

1.4 Fighting food waste through the circular economy business models

e-module 1 Circular economy and food supply chain
October 2021



Introduction

- Unnecessary food waste is a global problem that has become increasingly important in public and political programs in recent years. Food is valuable and its production can require many resources. It is estimated that almost one third of food is wasted or lost unnecessarily, which means that it is an extremely high economic cost, as well as a cost to the environment.
- About 88 million tonnes of food are thrown away annually in EU member states.
- In order to influence the rational management, EU has committed itself to achieving the goal of the UN Agenda 2030 for sustainable development with the corresponding goals of sustainable development, specifically goal 12.3. Responsible production and consumption with the specific goal of reducing food waste per capita, by half at the level of retail and consumers and reducing food losses along the entire production and supply chain.

Introduction

- Taking into account the projections of population growth on Earth, it is expected that the food industry will increase production, which inevitably leads to an increase in the amount of waste generated.
- Waste from the food industry and food scraps are not waste but raw materials that can be incorporated into other processes, and which are the basic principles of the circular economy - regeneration and circulation.
- The transition to a circular economy is one of the most important transformational challenges facing governments, businesses and communities. It is also a key opportunity - enabling progress towards the UN's sustainable development goals, including halving food wastage by 2030 and zero hunger, improving resource efficiency (land, energy, water) and creating potential for new economic models.

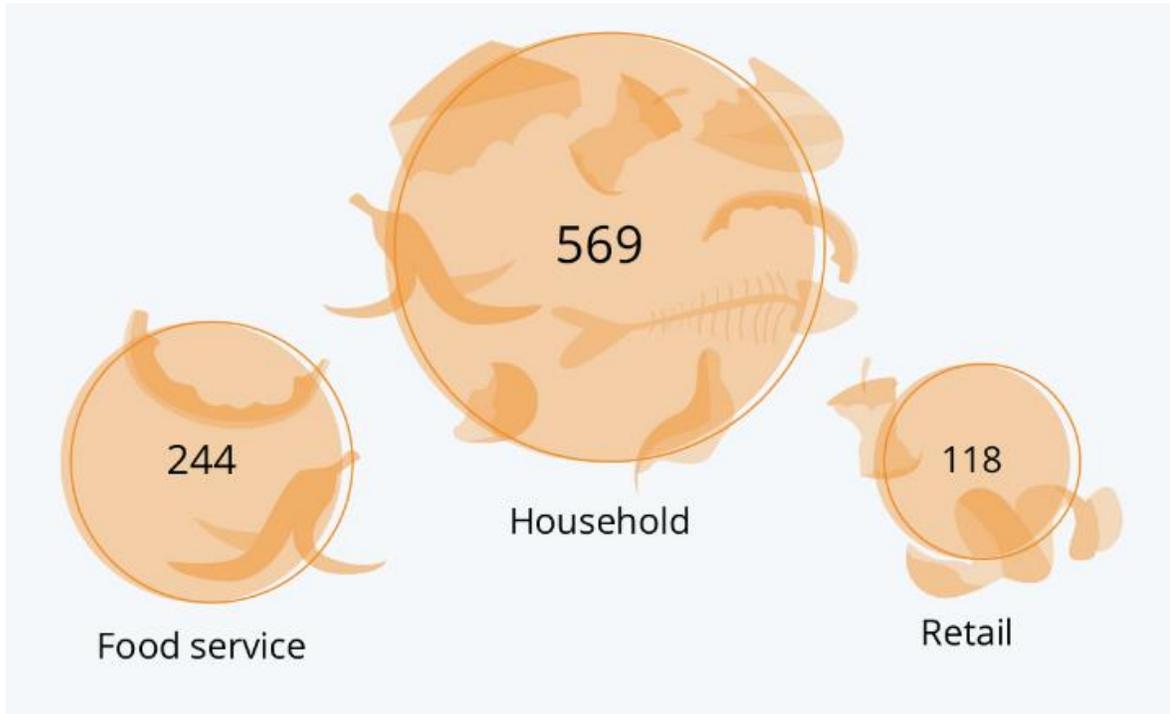
Prevention of food waste

The growing food production that is necessary to meet the needs of a growing number of people around the world involves serious environmental issues. Problems that can occur in food processing are related to energy and waste management. Large amounts of waste generated in the food industry raise important questions related to management problems, both from an economic and environmental point of view.



Source: <https://borgenproject.org/>

Estimated annual global food waste by sector (million tonnes)



Source: UNEP Food Waste Index

Prevention of food waste

A new report released by the United Nations Environment Program has revealed the shocking proportions of global food waste.

Its Food Waste Index for 2021 estimates that people throw away 931 million tons of food a year,

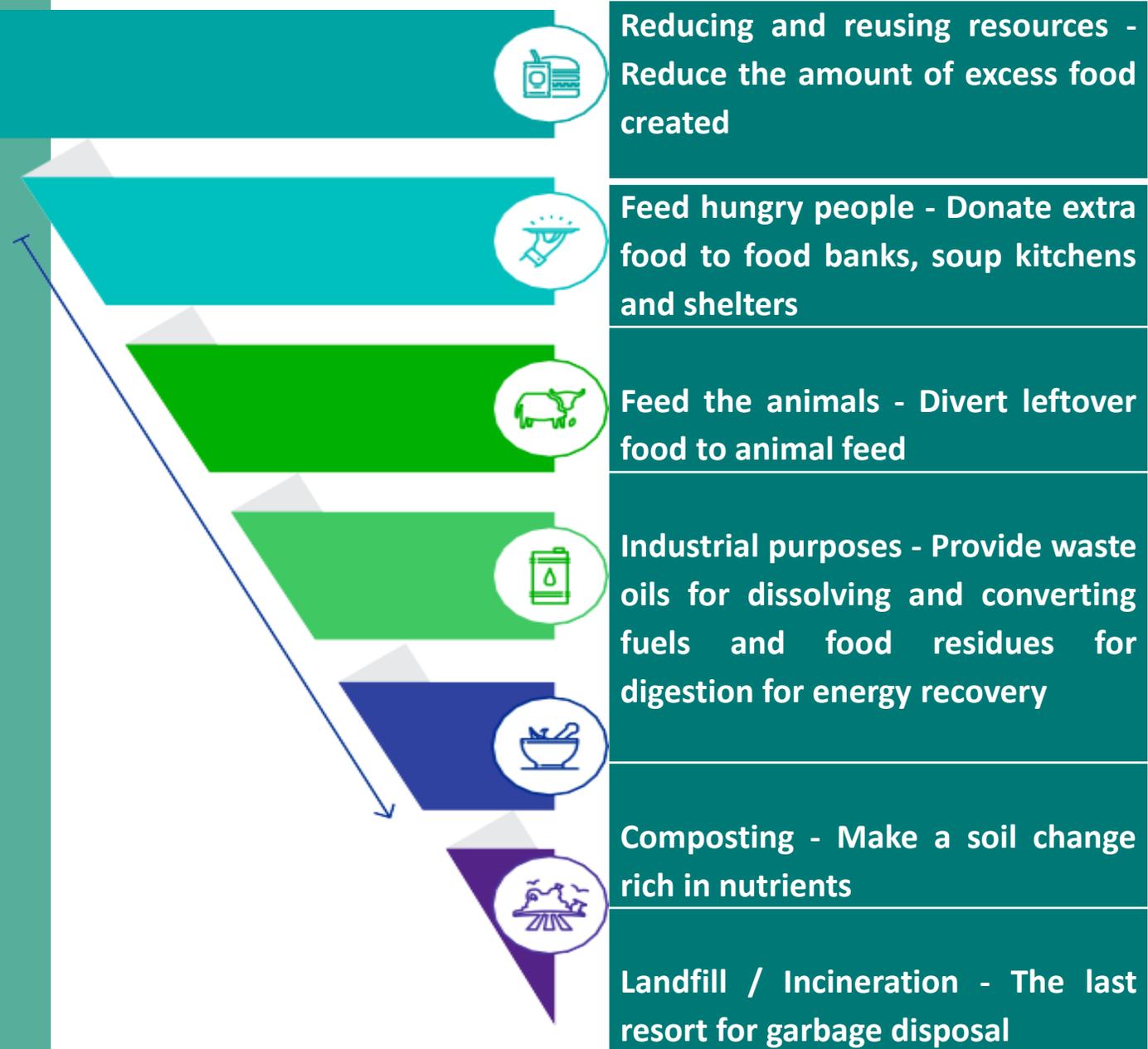
The average amount of food waste per capita is 74 kg on average

About 569 million tons fall into the category of household waste. Supermarkets and other businesses are also to blame for disposing of significant amounts of food, the report estimates that food services generate 244 million tons of food waste annually, while retail throws away 118 million tons.

Prevention of food waste

The production of food waste and by-products follows the entire life cycle of food, from agriculture to industrial production, food processing and sales, all the way to household consumption. In developed countries, 42% of food waste is generated in households, 39% is lost in industrial food production, 14% is generated in the food service sectors, and 5% is generated in retail chains and during distribution.

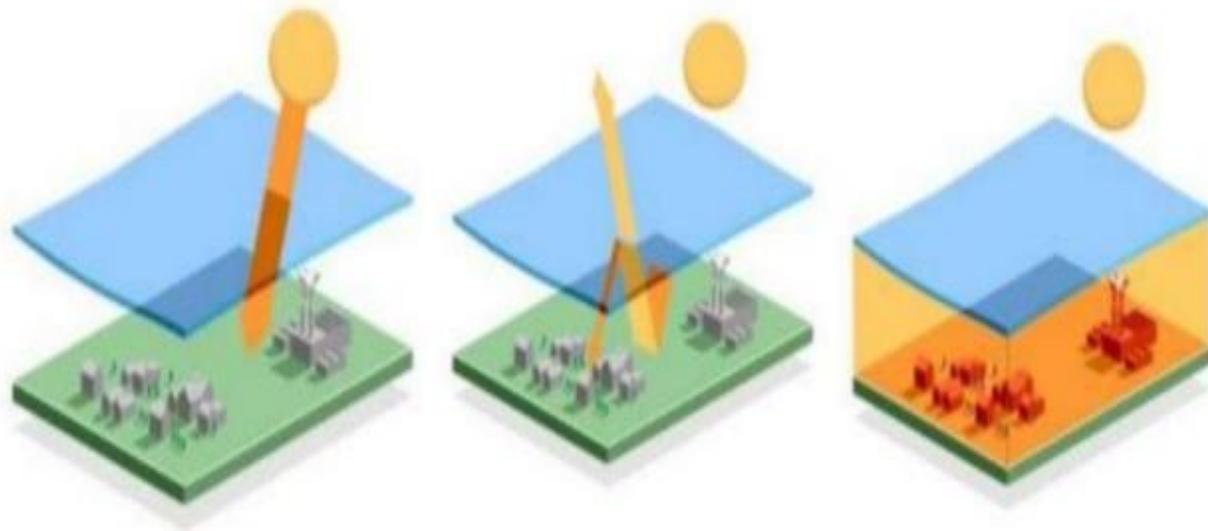
In order to reduce the amount of food waste generated, preventive action is needed.



Prevention of food waste

According to the Food and Agriculture Organization (FAO), food waste is responsible for 8% of global man-made greenhouse gas emissions. The FAO concludes that almost 30% of all available agricultural land in the world - 1.4 billion hectares - is used for food produced but not eaten. The amount of water used to produce uneaten food is 250 km³, which is the amount of water that flows through the Volga annually or three times the amount of water in Lake Geneva.

In order to reduce the amount of food waste generated, preventive action is needed.



Source: Dubravko Horvat(2012.)

Possibilities of recycling food scraps

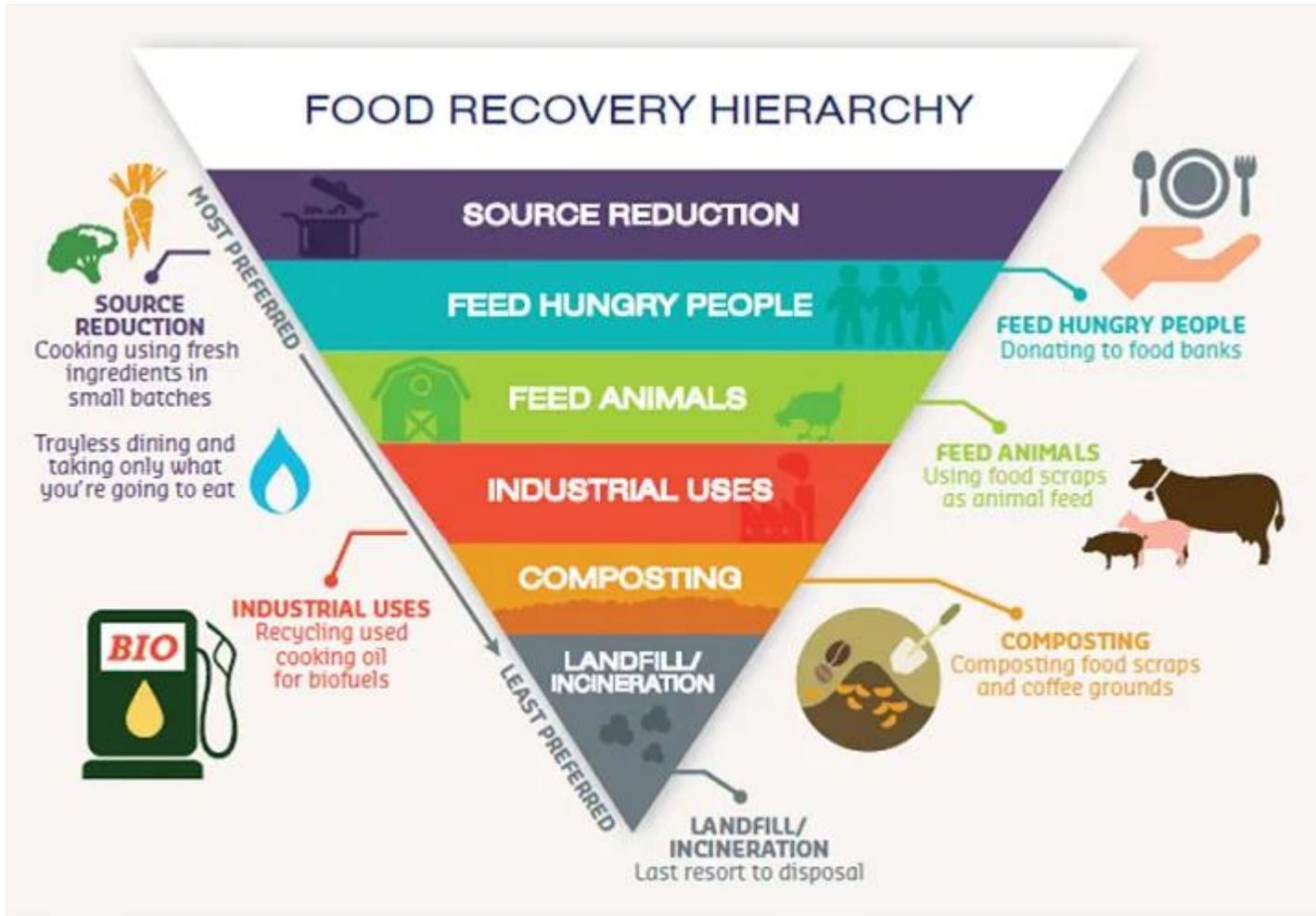


Waste and by-products have great potential for reuse through various production systems. Given the limitations in the industry, there is a great tendency towards the possibility of using by-products and the use of essential food ingredients, as they can be an important source of compounds that can partially or completely replace certain raw materials.

The aim is to reduce the amount of waste through an adequately developed production strategy, and then to define the principle according to which any generated waste and by-products can be used in the production of other food or non-food products. Therefore, the implementation and realization of various initiatives at the industrial level leads to the achievement of maximum utilization of waste or zero waste in landfills.

Possibilities of recycling food scraps

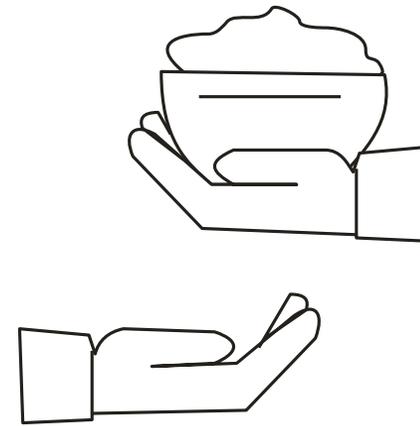
Hierarchy of food waste management



- The goal of food management is based primarily on real production in accordance with the needs and rational food management in reducing waste
- Surplus food should be sold or donated cheaper
- Process into animal feed
- Use as raw material for new products:
 - ❖ Energy
 - ❖ Bio plastic
 - ❖ Compost

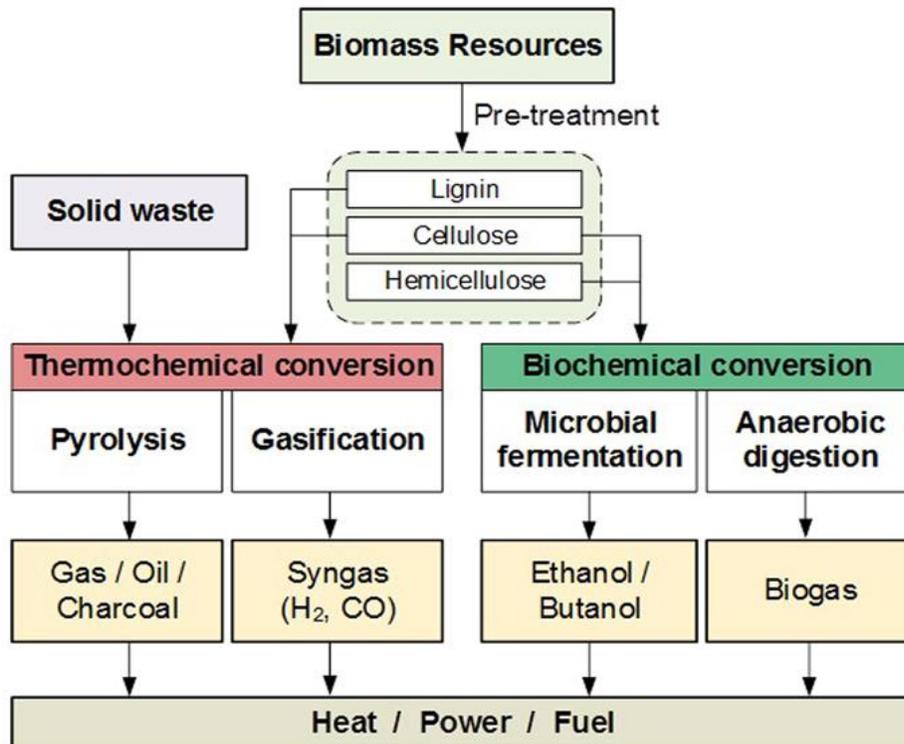
Possibilities of recycling food scraps

Food donation is one of the tools to contribute to the achievement of the objectives set out in Directive 2008/98 / EC, as last amended by Directive (EU) 2018/851 of the European Parliament and of the Council of 30 May 2018 amending Directive 2008/98 / EC on waste (OJ L 150, 14.6.2018). It is necessary to use economic instruments and other measures in order to encourage the application of the order of precedence of waste management. One of the measures should be to facilitate the food donation process. Food donation supports the fight against poverty and hunger in the world, and at the same time it is an effective tool for redistributing excess food surplus, making donation one of the most desirable options for the overall reduction of food waste.



DONATEFOOD

Possibilities of recycling food scraps



Source: Jacob N. Chung (2013.)

Bio-chemical conversion

- Biochemical conversion processes include anaerobic digestion and fermentation.
- It is used for waste with a higher content of organic / biodegradable / substance as well as high moisture content.
- Anaerobic digestion decomposes organic waste under controlled conditions, without the presence of oxygen, resulting in biogas that can be used for energy production.
- During anaerobic digestion, a dry residue is formed - the so-called digestate that can be used as a soil conditioning agent.
- Alcoholic fermentation is the transformation of the organic part of the waste into ethanol through a series of biochemical reactions using special microorganisms.
- Its most common application is in the fermentation of wood biomass, where it is converted into cellulose ethanol Æ biofuel production, eg for internal combustion engines.

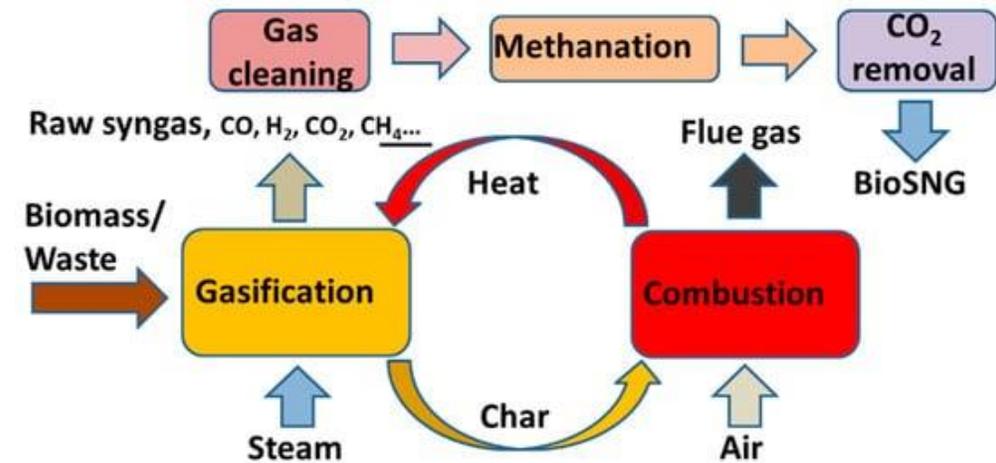
Possibilities of recycling food scraps

Pyrolysis and gasification

- represent more advanced technologies of thermal treatment of waste in which fuel is produced from waste - an energy carrier that can later be used as fuel in steam generators or gas engines and even more recently in gas turbines and as a raw material for chemicals and liquid fuels.

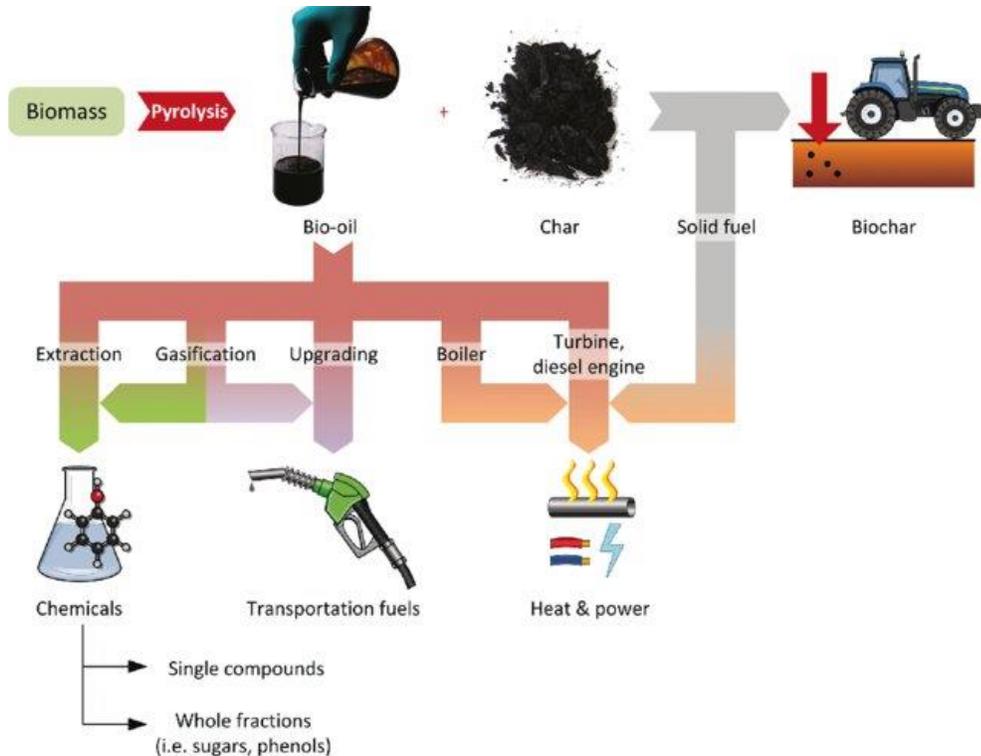
Gasification

- can be thermal (with partial combustion) or plasma.
- is the process of partial thermal degradation of a substance in the presence of oxygen, but with insufficient oxygen to fully oxidize the fuel. The general characteristics of waste gasification are the following:
 1. A gas such as air, oxygen, or water vapor is used as an oxygen source and / or serves as a carrier gas to remove reaction products from the reaction site;
 2. The process takes place at average temperatures, usually above 750 ° C (with plasma gasification > 1,600 ° C);
 3. The products are synthetic gas (the main fuels are methane, hydrogen, and carbon monoxide) and a solid residue (consisting of non-combustible material and a small amount of carbon)



Source: Yau-Pin Chyou (2020)

Possibilities of recycling food scraps



Source: Davide Pettenella (2014.)

Pyrolysis (degassing)

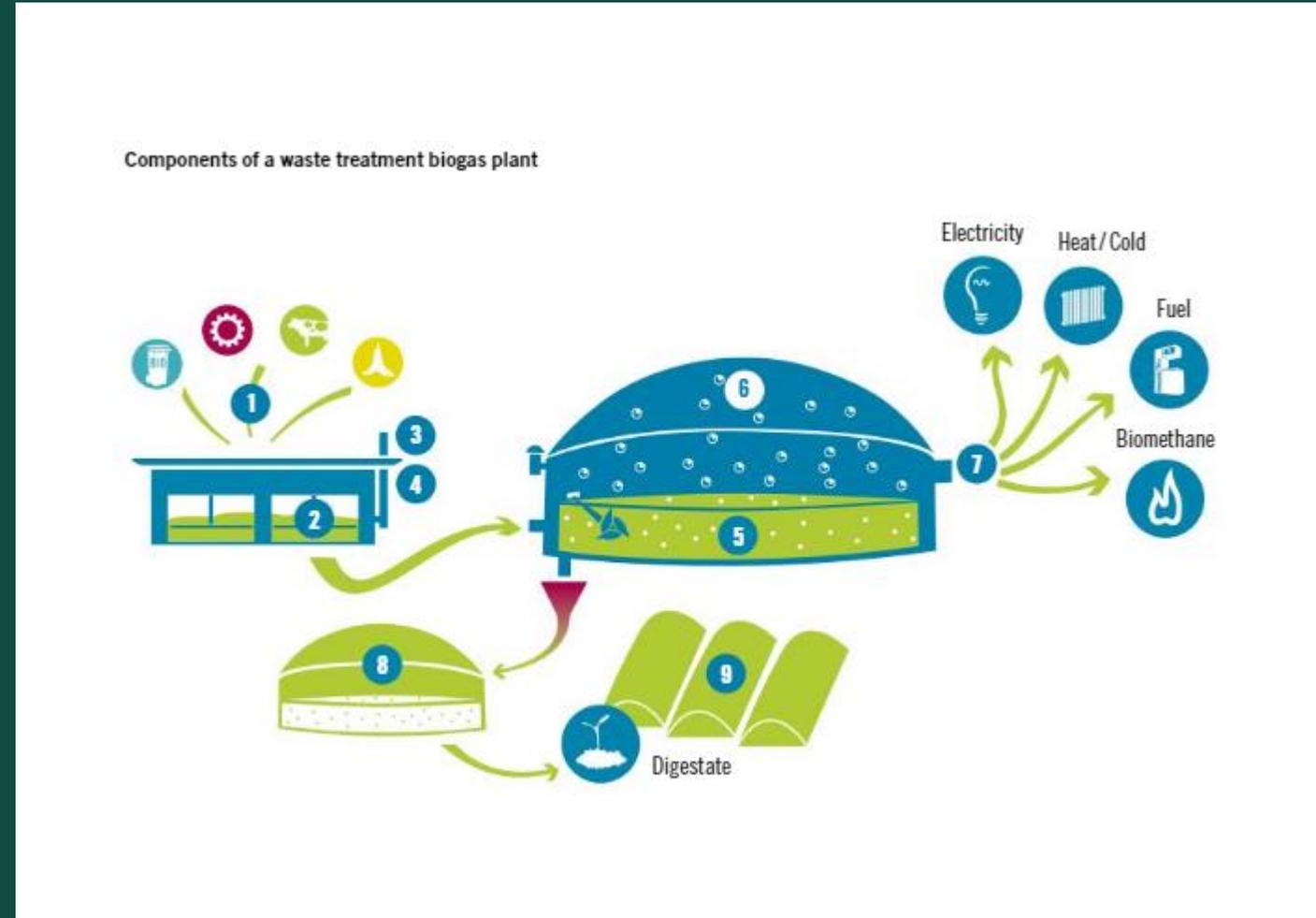
• is the thermal degradation of a substance without the presence of oxygen. The general characteristics of pyrolysis of waste materials are as follows:

1. No oxygen is present (or very little), except for the oxygen present in the fuel;
2. Process temperatures are relatively low, 300-800 ° C;
3. The products are synthetic gas (the main fuels are carbon monoxide, hydrogen, methane and higher hydrocarbons, including tar, paraffin and oils) and a solid residue (consisting of non-combustible material and a significant amount of carbon);
4. In general, the absence of oxidation, as well as the lack of additional dilution gas, means that the net heating power of the synthetic gas obtained by pyrolysis will be higher than that of the gasification process. The typical net heating power of pyrolysis gas is 10-20 MJ / m³;
5. The overall process generally converts less chemical energy of the fuel into heat energy than is the case with gasification.

Possibilities of recycling food scraps

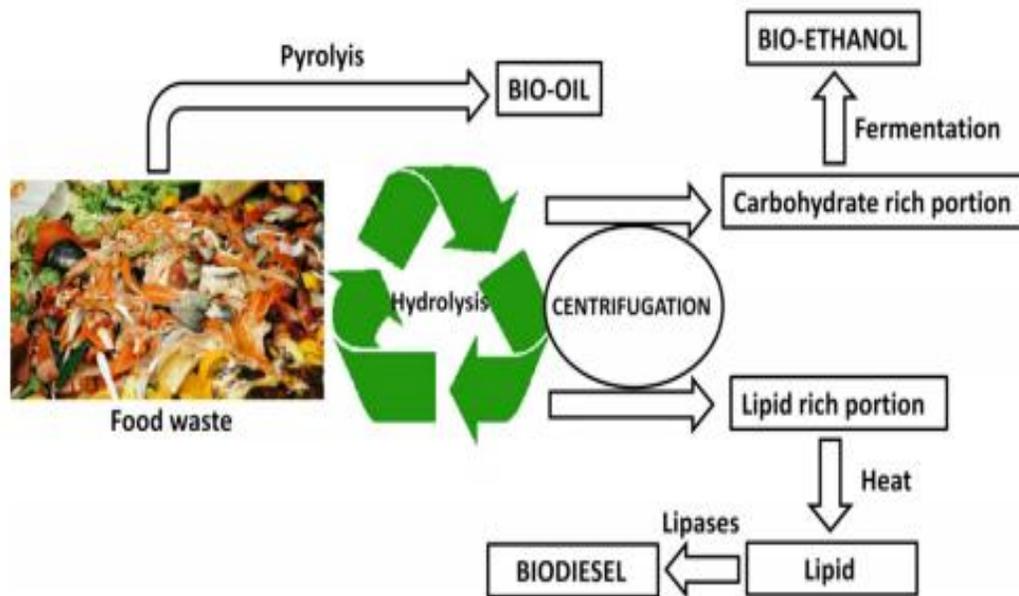
Biogas production

- Anaerobic digestion (AD) is a natural decomposition process during which organic matter is degraded into simpler chemical components under anaerobic conditions by anaerobic microorganisms. The reaction takes place in a closed reactor, with heating and stirring, in 3 stages:
 - hydrolysis (decomposition of complex organic compounds into simpler ones)
 - acidogenesis (production of CO_2 and H_2)
 - methanogenesis (production of CO_2 and CH_4), which produces biogas and stabilized digestate as final products of the process



Source: <http://dibicoo.org/wp-content/uploads/2020/07/Pres.-I-European-Biogas-Technologies.pdf>

Possibilities of recycling food scraps



Bioethanol is an important biofuel because it has the potential to replace gasoline. Alcoholic fermentation of food waste produces 92-96% of bioethanol.

Source: Sanjib Kumar Karmee(2016.):

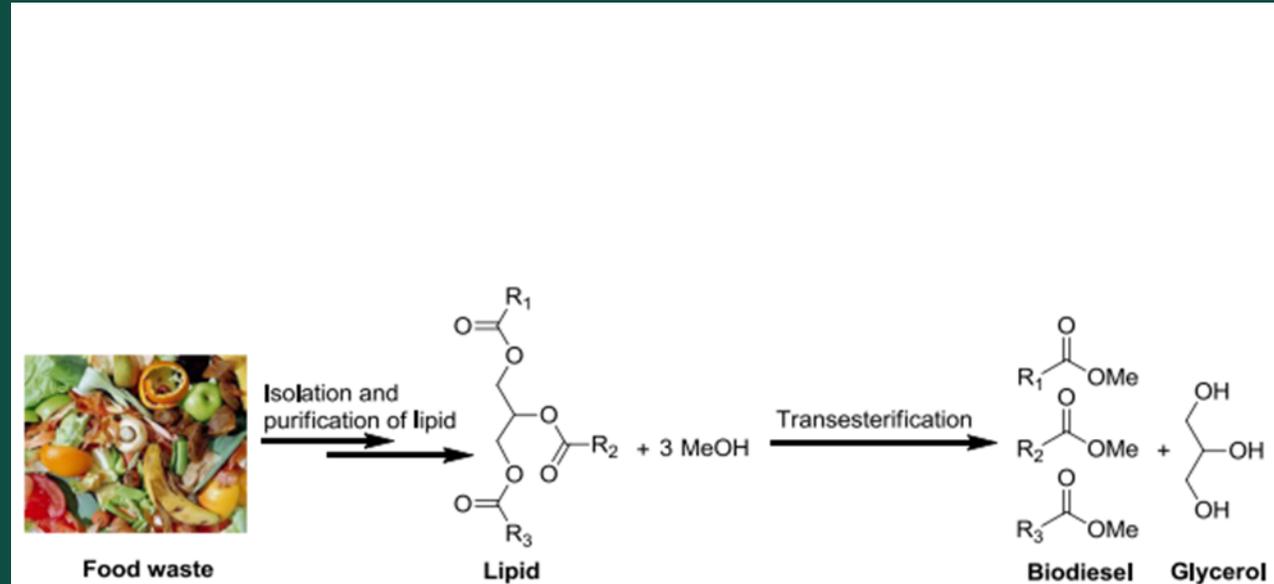
Possibilities of recycling food scraps

Biodiesel production

Biodiesel production from food residues requires lipid extraction. First, food waste is mixed with water (usually 100 g of food waste in 1 liter of water) to obtain a slurry, which is then strongly mixed with non-polar organic solvents, namely. n-hexanes diethyl ether.

The resulting mixture is then transferred to a separatory funnel. The organic layer was separated and evaporated under reduced pressure to give a lipid without an organic solvent.

After hydrolysis, the resulting hydrolytic mixture is centrifuged to separate the crude lipid from the food hydrolyzate. The crude lipid obtained was then heated to 100 ° C to give the lipid without water. In addition, lipids can be extracted using soxhlet extraction.



Source: Yiu Fai Tsanga (2019.)

Possibilities of recycling food scraps

Source: <https://www.kaffeeform.com/en/>



Bioplastics production provides great opportunities for the development of innovative technologies.

Example production of coffee cups from coffee juice from Kaffeeform.

Kaffeeform promotes the principle of circular economy. Increasing coffee consumption around the world produces an increasing amount of coffee grounds, which mostly goes straight into the trash. Here comes Kaffeeform: he normally use the lost resources as raw material. The result is an innovative material that is extremely durable. He finds his perfect second life as a coffee cup. The coffee cycle is over.



Possibilities of recycling food scraps

Composting

Biowaste is kitchen waste (food preparation residues) and garden or green waste. It makes up almost a third of household waste and is a valuable raw material for the production of quality biocompost. It is best that biowaste is biologically processed at the place of its origin. This process is called composting, which means the aerobic decomposition of biowaste to produce carbon dioxide, water, heat and compost as the final product (in just a few months). Compost feeds plants, ensures soil aeration, retains water and favors the growth of root plants, and therefore composting should be applied wherever possible (orchards, vegetable gardens, nurseries, parks, green areas, agricultural, livestock and forestry, food industry, catering, markets, cemeteries, schools, kindergartens, housing and other facilities). It's pleasure to know that compost is used for increasing the quality people own gardens, flower beds or lawns.



Innovative business solutions through CE for waste reuse

Based on lecture provided students should 5 examples of innovative idea of waste reuse, They can use any resource, scientific papers, google search (google scholar for more scientific research), books, specialized magazines etc.

The presentation of the examples should be in a form of short seminar with additional students opinion in few sentences on each of them whether it can or cannot be implemented in their country and why.

The seminars should be sent via e-mail to their supervisor



TRAIN-CE-FOOD project

<https://traincefood.si/en/home-english>

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This project has been co-financed by the European Commission, Directorate General for Internal Market, Industry, Entrepreneurship and SMEs. GA: SI2.823699.

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