# The Blue Economy: food waste valorisation

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# Motivation

- It is time to reconcile ourselves with biowaste. We may have thought that the progress was to be able to put our waste in a garbage can, a truck, and then an incinerator. And then, we don't talk about it anymore!
- This method, if it has the merit of simplicity, cuts the ancestral cycle of organic matter, with the direct effect of encouraging waste, emitting many **Greenhouse gases (GHG)**, and deprive the soil of its basic food.
- **We share these analyses here, and hope to give you the desire to take the plunge!**

- **Experience:**
  - **Degree Business Administration**
  - **Subject: Microecoomics (2nd year)**

# Motivation

- Biowaste consists of food waste and other natural biodegradable waste.

# Motivation

- Global plastic production reached almost **360 million tonnes in 2018** (Plastics Europe, 2019).

- In contrast, **bioplastics** production capacity in 2018 was only **2.01 million tonnes**, representing 0.56% of global plastic production (European Bioplastics, 2020).

- Currently, around **80% of all plastic produced worldwide is not recycled** or reused in other ways (Blank et al., 2020).

- However, the **cost of producing bioplastics** is much higher than petroleum-based plastics (Raza et al., 2018).

- One option to reduce the manufacturing costs of bioplastics would be to use suitable **waste and by-products as feedstock materials** (Saharan and Sharma, 2012).

# Some concepts
# 1. Circular Economy

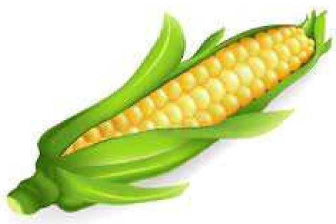
- The Circular Economy offers **new business opportunities by changing the traditional linear material use model** to a more sustainable, efficient and circular one (Lieder and Rashid 2016).

- It is a sustainable concept that focuses on keeping material value at a maximum by applying **reduce, reuse and recycle practices**, which benefits society in the aspects of economy and environment without aggravating the burden of primary natural resource extraction (Ghisellini et al., 2018).

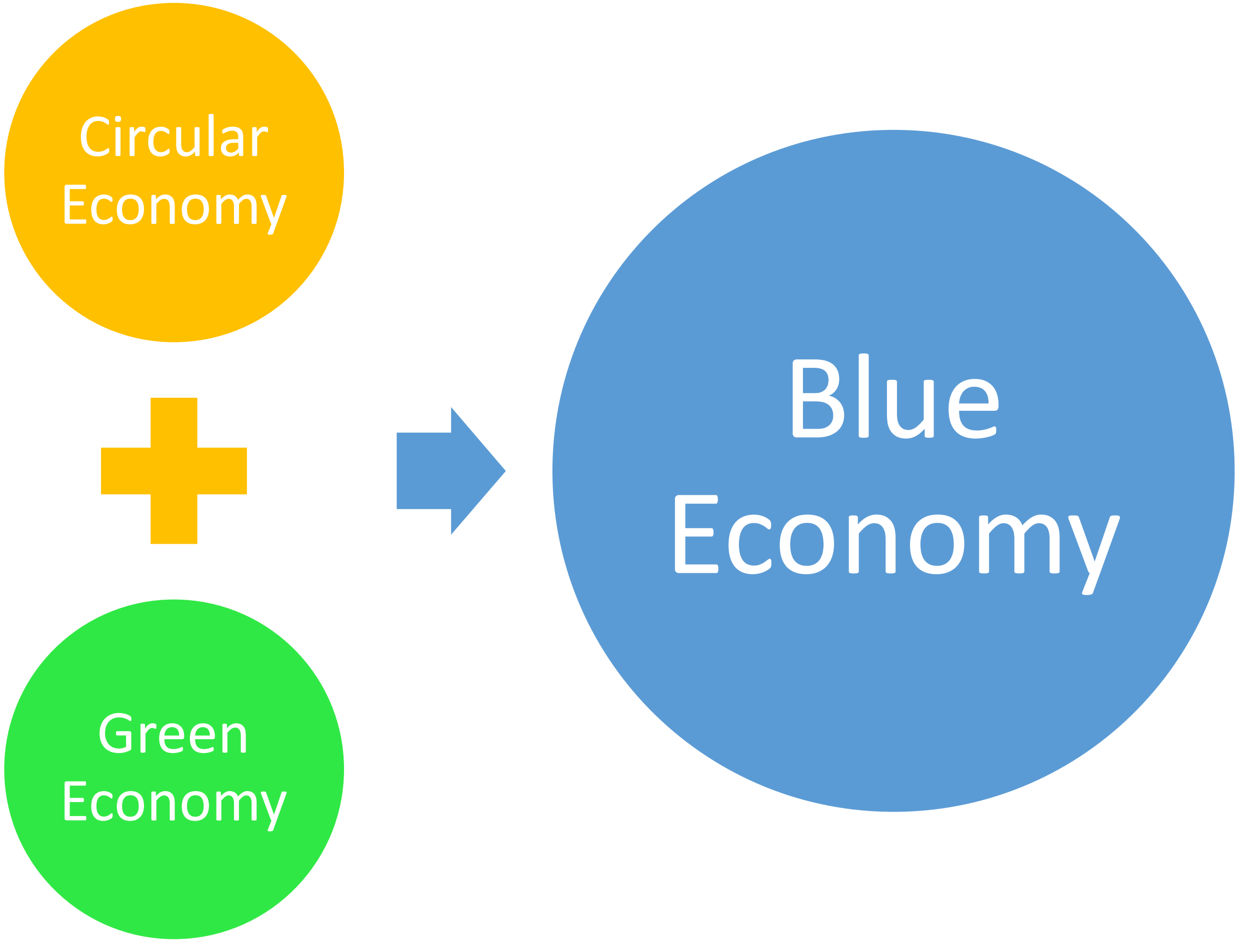
- **Defined** by the Ellen MacArthur Foundation (EMF), **three basic principles of the circular economy** are:
  - 1) preserve and enhance natural capital
  - 2) optimise the performance of resources in use
  - 3) promote system efficiency (EMF 2015).

# Some concepts
# 2. Green Economy

- In a Green Economy, employment and income growth is driven by public and private investment in economic activities, infrastructure and assets that **reduce carbon emissions and pollution**, improve energy and resource efficiency, and prevent the loss of biodiversity and ecosystem services (UNEP, 2012).
- However, the substitution of one product or process for another has revealed **unintended consequences, including collateral damage**.
  - For example, the use of **maize as a feedstock for biofuels** and bioplastics has increased the cost of tortillas (made from maize). The pursuit of bioplastics may further endanger food security. This is not sustainable development.
  - Another example concerns the use of palm **oil for biodegradable soaps** which has led to the destruction of huge tracts of rainforest and with it the habitat of the orangutan. That is not sustainable development.



# Some concepts
# 3. Blue Economy



# Some concepts
# 3. Green Economy

- The Blue Economy can be seen as a hybridisation between the Circular Economy and the Green Economy.
  - The **Circular Economy** still focuses on companies that are based on a single core business.
    - The **Blue Economy shows that having a portfolio of businesses can create more value**, not only in economic terms, but for society and nature as a whole.
  - In the **Green Economy** everything that is good for you and the environment is **expensive** (Mahenc, 2007). These high prices were often justified because local producers could not take advantage of economies of scale.
    - In the **Blue Economy model**, you start from **community resources**, and build a commitment to the resilience of your community. If **there is no waste**, you can generate more value, you can create more jobs.

# Some concepts
# 4. Food waste

- The **FAO** defines food waste as "losses of food in quality and quantity through the supply chain process that occurs at the production, post-harvest and processing stages" (FAO, 2019).

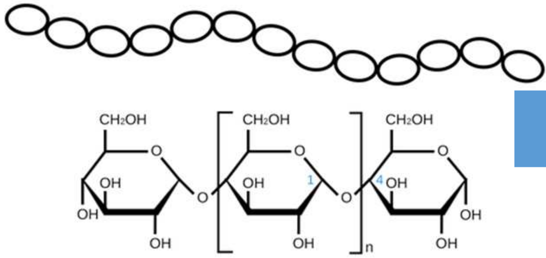
- Around **1.3 billion tonnes of food are lost or wasted each year worldwide**, corresponding to one third of all food resources produced for human consumption (FAO, 2019).

- The **European Union generates 90 million tonnes of kitchen waste** annually (Pfaltzgraff et al., 2013).
- Although EU guidelines stated that food waste should preferably be used as animal feed, it became illegal due to the concern of disease control (Cerda et al., 2018). Therefore, the **valorisation of food waste** through the production of value-added products may be an ideal and practical end-use.

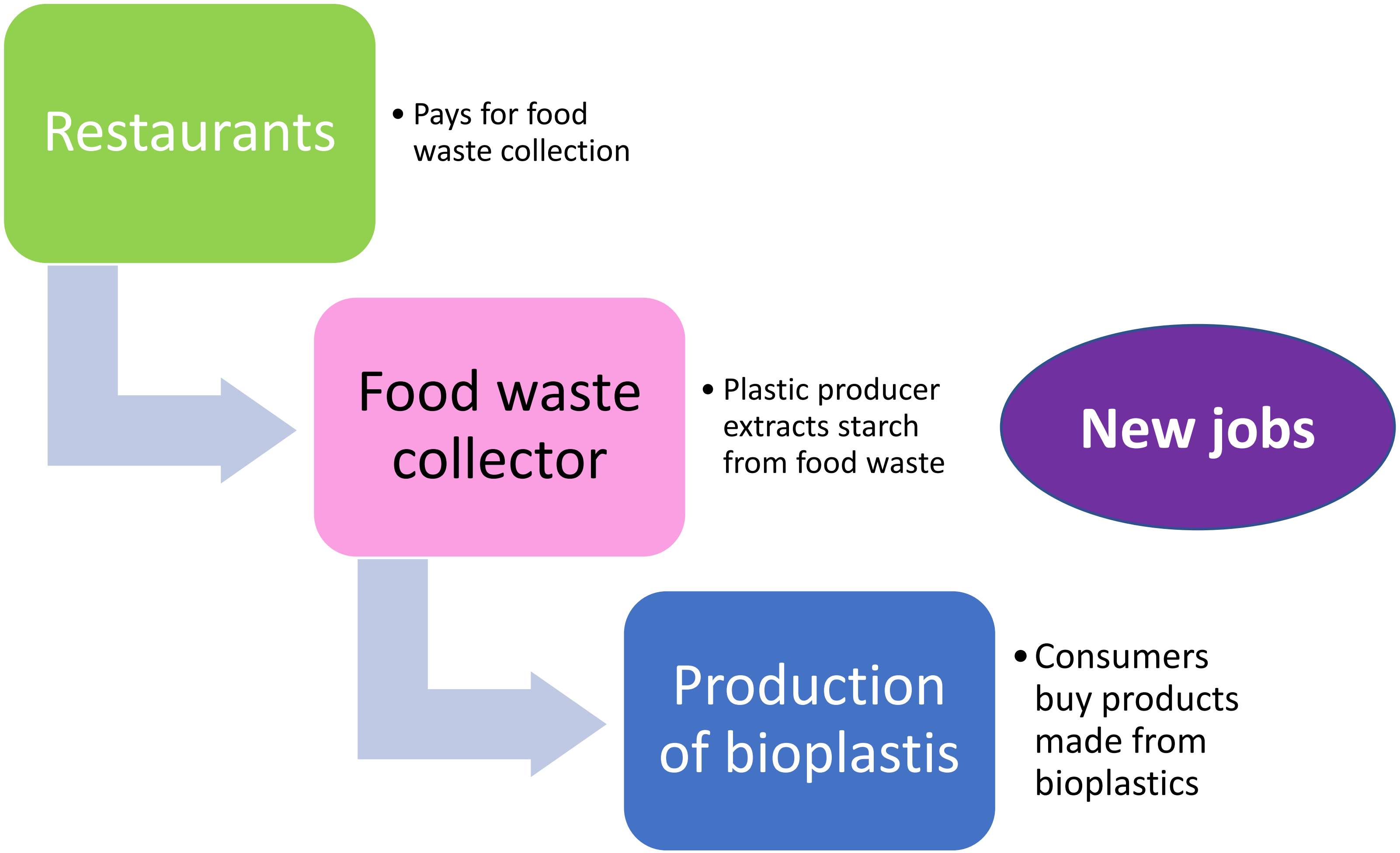
# Bioplastics from food waste

- In 2000, **Professor Yoshihito Shirai** of the Institute of Life Sciences, Kyushu Institute of Technology, Japan, opted for a simple but quite innovative solution (Sakai et al., 2003). He observed how **restaurants** in Japan discard large quantities of food.
- As a result of increasing **pressure on the local landfill** and the desire to reduce carbon emissions, Professor Shirai designed a PLA production unit based on raw material in the form of **starch from food waste**.
  - Although the starch content is lower than that of corn, this model is convincing, and the environmental **benefits outweigh any other bioplastic.**

Starch




# Bioplastics from food waste



# Objectives

- The **main objective:** analyse the net social benefits of **switching from petroleum-based plastics to bioplastics**, based on a cost-benefit analysis. The specific objectives are:


- The concept of **Cost-Benefit Analysis:** applied as a tool to evaluate a project in order to help the public sector to inform their decisions on the pursuit of bioplastic. Two scenarios have been compared.
- - **Scenario 1:** Status quo scenario in which the production of bioplastics is not introduced, and only the **production of fossil-based plastics is used.**
- - **Scenario 2:** New scenario in which PLA bioplastics are produced with a production capacity conditioned by **local food waste generation.**

# All concerned!

# Food Waste around the world

| Country Name | Reference | kg / capita food waste estimate | Confidence level |
|---|---|---|---|
| Austria | (Environment Agency Austria, 2017) | 39 | High |
| Belgium | (Flemish Food Supply Chain Platform for Food Loss, 2017) | 50 | Medium |
| Denmark | (Danish Environmental Protection Agency, 2018) | 79 | High |
| | (Edjabou et al., 2016) | 83 | High |
| Estonia | (Moora, Evelin, et al., 2015) | 78 | Medium |
| Finland | (Katajajuuri et al., 2014) | 67 | Medium |
| | (Stenmarck et al., 2016) | 64 | Medium |
| France | (ADEME, 2016) | 85 | Medium |
| Germany | (Schmidt et al., 2019) | 75 | High |
| Greece | (Abeliotis et al., 2015) | 142 | Medium |
| Hungary | (Kasza et al., 2020) | 94 | Medium |
| Ireland | (Stenmarck et al., 2016) | 55 | Medium |
| Italy | (Giordano et al., 2019) | 67 | Medium |
| Luxembourg | (Luxembourg Environment Ministry, 2020) | 89 | Medium |
| | (Caldeira et al., 2019) | 91 | Medium |
| Malta | (Caldeira et al., 2019) | 129 | High |
| Netherlands | (The Netherlands Nutrition Centre Foundation, 2019) | 50 | High |
| Norway | (Hanssen et al., 2016) | 79 | High |
| Poland | (Steinhoff-Wrześniewska, 2015) | 56 | Medium |
| Russian Federation | (Tiarcenter, 2019) | 33 | Medium |
| Slovenia | (Republic of Slovenia Statistical Office, 2020) | 36 | Medium |
| | (Republic of Slovenia Statistical Office, 2019) | 33 | Medium |
| | (Caldeira et al., 2019) | 77 | Medium |
| | | 78 | Medium |


[UNEP Food Waste Index Report 2021 | UNEP - UN Environment Programme]

# Food Waste around the world

| Country Name | Reference | kg / capita food waste estimate | Confidence level |
|---|---|---|---|
| Austria | (Caldeira et al., 2019) | 31 | High |
| | (Environment Agency Austria, 2017) | 26 | High |
| Belgium | (Flemish Food Supply Chain Platform for Food Loss, 2017) | 20 | Medium |
| Denmark | (Danish Environmental Protection Agency, 2014) | 21 | High |
| Estonia | (Moora, Piirsalu, et al., 2015) | 17 | High |
| Finland | (Katajajuuri et al., 2014) | 23 | Medium |
| | (Stenmarck et al., 2016) | 24 | Medium |
| France | (BIO Intelligence Service, 2010) | 17 | Medium |
| | (ADEME, 2016) | 32 | Medium |
| Germany | (Schmidt et al., 2019) | 21 | High |
| Ireland | (Stenmarck et al., 2016) | 56 | Medium |
| Luxembourg | (Luxembourg Environment Ministry, 2020) | 21 | Medium |
| Norway | (Stensgård et al., 2019) | 5 | Medium |
| Serbia | (Bogdanović, et al., 2019) | 6 | Medium |
| Slovenia | (Republic of Slovenia Statistical Office, 2020) | 20 | Medium |
| | (Republic of Slovenia Statistical Office, 2019) | 20 | Medium |
| Sweden | (Swedish Environmental Protection Agency, 2014) | 20 | High |
| | | 21 | High |
| Switzerland | (Beretta et al., 2013) | 40 | Medium |
| United Kingdom of Great Britain and Northern Ireland | (WRAP, 2020b) | 17 | High |

# *Catalogue impacts and select measurement indicators*

- **On the cost side:**
  - investment costs
  - production costs
  - water treatment costs.
- **On the benefit side:**
  - obtaining secondary products (ethanol, gypsum),
  - reduction of carbon emissions and reduction of hazardous waste. $CO_2$ emission is the sum of energy use (electricity and fuel oil) and emission into the atmosphere.
- As the production technology of fossil-based plastic has been developed over more than 60 years, its energy consumption has been effectively improved up to the maturity stage.
- Consequently, this traditional process requires less energy (per tonne of product) than PLA production, which is at an embryonic stage.

# Example

A fictitious case compares the production of 100,000 tonnes of fossil-based plastic and 100,000 tonnes of bioplastic from food waste.

- **Production costs and capital investment** in technology for bioplastic are higher than for fossil-based plastic.
- However, the **reductions in pollutant gases** and the direct and indirect spin-off benefits are higher for bioplastic.
- Consequently, the **net benefit** is 7.34 million euros compared to a loss of 186.66 million euros.

*Cost-Benefit Analysis of the production of 100,000 tonnes of plastic of fossil origin or bioplastic (millions of euros)*

| | | Bioplastic | Fossil-based plastic |
|---|---|---|---|
| Direct costs | Production costs | 225 | 77 |
| | **Capital and technology** | **330** | **108** |
| | Land cost | 0.74 | 0.74 |
| Indirect costs | Greenhouse gas emissions | 30 | 143 |
| | Oportunity cost (land) | 0,92 | 0,92 |
| **Total costs** | | **586,66** | **329,66** |
| Direct benefit | Sales | 300 | 143 |
| Indirect benefit | Sales | 294 | 0 |
| **Total benefit** | | **594** | **143** |
| **Net benefit** | | **7,34** | **-186,66** |

# Conclusions

- The assessment of this teaching project has been very positive.
- Students have become familiar with new approaches to economics that are not usually covered in traditional textbooks.
- The **Blue Economy** is a way to reconcile economic profitability, environmental care and a local/regional approach.
- In addition, students have become familiar with the **reality of food waste**, which is not given the importance it deserves.
- They have also become **familiar with economic and environmental vocabulary in English**, thus practising the ability to cope in a language other than their native one.
- Finally, the exhibition of their work has helped them to learn about the **realities of other cities** around the world, promoting the concept of caring for the environment as a global concern.

# Thanks for your attention

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