31]";

- put taxes based on the actual weight or volume of waste produced (pay- as-you-throw principle) with a fixed fee and a variable fee, which would depend on consumer's behavior (thus, giving him the choice to reduce waste and save money);
- landfill bans;
- recycling policies: establishing standards and requirements in order to reduce food waste and increase the food waste's quality in order to produce higher quality feedstock's source.

[31] World Biogas Association, *Global Food Waste Management: an Implementation Guide for Cities*, C40 cities, 2018.

12. Food Donation

According to the European Federation of Food Banks (FEBA), in 2016, 535 thousand tonnes of food were distributed to over 6 million people[1]. However, this is still a small fraction, since "in the EU, close to one-quarter of the population– 119.1 million people – were at risk of poverty or social exclusion in 2015 and 42.5 million people were not able to afford a quality meal every second day[2][3]".

Therefore, it is necessary to value any food surpluses that occur during the food supply chain by redistributing them for human consumption.

By fostering food donation not only you reduce food waste generation, but also fight against poverty. However, there are still legal and operational barriers to food donations.

Food donation implies the recovery and the redistribution of food and FAO gives a definition of it:

Recovery of safe and nutritious food for human consumption is to receive, with or without payment, food (processed, semi-processed or raw) which would otherwise be discarded or wasted from the agricultural, livestock and fisheries supply chains of the food system. *Redistribution of safe and nutritious food for human consumption* is to store or process and then distribute the received food pursuant to appropriate safety, quality and regulatory frameworks directly or through intermediaries, and with or without payment, to those having access to it for food intake[4].

Food that can be donated is therefore food that is suitable for human consumption and respect with food safety[5][6] requirements established at EU level as well as national level. This includes food that did not meet customer's specifications, had altered label but did not compromise food safety or have passed the best-before date label.

[1] European Federation of Food Banks (FEBA), http://www.eurofoodbank.eu/

[2] Eurostat, 2017.

[3] European Commission, *EU Guidelines on food donation*, 2017.

[4] Food and Agriculture Organization (FAO), *Comprehensive definition for recovery and redistribution of safe and nutritious food for human consumption*, 2015, http://www.fao.org/save-food/news-andmulti-media/news/news-details/en/c/288692/.

[5] Regulation (EC) No 852/2004 of the European Parliament and of the Council of 29 April 2004 on the hygiene of foodstuffs.

[6] Regulation (EC) No 853/2004 of the European Parliament and of the Council of 29 April 2004 laying down specific hygiene rules for food of animal origin.

Food products can be donated from food business operators to food banks, charity organizations or directly to consumers themselves.

The EU framework for food donations is based on the EU food law, in particular the Regulation 2002/178/EC, called also the General Food Law. The redistribution of food is covered by this regulation, since it is considered as placing food on the market, whether it is free of charge or not.

The General Food Law gives a definition also of:

- food business, which means "any undertaking, whether for profit or not and whether public or private, carrying out any of the activities related to any stage of production, processing and distribution of food[7]";
- food business operator is "the natural or legal persons responsible for ensuring that the requirements of food law are met within the food business under their control[8]".

Food business operator shall ensure that foods satisfy the food law's requirements at all stages of production, processing and distribution[9]. Therefore, food business operators have the primary responsibility[10] to comply with all the requirements of food laws, both EU and national laws, in particular food safety and food hygiene with HACCP.

It is Member States' responsibility the enforcement of food law as well as the monitoring and the verification that the requirements of food law are fulfilled by food business operators[11].

Involved in the redistribution of food there are other actors: redistribution organizations (Ros), such as food banks, and charity organizations (COs), respectively acknowledged as back-line and front-line organizations. The former recover food from actors in the food supply chain and redistribute it to charity organizations, while the latter are the ones which provide food to their beneficiaries in various forms, whether free of charge or not.

Along food business operators, redistribution organizations (Ros) and charity organizations (COs) must also verify if the food law's requirements are respected in all the activities under their control.

[7] Article 3(2) of the General Food Law, Regulation 2002/178/EC.
[8] Article 3(3) of the General Food Law, Regulation 2002/178/EC.
[9] Article 17(1) of the General Food Law, Regulation 2002/178/EC.
[10] Recital 30 of the General Food Law, Regulation 2002/178/EC.
[11] Article 17(2) of the General Food Law, Regulation 2002/178/EC.

Food products are considered unsafe if they are injurious to health and unfit for human consumption[12]. If such unsafe food is imported, produced, processed, manufactured or distributed on market, all food business operators are required to withdraw, recall or notify the authorities[13].

To this aim, the General Food Law imposes a traceability[14] of all foods placed on the EU market, documenting where it has been sourced from and to whom the food has been distributed.

Another main requirement of food donation is the hygiene standards, which are applicable to all food donation activities, thus covering the redistribution of surplus foodstuffs. All customers must be equally protected, thus ensuring food safety standards, hygiene requirements, respecting the cold chain and proper labelling.

The main regulations regarding the food hygiene are the Regulations (EC) No 852/2004 and the Regulations (EC) No 853/2004.The former lays down general requirements of foodstuffs which must be respected by all actors, while the latter comprises of additional specific food hygiene rules regarding food of animal origin.

Given this framework, the harmonization of Member States' national laws to EU rules should be fostered. Moreover, it should be encouraged the donation of food from food business operators to charities and food banks by introducing several changes.

1. Amending the Directive 2006/112/EC, in particular articles 16 and 74, in order to exclude food donations from VAT and harmonizing national legislations of Member States: some MSs consider the VAT of donated food close to zero, while other calculate the VAT on the price of donated food as if it was a commercial transaction, leading to negative consequences for food donation.
2. Member States should take into account when determining the VAT on food donations, especially when the food products are close to their best-before or use-by dates or are not fit for sale but are suitable for human consumption.
3. Provide fiscal incentives in order to support redistribution schemes through, for example, tax deductions or tax credits.
4. Dissemination of good policies among EU countries regarding policies addressing food waste's prevention and reduction.
5. Promote the allowance of donating food products that are beyond their best-before date label.

[12] Article 14(1) and 14(2) of the General Food Law, Regulation 2002/178/EC.
[13] Article 19 of the General Food Law, Regulation 2002/178/EC.
[14] Article 18 of the General Food Law, Regulation 2002/178/EC.

The Directive 2006/112/EC states that food donations are taxable (Article 16) and "*the taxable amount is the purchase price at the moment of the donation adjusted to the state of those goods at the time when the donation takes place*" (Article 74).

Results

At European level, we have seen gradual results towards the implementation of circular economy model as well as regarding the food policies, especially food waste. However, a common vision is still missing but many institutional bodies and experts are pushing for the adoption of a Common Food Policy.

The Directive 2008/98/EC[1] revised and the legal framework for waste management by reassuring principles laid out in the Directive 2006/12/EC[2] that laid the foundation for the legislative framework for handling waste and for the actions, establishing the waste hierarchy and giving clear definitions of what waste is and the measure that need to be taken in order to reduce it, such as prevention, re-use and recycling.

The communication COM(2015) 614 final[3,] called "closing the loop - An EU action plan for the Circular Economy**"**, sets out a concrete and ambitious plan to support the transition towards a circular economy in order to create a sustainable, low-carbon and resource-efficient and competitive economy", giving priority, among other goals, to the food waste.

The Communication COM(2018) 29 final[4,] "on a monitoring framework for the circular economy" sets a monitoring framework for measuring the progress of Member States towards circular economy through 4 main dimensions, 10 indicators with sub-indicators.

For the European Communities, the definition of food is given by the Regulation (EC) no. 178/2002, however the regulation does not speak yet of the food waste and loss.

[1] Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri= CELEX: 32008L 0098.

[2] Directive 2006/12/EC Of The European Parliament And Of The Council Of 5 April 2006 On Waste, https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006: 114:0009: 0021:en:PDF.

[3] Communication From The Commission To The European Parliament, The Council, The European Economic And Social Committee And The Committee Of The Regions Closing The Loop - An EU Action Plan For The Circular Economy, https://eur-lex.europa.eu/resource.html?uri=cellar:8a8ef5e8-99a0-11e5-b3b7-01aa75ed71a1.0012.02/DOC_1&format=PDF.

[4] Communication From The Commission To The European Parliament, The Council, The European Economic And Social Committee And The Committee Of The Regions on a monitoring framework for the circular economy, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2018%3A29%3AFIN.

In 2015, there's a proposal to amend Directive 2008/98/EC, with the COM (2015) 595:

- a broad definition of food waste was given,
- proposed several goals to reduce food waste;
- adopt a common methodology to measure food waste by 2017;
- "reduce the generation of food waste in primary production, in processing and manufacturing, in retail and other distribution of food, in restaurants and food services as well as in households".

In 2018, the Commission delegates an Expert Group on Food Losses and Food Waste to establish a common methodology to measure food waste. Several methods have been proposed, while the latest one is this tab[5]:

Stage of the food supply chain	Food wasted destined to waste treatment operations (composting, biogas, land application, incineration, landfilling)		Food waste removed to sewer/wastewater		Food sent for redistribution (food donation)
	Total	Edible fraction	Total	Edible fraction	
1. Primary Production					
2. Processing and manufacturing					
3. Distribution (including retail)					
4. Restaurants and food services					
5. households					

Table 13

At local level, a key role in shaping food systems is attributed to the cities, where lives the 55% of the world's population lives in urban areas, and it is expected to increase to 68% by 2050[6].

[5] Format to report amounts of food waste - concept Bartosz Zambrzycki European Commission, DG Health and Food Safety Unit E1, 2018, https://ec.europa.eu/food/sites/food/files/safety/docs/fw_eu-actions_ms_20180709_pres-02.pdf

[6] Food and Agriculture Organization (FAO), Milan Urban Food Policy Pact (MUFPP), *Milan Urban Food Policy Monitoring Framework*, 2019 http://www.milanurbanfoodpolicypact.org/wp-content/uploads/2019/11/CA6144EN.pdf

In this context, the Milan Urban Food Policy Pact (MUFPP) was signed, in 2015, by city delegations (163 in 2018[7,] of which 84 in Europe[8)] from all the world.

The cities will adopt a food policy that aim to:

- develop "sustainable food systems that are inclusive, resilient, safe and diverse, that provide healthy and affordable food to all people in a human rights-based framework, that minimise waste and conserve biodiversity while adapting to and mitigating impacts of climate change[9]";
- the coordination of actions at city level (municipal and community levels as well as between city departments and agencies) and with regional and national food-related policies;
- the creation of programmes and initiatives regarding the entire food supply chain (thus including the production, the distribution, the safety) as well as social protection, education and waste reduction.

The MUFPP was accompanied by an Urban Food Policy Framework for Action, which lists 44 indicators and a series of 37 recommended actions that should be taken in: ensuring an enabling environment for effective action, sustainable diets and nutrition, social and economy equity, food production, supply and distribution as well as food waste.

Many successful examples have been reported:

- the 40% of the 300 000 tonnes of waste in Latvia produced every year is biomass, which, if treated correctly and efficiently, produces: 31-33 gWh of energy annually, 20 gWh of heat, 390 tonnes of high quality tomatoes, reduce the GHG emissions of 2000 meters cubic per hour and gives work to 17% of the neighborhood (62 persons);
- in 10 months, the Municipality of Ghent (Belgium) redistributed 300.34 tonnes of food to 18 971 people in need through 58 local charity organization and 29 wholesale and retailer actors and generated the employment of 19 people and the reduction of 762 tonnes of CO2;

[7] Milan Urban Food Policy Pact (MUFPP), *3rd Annual Gathering and Mayor Summit*, 2017, http://www.milanurbanfoodpolicypact.org/wp-content/uploads/2018/02/3rd-MUFPP-Annual-Gathering-REPORT.pdf

[8] Milan Urban Food Policy Pact (MUFPP), *3rd Annual Gathering and Mayor Summit*, 2017, http://www.milanurbanfoodpolicypact.org/wp-content/uploads/2018/02/3rd-MUFPP-Annual-Gathering-REPORT.pdf

[9] Milan Urban Food Policy Pact (MUFPP), *Milan Urban Food Policy Pact*, 2015, http://www.milanurbanfoodpolicypact.org/wp-content/uploads/2016/06/Milan-Urban-Food-Policy-Pact-EN.pdf

- in Milan (Italy) 150 tonnes of fruits and bread were recovered and redistributed through 35 local food and implemented a discount on waste tax (which would impact for 1.8 million euros);
- in Bruges (Belgium), in healthcare institution, it was reached areduction of 27 652 kg of food waste per year, which means a saving of 27 652 euros per year as well as a reduction of 88 487 kg of CO2;
- in Nantes (France), the revitalization of waste lands and brownfields led to the re-cultivation of circa 450 hectares, generating employment in the agricultural sectors, the creation of short food supply chains and the diversification of territorial food system;
- in Ljubjana (Slovenia), on an area of 65 292 m3 were created 705 allotment gardens (each of an anrea of 60 m3) to be rented for 3 to 5 years. This led to ensure self-employment generating and income of 200-400 per month for each occupied person, ensuring also their food security and selling the surplus. The expected economic impact of urban gardening is expected to be of 1.1 millions euros per year;
- Almere (Netherlands), the aim "is to produce 20% of the total demand for food (vegetables, fruits, milk and eggs) within a radius of 20km from the city centre»[10], through the renting of plots (23 euros per month).

It is important to mention that several cities earmarked funds (Ede, Copenhagen, Birmingham) created a specific team for the food policy (Ede, Vienna) or the figure of the food councilor was created (Ede) or the creation of a platform to gather all the stakeholders (Ghent).

The contribution given by the application of circular economy to food system would also benefit other systems.

An increased food supply and wider choice of food products and thus a healthier diet and an alternative to fast food products:

- in Copenhagen (Denmark) the 88% of the food products provided by the food public system is composed of organic food products, whose demand tripled throughout the years;
- in Birmingham (UK) the project aimed to tackel childhood obesity in order to raise awareness and and foste the adoption of healthy lifestyle;

[10] Food and Agriculture Organization (FAO), Milan Urban Food Policy Pact (MUFPP), *Almere*, 2018, http://www.milanurbanfoodpolicypact.org/wp-content/uploads/2018/07/ Brief-16-Almere.pdf

- in Vienna, the aim was to create a sustainable food supply and to provide a wide varieity of fresh and healthy food. The 70% of the food products provided are sourced from Austria while the 33% is organic.

It is worth mentioning the reduced GHG emissions (Ghent, Latvia, Bruges), social benefits, such as inclusion of disadvantages groups and of people in need (Ljubjiana, Almere, Ghent), generation of jobs (Latvia, Ghent, Ljubjana) and the economic policies implemented by the Municipality (Milan).

Discussion

At European level, the measures and the efforts taken are going towards the adoption of a framework for a Common Food Policy, however it's still being on development and a radical reform of the CAP is also needed.

Regarding the Circular Economy, in 2018 with the adoption and the implementation of the Circular Economy Monitoring Framework, it is possible to measure through indicators the progresses of EU Member States and of the European Union itself towards a "sustainable, low-carbon and resource-efficient and competitive economy".

As the experts of iPES Food reports the increasing need of a Common Food Policy shows that the current main food systems (industrialized, standardized, profit-driven and export-oriented) are unsustainable and the European Union has the tools to change the trajectory but, even if the latest reforms of the Common Agricultural Policy (CAP) showed some progress, there is the lack of substantial reforms to the CAP's Pillars, the lack of coherence and coordination among policy areas, policy makers (especially the policy Directorate-Generals (DGs)) and the several levels of governance to apply a holistic approach to the problem as well as the non-involvement of citizens, territorial initiatives and the intromission of the powerful interests of the food industry.

Even the the European Economic and Social Committee (EESC) and the European Committee of Regions (ECR) are pushinf forward the adoption a comprehensive sustainable food policy at EU level.

The iPES Food experts proposed the adoption of a Common Food Policy, based on:

- ensuring access to land, water and healthy soils;
- rebuilding climate-resilient, healthy agro-ecosystems;
- promoting sufficient, healthy and sustainable diets for all;
- building fairer, shorter and cleaner supply chains;
- putting trade in the service of sustainable development.

In these years, the major actors in shaping the food system and promoting circular economy have been at local level, especially the cities, which accounts for the 70% of

global food supply (represented by urban food markets)[1], 75% of natural resources are consumed[2], the production of the 50% of global waste[3] and the generation of the emission of 60-80% of GHG[4]. Thus cities represent ideal place where to test and develop food policies.

It is also estimated that in cities lives the 55% of the world's population lives in urban areas, and it is expected to increase to 68% by 2050[5].

The various successful strategies and plans implemented by some European cities proves that a lot can be done, but it is essential that at higher level (national and european ones) start taking into account local initiatives and develop a favorable framework for the creation and the fostering of these initiatives.

[1] WB. 2015. *Investing in Urban Resilience. Protecting and Promoting Development in a Changing World* [online]. Washington DC. [Cited 25/09/2019]. https://www.gfdrr.org/sites/default/files/publication/Investing%20in%20Urban%20Resilience%20Final.pdf

[2] Ellen MacArthur Foundation (EMF), *Cities and the circular economy for food,* 2018

[3] Ibid.

[4] Ibid.

[5] Milan Urban Food Policy Pact (MUFPP), *Milan Urban Food Policy Pact*, 2015, http://www.milanurbanfoodpolicypact.org/wp-content/uploads/2016/06/Milan-Urban-Food-Policy-Pact-EN.pdf

Conclusions

Through the recognition of the political (e.g. Common Food Policy and policies), economic (e.g. food production costs), environmental (e.g. the negative and positive impacts on the ecosystems), legislative (e.g. European Union Frameworks) and social (e.g. food security and social inclusion) dimensions, this thesis applies to the increasing concerns regarding food resources, in particular to the problem of food waste and the solutions provided by the circular economy's measures and strategies, either in the form of a theoretical model (e.g. concepts of circular economy) and in the form of applied practice (e.g. Urban Food Policies).

As early as 2012 in Europe, it was estimated that the food waste generated is 88 million tonnes[1] and that we are wasting 20 % of the total food produced[2] and another 11% lost at consumer level[3]. The food loss and waste is the consequence of an inefficient, unfair and unsustainable food system. A sustainable food system can be defined as a "food system that ensures food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition of future generations are not compromised"[4]", a food system that is "regenerative, resilient, non-wasteful, and healthier[5]". A food system that would close "nutrient loops with minimal leakage and maximum long-term value extraction from each loop in short, local supply chains with almost zero waste. The system would offer accessible, fresh, and healthy food that would encourage consumers to embrace a healthier and/or less resource-intensive diet".

This would be possible by applying the principle of circular economy:

"Circular systems also encourage biological nutrients to re-enter the biosphere safely for decomposition to become valuable feedstock for a new cycle. In the biological cycle,

[1] EU FUSIONS Project, *Estimates of European food waste levels*, 2016.

[2] EU FUSIONS Project, *Estimates of European food waste levels*, 2016.

[3] Ellen MacArthur Foundation, *Growth Within: a Circular Economy Vision for a Competitive Europe*, 2015, https://www.ellenmacarthurfoundation.org/assets/downloads/publications/EllenMacArthurFoundation_Growth-Within_July15.pdf

[4] *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, June 2014.

[5] Ellen MacArthur Foundation, *Towards A Circular Economy: Business Rationale for An Accelerated Transition*, 2014, https://www.ellenmacarthurfoundation.org/assets/downloads/TCE_Ellen-MacArthur-Foundation_9-Dec-2015.pdf

products are designed by intention to be consumed or metabolised by the economy and regenerate new resource value. For biological materials, the essence of value creation lies in the opportunity to extract additional value from products and materials by cascading them through other applications"[6].

The application of new methods of sustainable and regenerative agriculture, such as precision agriculture and organic agriculture, can preserve and enhance the natural capital: establishing closed loop for nutrient flows, thus minimizing the use of pesticides and synthetic fertilizers, promote the recovery of valuable material such as nutrients, energy from the waste streams, sustain the urban- (such as, urban gardens, aquaponic and hydroponic agriculture) and peri-urban farming that provide healthy local food and foster short supply chains, thus promoting healthier diets.

This would mean cost reductions for resource inputs (land, water use as well as fuel, energy), waste generation, reduced GHG emissions while enhancing resource productivity through healthier soil and higher yields and the recirculation of nutrients.

However, the actual food systems are still predominantly following the lineal model: the lack of inclusion of externality costs in the food products' prices, the absence of establishing closed loops and thus the recovery of nutrients and energy from food waste and waste water, the lack of support to local initiatives and organic farming and of a policy framework that would encourage these practices, the recovery and recirculation of nutrients and material and the methods of separate collection of waste.

A key role is reserved to the cities and urban areas, where it is expected that approximately the 55% of world's population lives in and the number is growing. "As population and urbanisation grows, more food is being produced and more food is being wasted"[7] and as the number of people that live in cities increases, the higher will be the pressure on cities' infrastructure and thus even on basic services.

Thus it is essential to promote and sustain urban food policies, which can be defined as:

> «[…] a concerted action on the part of city government to address food-related challenges […] through significant involvement of civil society and other actors […]. Integrated urban food policies refer to policies seeking to address multiple

[6] Ellen MacArthur Foundation, *Towards A Circular Economy: Business Rationale for An Accelerated Transition*, 2014, https://www.ellenmacarthurfoundation.org/assets/downloads/TCE_Ellen-MacArthur-Foundation_9-Dec-2015.pdf

[7] World Biogas Association, C40 cities, *Global Food Waste Management: An Implementation Guide for Cities*, 2018

> food systems challenges, and typically require multiple government departments and policy areas to be bridged and novel governance bodies to be established. The process of developing integrated urban food policies often starts with an assessment of all the food-related challenges faced by the city, and the whole range of policy levers the city has at its disposal to deal with them (Bricas, 2017). However, most urban food policies consist of targeted actions with specific goals, […] (e.g. obesity, food waste). Such actions can pave the way for — and be incorporated into — integrated food policies at a later stage and may also have benefits in other policy areas. […] Many problems associated with the food system are contingent on imperatives at the national and international levels, e.g. trade, economic, agriculture and public health policies, and cannot be fully addressed at the city level.»[8.]

In 2015, the Milan Urban Food Policy Pact (MUFPP) was signed, showing the intentions and the roadmaps of many european cities towards a sustainable food system. They claim to: "develop "sustainable food systems that are inclusive, resilient, safe and diverse, that provide healthy and affordable food to all people in a human rights-based framework, that minimise waste and conserve biodiversity while adapting to and mitigating impacts of climate change"[9"]; "the coordination of actions at city level (municipal and community levels as well as between city departments and agencies) and with regional and national food-related policies"; "the creation of programmes and initiatives regarding the entire food supply chain (thus including the production, the distribution, the safety) as well as social protection, education and waste reduction".

There are reported also several examples on initiatives, measures and strategies taken by european cities.

Another key element of the circular economy applied to the food policies is the food waste management.

It can have several positive impacts on many fields: increase soil health, food security create jobs, generate digestate and compost and other high value products[10,] promote sustainable development, reduce dependence on synthetic fertilisers and fossil fuels, GHG emissions and need of landfills, pathogens in the waste (if anaerobically digested) thus promoting higher hygiene and sanitation, increase renewable production of energy as well

[8] IPES-Food, *What makes urban food policy happen?*, International Panel of experts on sustainable food system, 2017.

[9] Milan Urban Food Policy Pact (MUFPP), *Milan Urban Food Policy Pact*, 2015, http://www.milanurbanfoodpolicypact.org/wp-content/uploads/2016/06/Milan-Urban-Food-Policy-Pact-EN.pdf

[10] Ellen MacArthur Foundation, *Towards the Circular Economy*, 2013, https://www.ellenmacarthurfoundation.org/assets/downloads/publications/TCE_Report-2013.pdf

as serving for increasing the resilience of cities' basic services (transport fuel, biogas for household consumption, energy, light, electricity, heating and cooling).

Among the several methods, two of them enjoy of good reputation: the anaerobic digestion treatment and the composting.

The anaerobic digestion produces biogas, which can be used for domestic use or can be upgraded into biomethane, thus becoming fuel. What is left after the process is called digestate, which is rich in nutrients and organic matter, restoring soil health and can be use as bio-fertiliser.

The AD reduces the reliance on fossil-fuel energy and increasing energy security, reduces the GHG emissions, increases the sustainability of industries through its products and the efficient use of resources as well as the recirculation of nutrients and organic matter to the soil through digestate, the food security, prevents the spread of diseases and creation of landfills and protect water bodies, create employment since the food waste collection and separation as well as the maintenance of the AD plants are labour-intensive.

Regarding the compost, it is rich in nutrients (nitrogen, phosphorus and potassium) and organic matter, thus containing organic carbon, to help the restoring of soils and replenishing carbon storages. However, the quality of the compost depends on many factors, such as the quality of the inputs.

In 2015, the European Union created the Circular Economy Package, which, among the priority areas, included food waste. From that moment, food waste became a staple in the agenda.

The communication COM(2015) 614 final[11,] called "closing the loop - An EU action plan for the Circular Economy**"**, sets out a concrete and ambitious plan to support the transition towards a circular economy in order to create a sustainable, low-carbon and resource-efficient and competitive economy.

About the food waste, which is an increasing concern in Europe, the Commission, with Member States and stakeholders, will develop a methodology to measure food waste generated throughout the entire value chain (production, distribution, conservation and consumption) and define significant indicators.

[11] Communication From The Commission To The European Parliament, The Council, The European Economic And Social Committee And The Committee Of The Regions Closing The Loop - An EU Action Plan For The Circular Economy, https://eur-lex.europa.eu/resource.html?uri=cellar:8a8ef5e8-99a0-11e5-b3b7-01aa75ed71a1.0012.02/DOC_1&format=PDF

The Communication COM(2018) 29 final[12,] "on a monitoring framework for the circular economy" sets a monitoring framework for measuring the progress of Member States towards circular. economy through 4 main dimensions, 10 indicators with sub-indicators.

The EU Member States shall take measures to at least: reduce the generation of food waste either at production level that at distribution level (such as restaurants) and at consumer level; encourage food donation and other redistribution system and Member States shall adopt specific food waste prevention programs.

The DIRECTIVE 2006/12/EC[13] on waste laid the foundation for the legislative framework for handling waste and for the actions that must be undertaken by Member States.

the Directive 2008/98/EC[14] established the "waste hierarchy", a priority order of actions in the waste prevention and management legislation and policy of Member States.

A section is also given to the food donation, which can be defined as the:

Recovery of safe and nutritious food for human consumption is to receive, with or without payment, food (processed, semi-processed or raw) which would otherwise be discarded or wasted from the agricultural, livestock and fisheries supply chains of the food system. *Redistribution of safe and nutritious food for human consumption* is to store or process and then distribute the received food pursuant to appropriate safety, quality and regulatory frameworks directly or through intermediaries, and with or without payment, to those having access to it for food intake[15.]

In 2017, also the European Committee of the Regions called for "a comprehensive, sustainable EU food policy which is democratically shaped, designed with a common and

[12] Communication From The Commission To The European Parliament, The Council, The European Economic And Social Committee And The Committee Of The Regions on a monitoring framework for the circular economy, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2018%3A29%3AFIN

[13] Directive 2006/12/EC Of The European Parliament And Of The Council Of 5 April 2006 On Waste, https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006: 114:0009: 0021:en:PDF

[14] Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri= CELEX: 32008L 0098

[15] Food and Agriculture Organization (FAO), *Comprehensive definition for recovery and redistribution of safe and nutritious food for human consumption*, 2015, http://www.fao.org/save-food/news-andmulti-media/news/news-details/en/c/288692/).

long-term vision, based on the latest scientific insights and in line with a multilevel governance approach that addresses food production and nutrition in a more comprehensive manner, promoting more sustainable production and consumption patterns, establishing a link across different policy areas, including, among others, food production, agriculture, environment, health, consumer policy, employment and rural development, and creating jobs and growth in Europe's Regions and Cities[16]". The Committee also stated to take into account the ecosystems, since "[e]nvironmental costs are currently externalised in food production, leading to a situation where food produced in a more sustainable manner seems to be more expensive, mainly due to higher manufacturing costs[17]", which are not reflected in the final price of the food product.

An increasing number of actorts are pushing for the creation and the adoption of Common Food policy of the European Union. It can be defined as:

> a policy setting a direction of travel for the whole food system, bringing together the various sectoral policies that affect food production, processing, distribution, and consumption, and refocusing all actions on the transition to sustainability"[18.]

The aim of the Common Food Policy would be:

1. Ensuring Access to Land, Water and Healthy Soils
2. Rebuilding Climate-Resilient, Healthy Agro-Ecosystems
3. Promoting Sufficient, Healthy And Sustainable Diets For All
4. Building Fairer, Shorter And Cleaner Supply Chains
5. Putting Trade in the Service of Sustainable Development

The European Union is moving forward the right direction: reforms of the CAP, the programmes such as FOOD 2030 and even the institution such as the ECR is promoting this new view on the food system. A significant push is being given by cities, which are organizing on their own as well as citizens' initiatives and the EU should take them into consideration in order to create a true comprehensive, sustainable and fair food system.

[16] Opinion of the European Committee of the Regions — Towards a sustainable EU food policy that creates jobs and growth in Europe's Regions and Cities, ECR, 2017

[17] Ibid.

[18] IPES-Food, *Towards a Common Food Policy for the EU - The policy reform and realignment that is required to build sustainable food systems in Europe*, 2019.

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