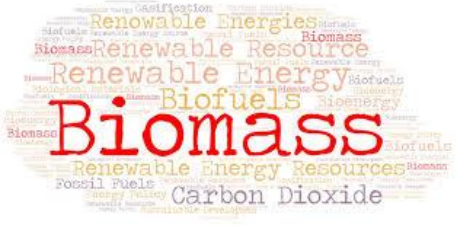
National Technical University of Athens
School of Chemical Engineering
Unit of Environmental Science & Technology

Current trends and future potential of biowaste and biomass



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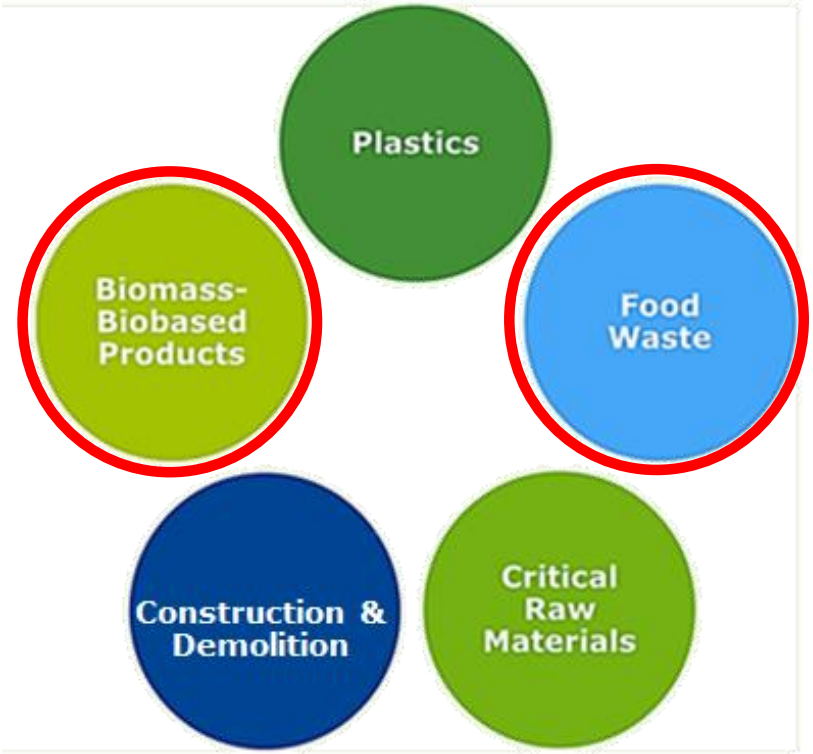
7th International Conference on Sustainable Solid Waste Management, 26-29 June 2019, Heraklion, Crete Island, Greece

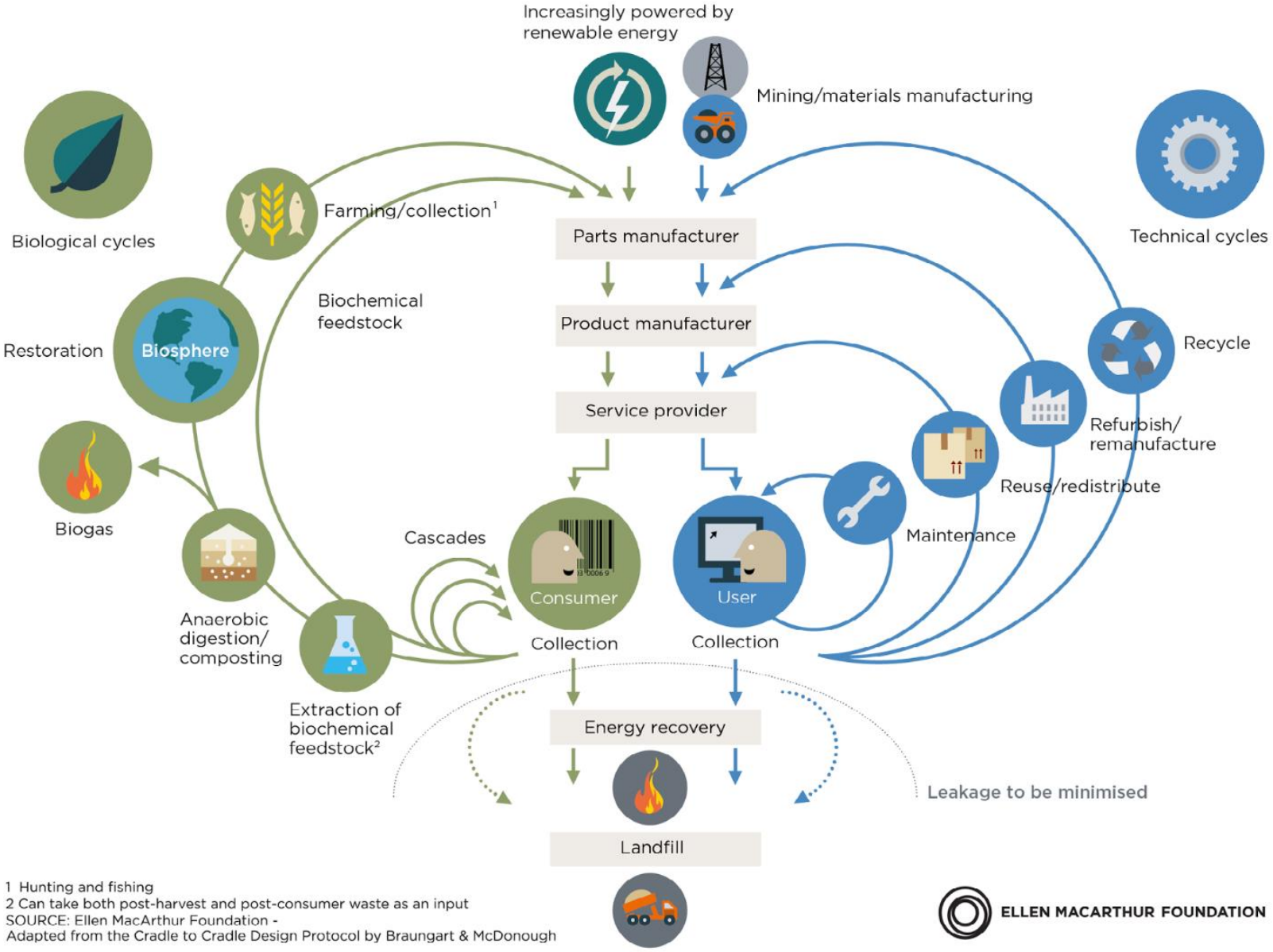
EU action plan for the Circular Economy

4 Key areas of action

5 Priority sectors



Circular economy



1 Hunting and fishing
2 Can take both post-harvest and post-consumer waste as an input
SOURCE: Ellen MacArthur Foundation -
Adapted from the Cradle to Cradle Design Protocol by Braungart & McDonough

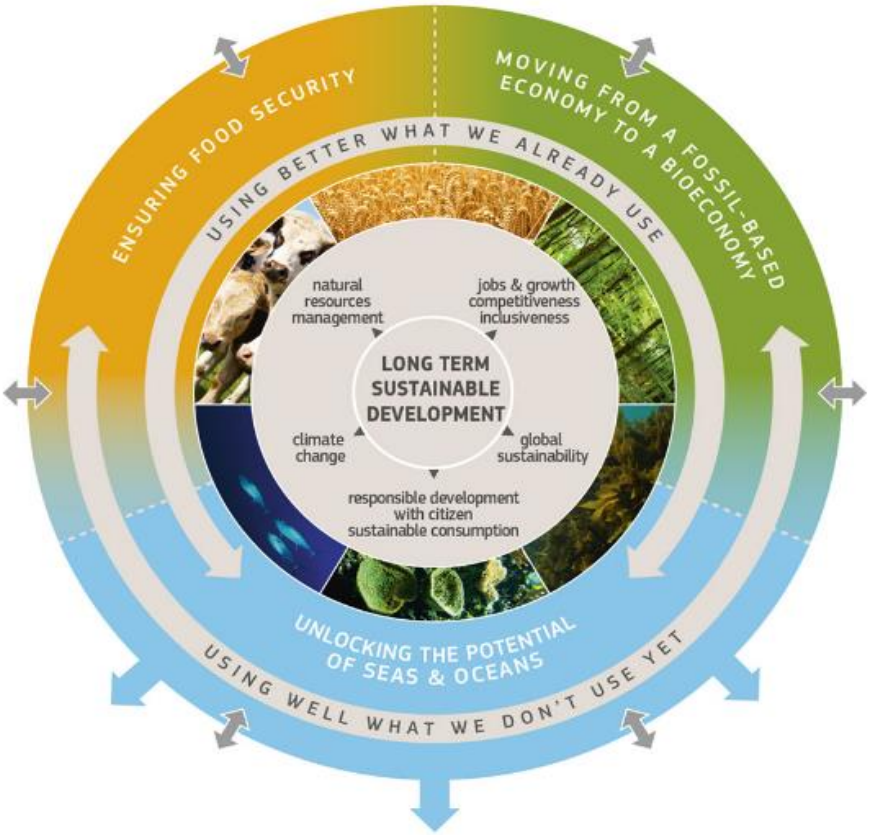
ELLEN MACARTHUR FOUNDATION

Bioeconomy

A sustainable bio-economy may be built on the principle of resource efficiency, circular economy and minimum environmental impact;

Requirements:

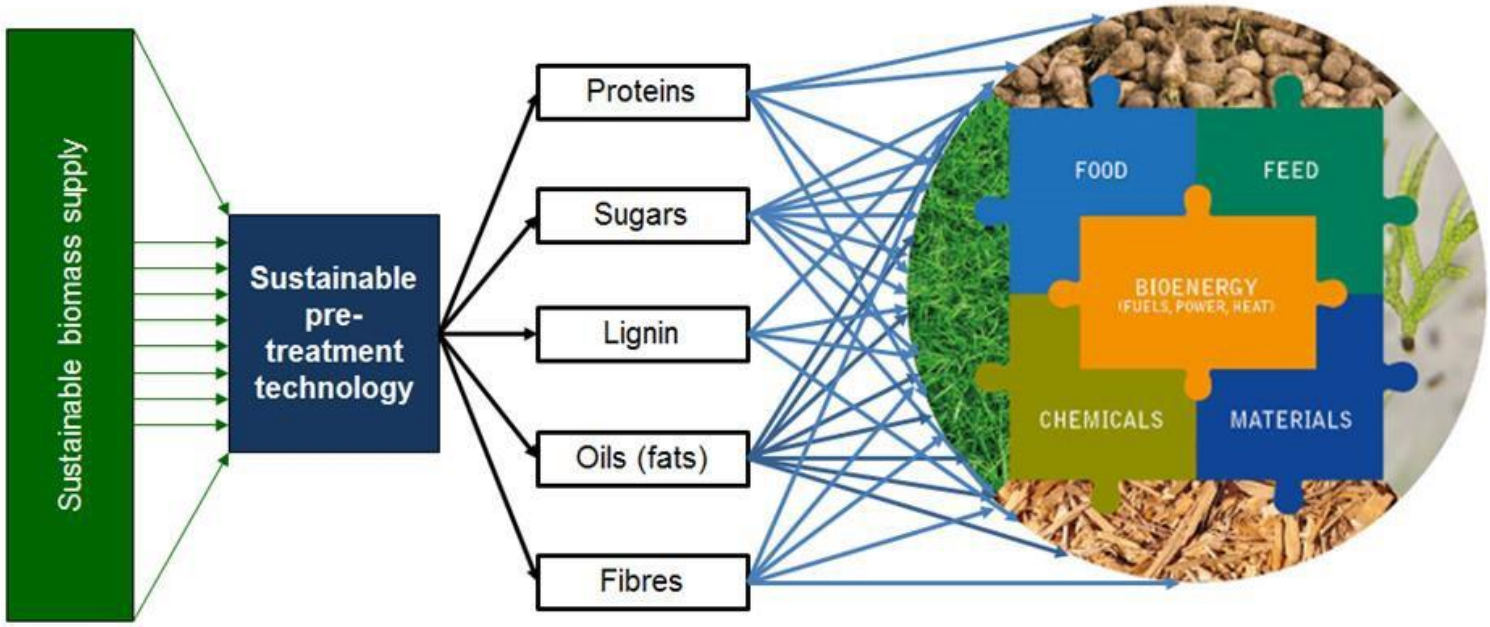
- The development of **new value chains**
- Bringing existing value chains to new levels, through **optimised uses of feedstock and industrial sidestreams**;
- Bringing **technology to maturity through research and innovation**, and through upgrading and building demonstration and flagship biorefineries.



Role of bioeconomy in CE

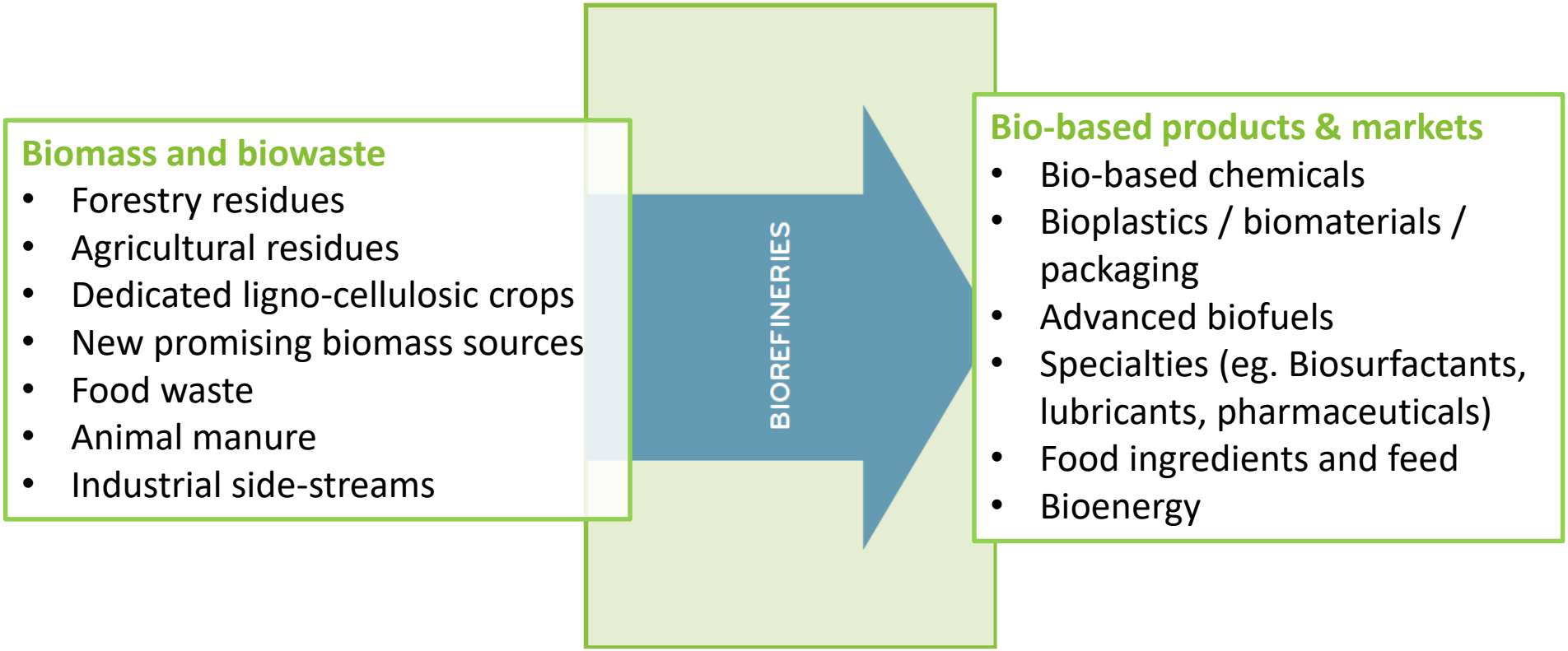
- Bioeconomy is circular by nature.
- Bioeconomy regenerates CO_2 and uses renewable raw materials to make greener everyday products.
- Bio-based products and materials have the benefit of achieving a more balanced carbon cycle in comparison to fossil alternatives.
- Circular economy is complementary to the renewable character of the bioeconomy and must facilitate the recycling of carbon after efficient uses.

Biorefinery

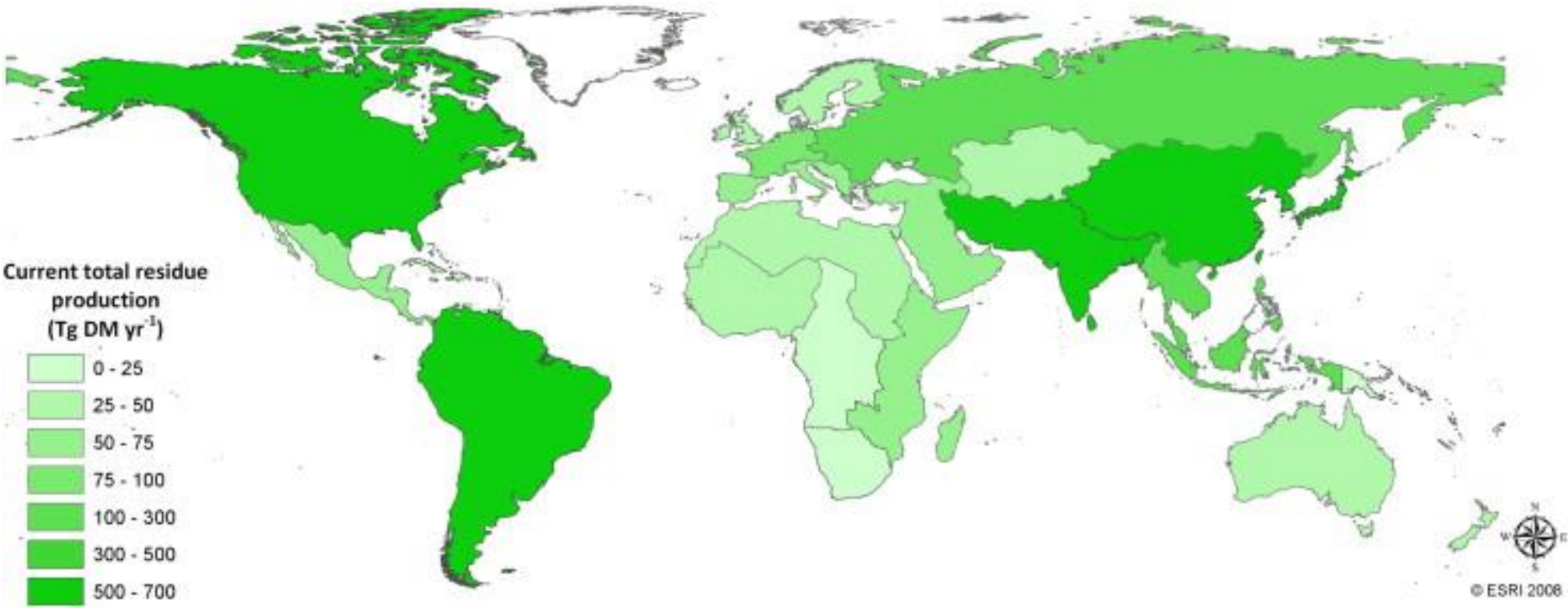


Sustainable processing of biomass into a portfolio of marketable biobased products (food and feed ingredients, chemicals, materials, fuels, energy, minerals, CO_2) and bioenergy (fuels, power, heat).

Valorization - Biorefinery

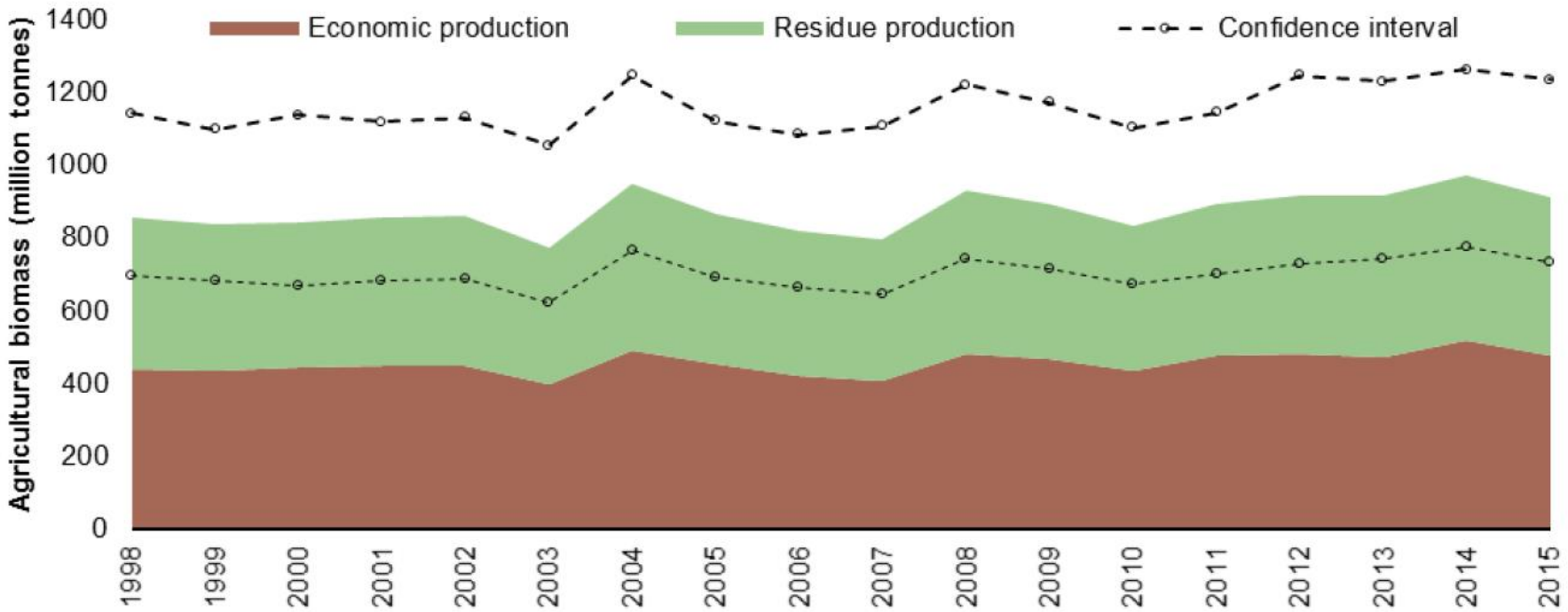


Agricultural residues in the world



Geographical distribution of production of residues from barley, maize, rice, soybean, sugar cane and wheat production.

Agricultural residues in EU



Source: JRC, Eurostat, 2017[4]

Total

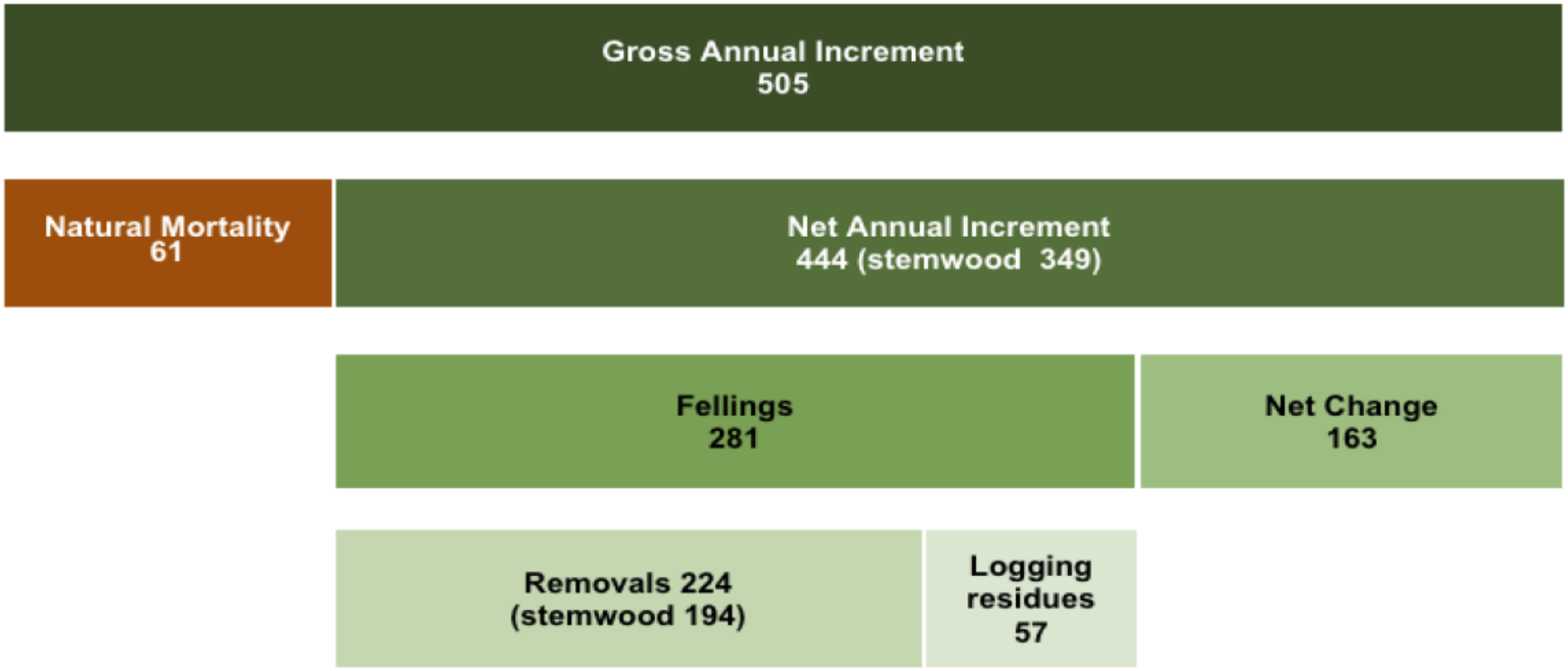
956 Mt of dry matter (averaged from 2006 to 2015)

514 Mt (or 54%): primary products (biomass produced as grains, fruits, roots)

442 Mt (or 46%): e.g. dry biomass from leaves, stems

Forest residues

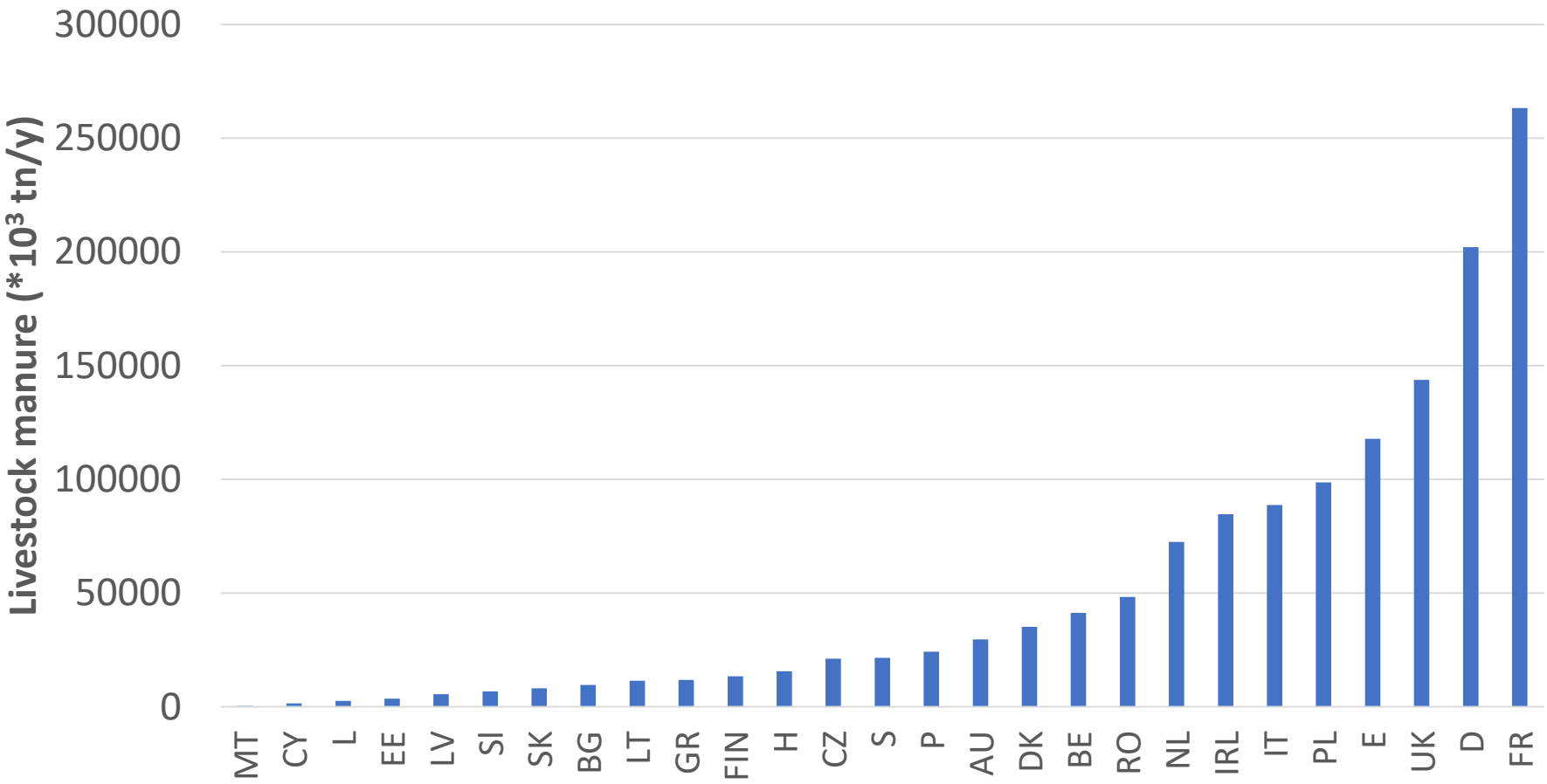
Forest residues consist of small trees, branches, tops and un-merchantable wood left in the forest after the cleaning, thinning or final felling of forest stands.



Increment, fellings and removals in EU-28 forest area available for wood supply; average values in Mt/yr for the period 2004-2013.

Animal residues

EU: 1.4 billion ton/year manure



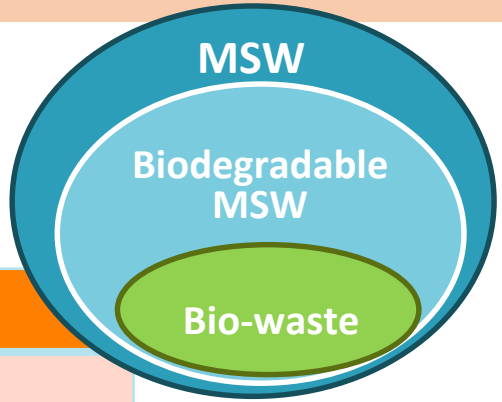
Biowaste

It includes:

- ✓ biodegradable garden and park waste
- ✓ food and kitchen waste from households, restaurants, caterers and retail premises, and
- ✓ comparable waste from food processing plants.

It does **NOT** include:

- ✗ forestry or agricultural residues,
- ✗ manure,
- ✗ sewage sludge, or
- ✗ other biodegradable waste (e.g. natural textiles, paper or processed wood).



European Waste Catalogue	
Description	**EWC Code**
Biodegradable kitchen and canteen waste	20 01 08
Waste from markets	20 03 02
Biodegradable garden and park wastes	20 02 01

Food waste

Every step of the food chain uses resources and generates more waste & pollution

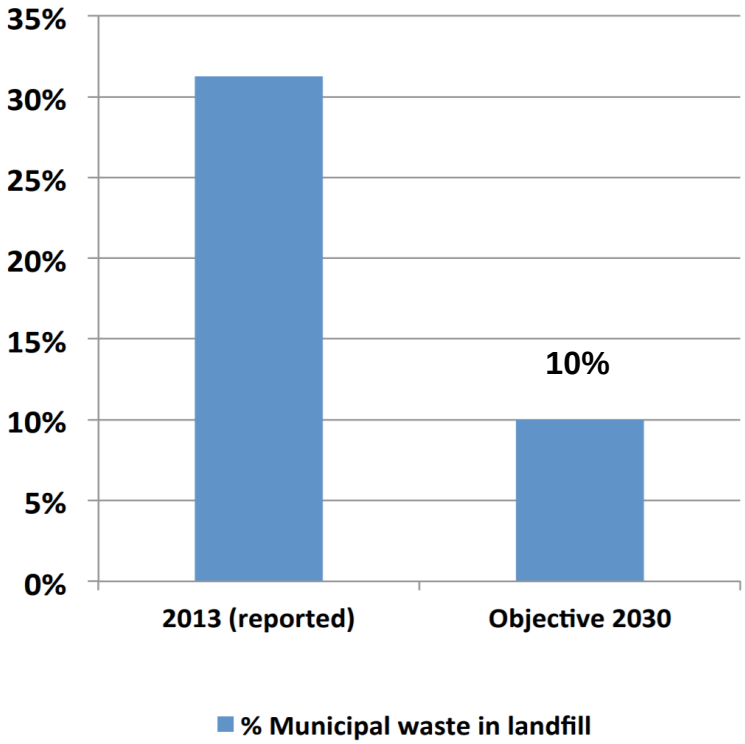
DEVELOPING ECONOMIES WASTE 40% OF FOOD DURING THE **FIRST** TWO STEPS OF THE VALUE CHAIN

- Poor harvesting techniques
- Poor storage facilities
- Poor transportation infrastructure

DEVELOPED ECONOMIES WASTE 40% OF FOOD DURING THE **LAST** TWO STEPS OF THE VALUE CHAIN

- Retailers encourage over consumption
- Stores and markets throw away food in good condition
- Consumers buy and cook more than needed

EU LEGISLATION REVISION
New targets for MSW landfilling



- Member States should reduce MSW ending at landfills to **10%** until **2030.**
- Bio-waste separate collection

Member States should reduce food waste:
by **30%** until **2025** &
by **50%** until **2030.**

Food waste as a problem in the world

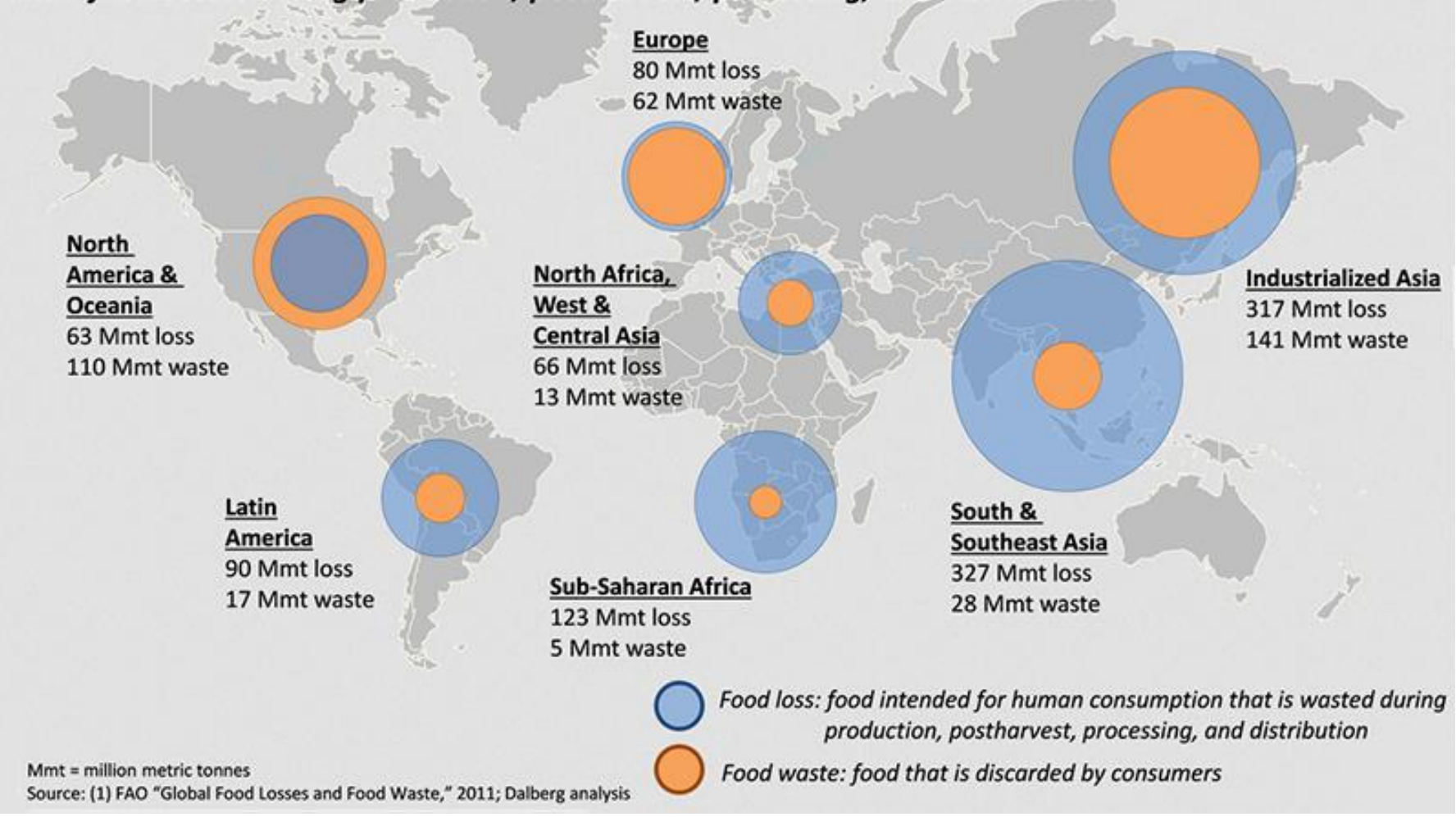
GLOBALLY:

- Every year **1/3 of the world production** of food ends up in the trash
- **1.3 billion tons** of food still perfectly edible are lost or wasted, enough to **feed 3 billion people**
- **3.3 Giga-tonnes of GHG emissions** is the carbon footprint of FW (8% of global GHG emissions)
- **3 times the water volume of Lake Geneva** is used to produce food that is lost/wasted
- **30% of world's agricultural land** is occupied to produce food that is never consumed

- **Increase in food prices**: The more food we waste, the higher the demand on the global market, which drives up prices.

Food waste and food loss around the world, millions of metric tons[1]

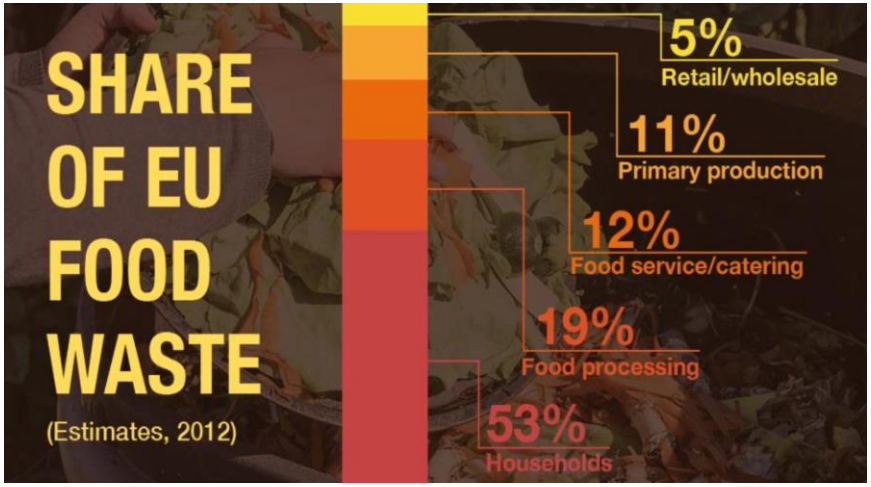
Unlike consumer driven waste in the developed world, over 90% of all wastage in developing Asia and Africa occurs during production, postharvest, processing, and distribution



Mmt = million metric tonnes
Source: (1) FAO "Global Food Losses and Food Waste," 2011; Dalberg analysis

Food waste as a problem in EU

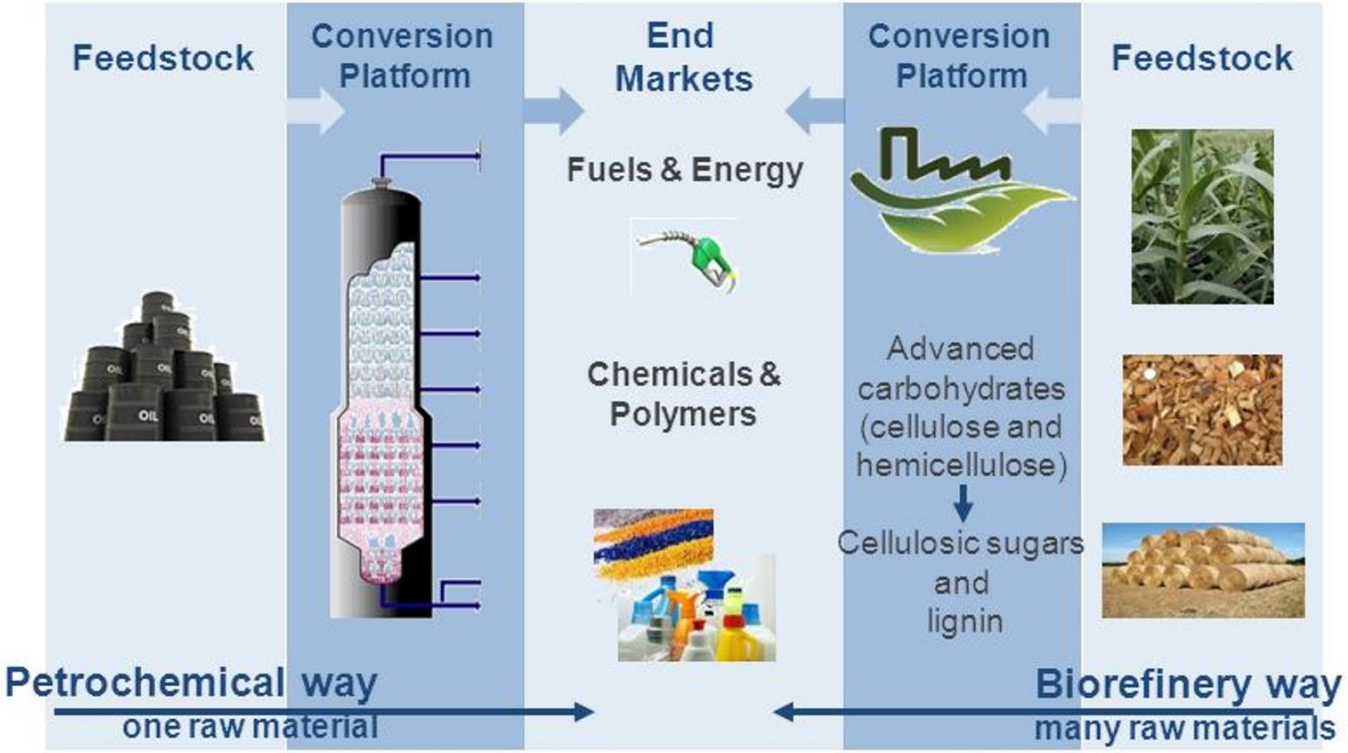
IN EUROPE:



- **53% of EU FW** comes from households: OUR OWN kitchen is the guilty!

- Every year **88 million tonnes of food (or 173 kg FW per person per year)** ends up in the trash – **could feed 200 million people.** This number is expected to **rise to approx. 126 million tonnes by 2020** if no action is taken.
- **20% of EU food production is lost or wasted**
- **170 Million tonnes of CO_2 emissions** emitted from production and disposal of EU food waste
- **143 billion euros** related costs (**almost 600 €** per year per household)

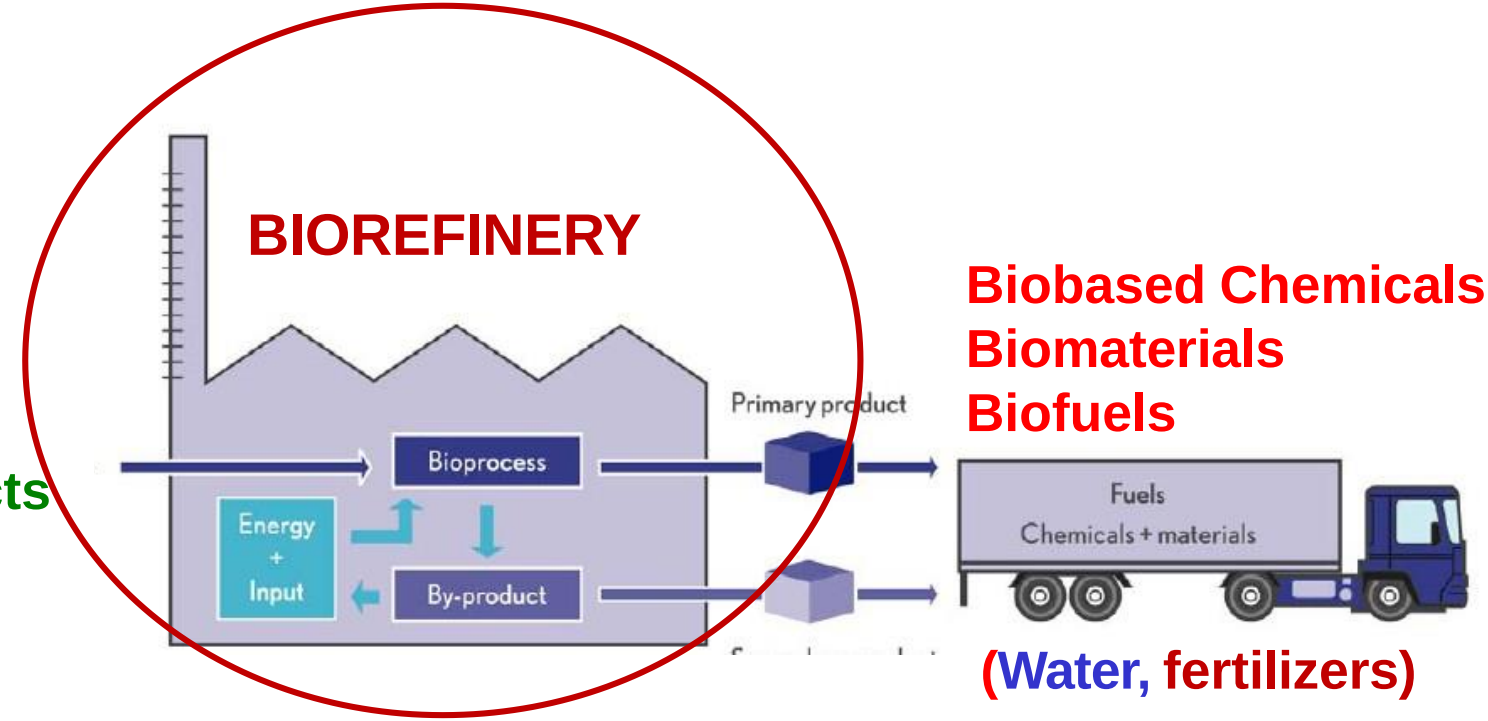
Biorefinery to valorize biowaste:
the alternative concept to petroleum-based processes and products



Biorefinery:
Is the alternative concept to today's fuel-based refineries which produces fuels, chemicals, energy etc. from biomass-based materials

Biowaste Biorefinery

Organic Byproducts & waste



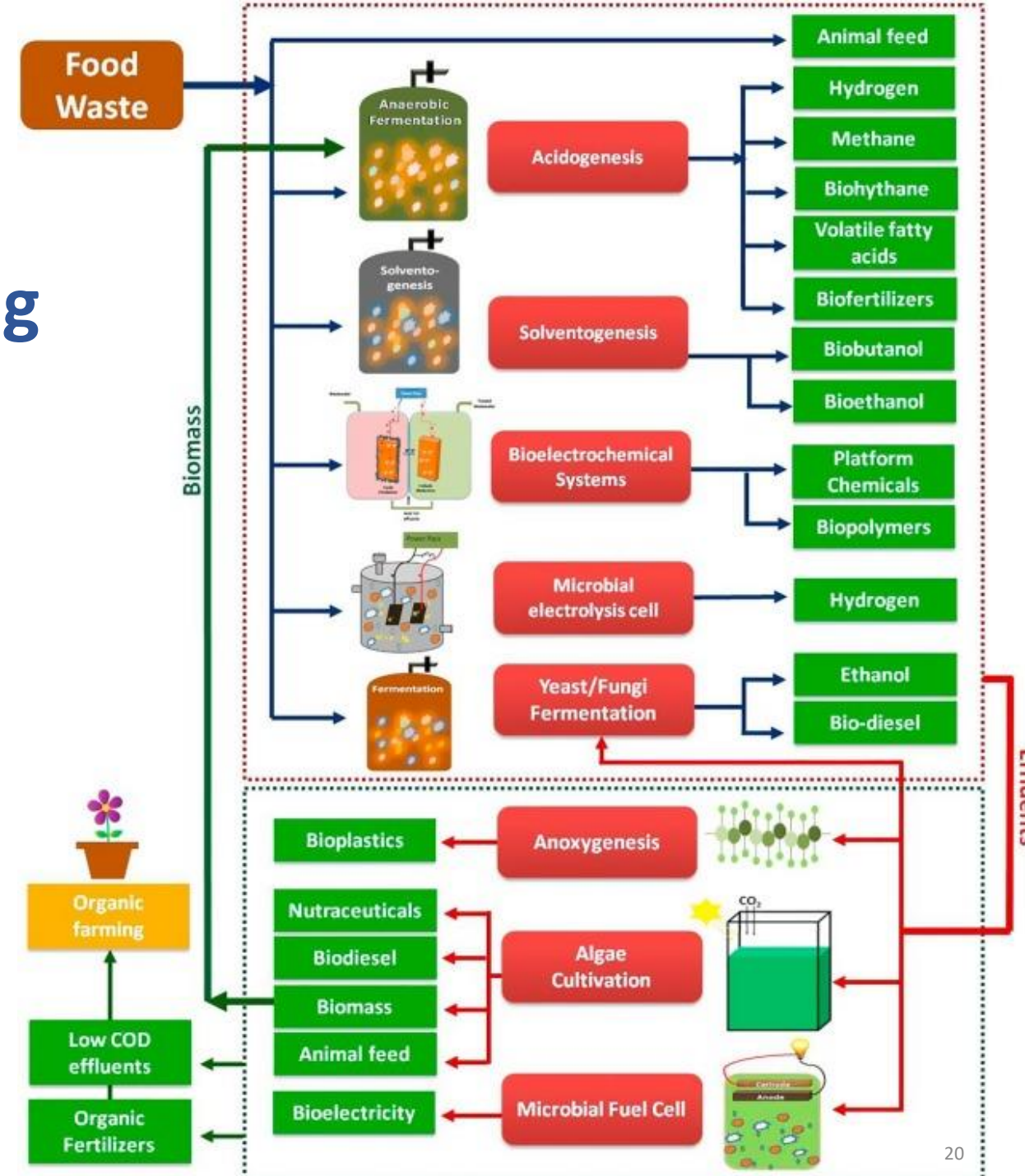
Biobased Chemicals
Biomaterials
Biofuels

(Water, fertilizers)

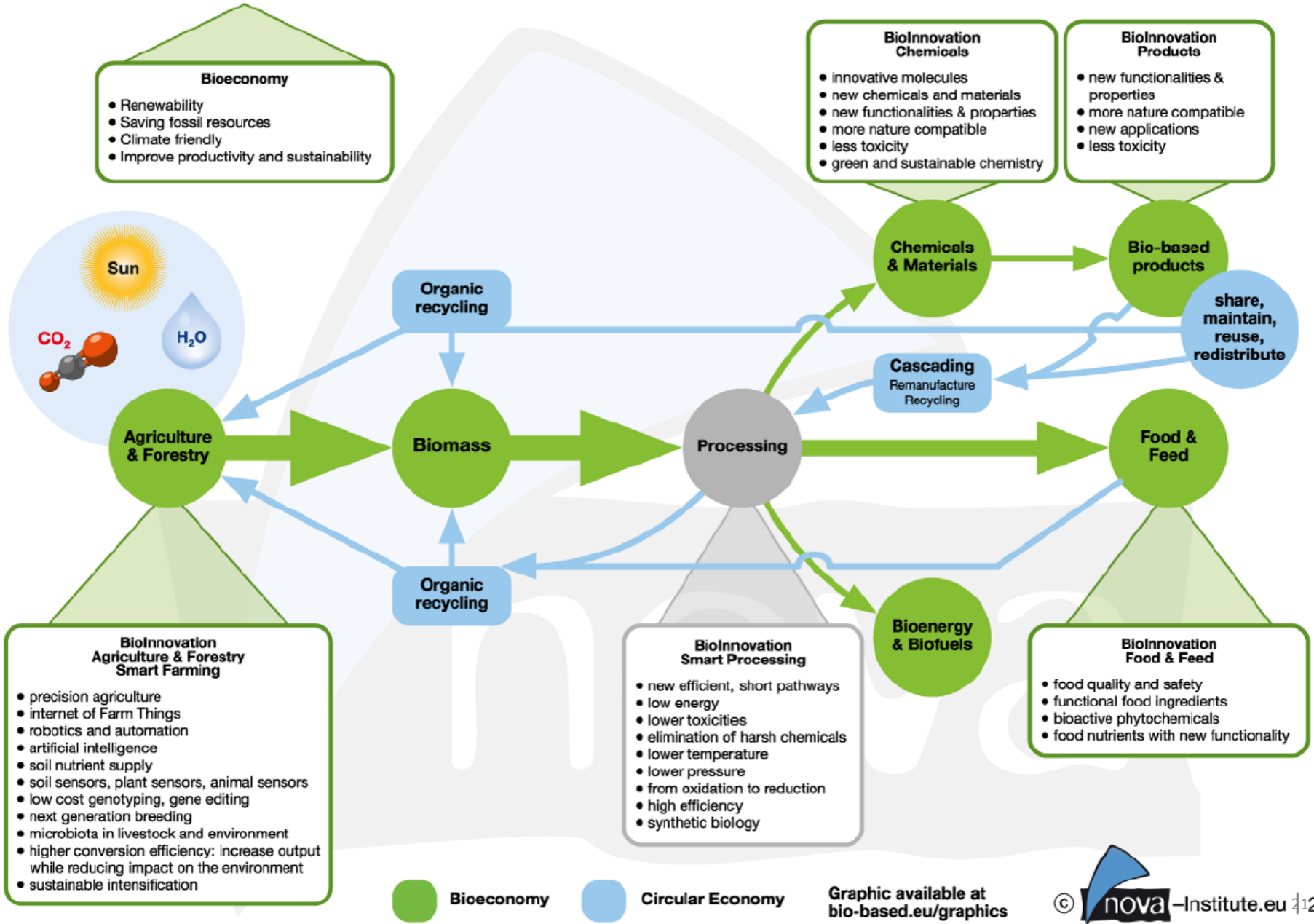
Optimal biorefinery concepts should achieve:

- minimal energy and water consumption,
- no generation of waste,
- high biomass to product conversion yield,
- low production cost and environmental impact, and
- high societal acceptance.

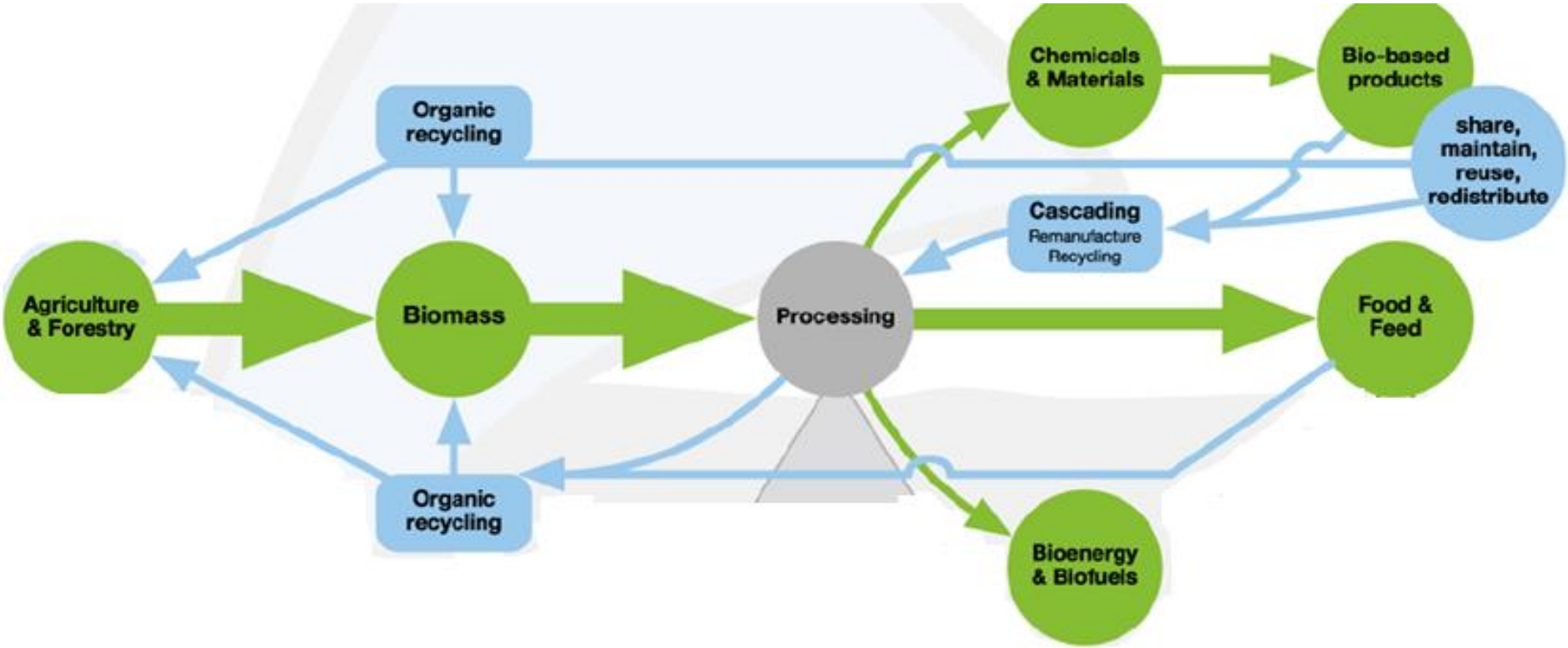
Conceptualising food waste biorefinery



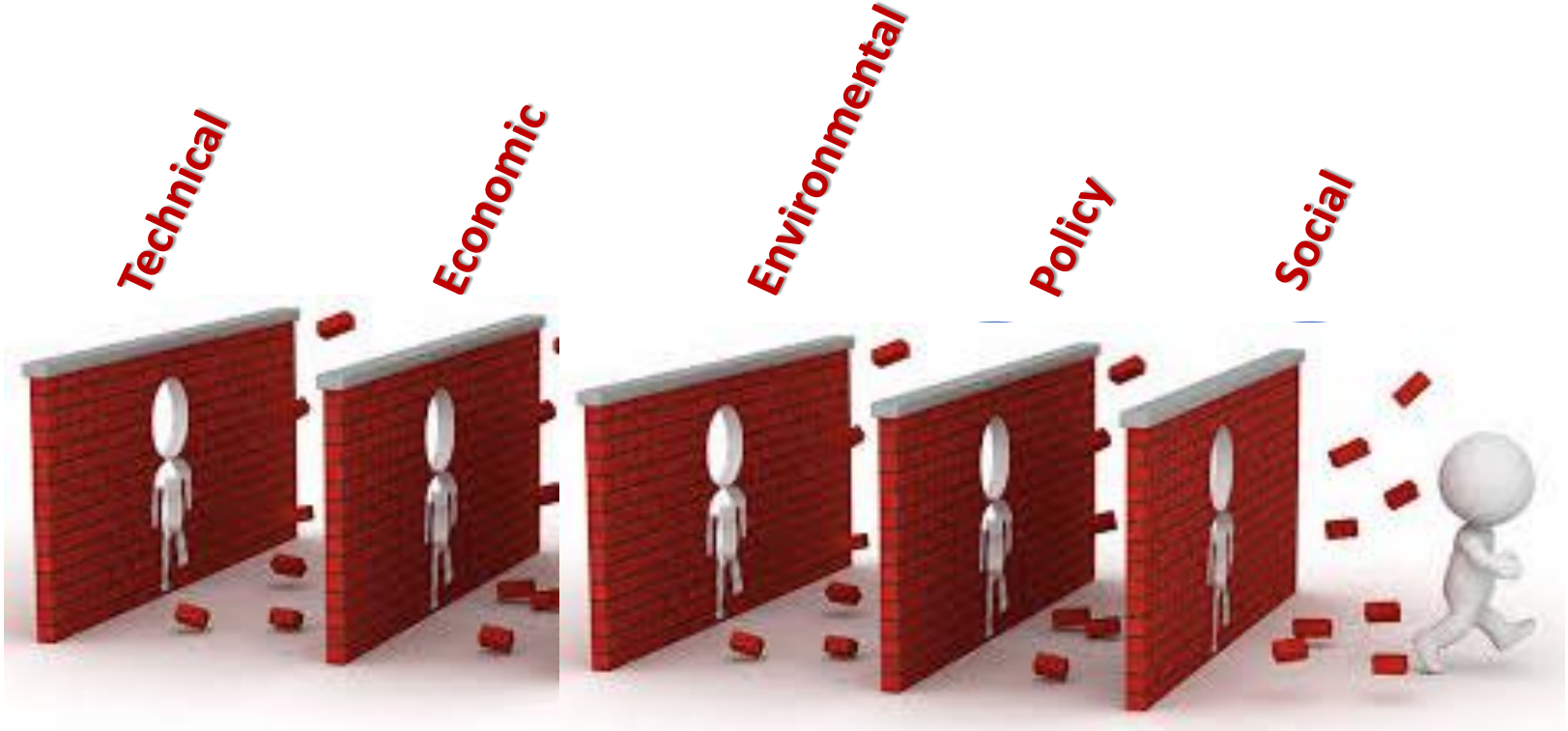
Conceptualising biomass biorefinery



Conceptualising biomass biorefinery



Barriers

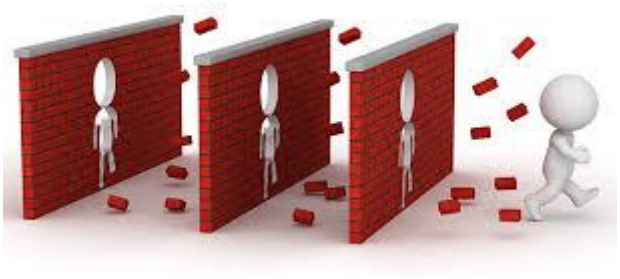


Technical barriers

- The collection network remains a challenge as it is an unorganized sector, so efforts should be made to render it much faster and easier.
- The scale-up design should ensure reliable and continuous supply of feedstock.
- The purification of end-products should be ensured.
- The quality of end-products should meet the product's specifications and standards.
- Regarding biofuel products, their compatibility with the conventional fuel distribution network is of vital importance.

The successful commercialisation of the integrated process requires favourable economics for each step along the value chain from biomass/biowaste to added-value products.

Barriers



ECONOMIC BARRIERS

- Feedstock Costs
- Storage and Delivery
- Feedstock Conversion Technologies and Costs
- Infrastructure Investments for Biorefineries
- Infrastructure Investments for end-product Distribution

POLICY BARRIERS

- Blend Wall
- Uncertainties in Government Policies
- Nonfederal Laws, Rules, Regulations, and Incentives Affecting Biomass Energy

ENVIRONMENTAL BARRIERS

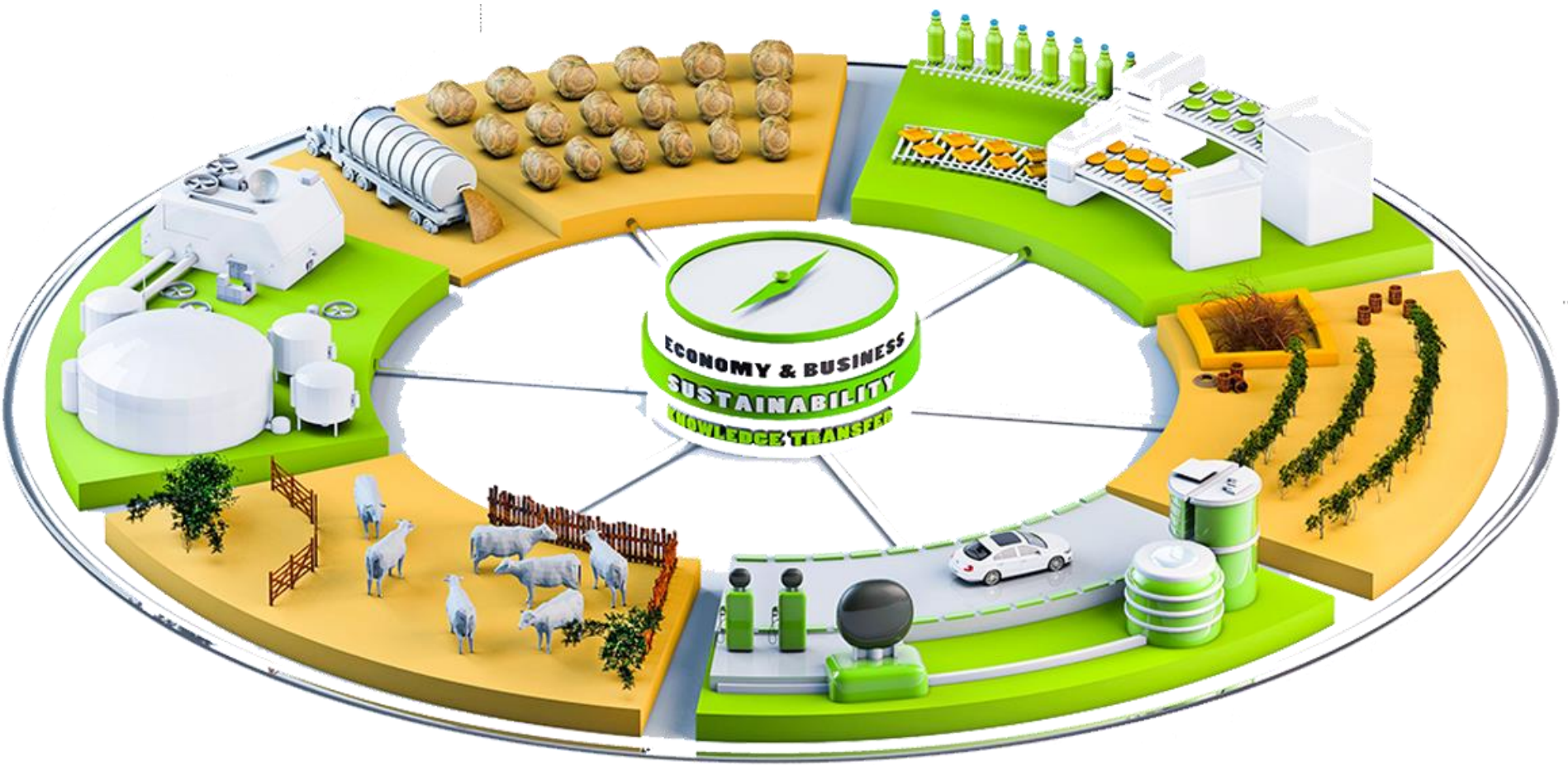
- Life-Cycle GHG Emissions
- Air and Water-Quality Effects from Biorefineries
- Water Use for Irrigating Feedstock and in Biorefineries

SOCIAL BARRIERS

- Knowledge, Attitudes, and Values of Farmers and Forest Owners
- Consumer Knowledge, Attitudes, and Values about Biofuels
- Information and Outreach

Current Research Projects in UEST

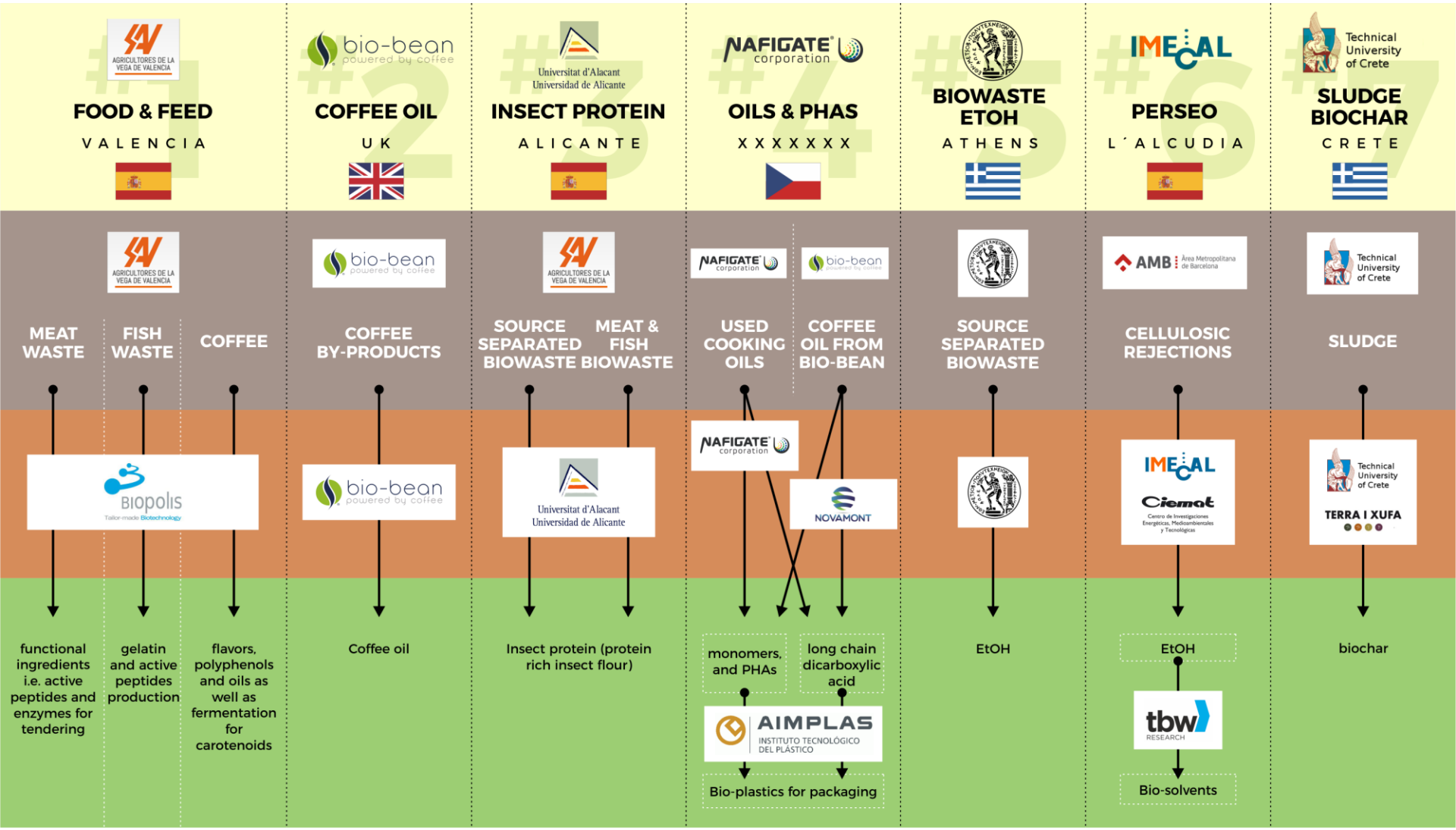
Innovative approaches to turn agricultural waste into ecological and economic assets



HORIZON 2020

NoAW
ID: 688338

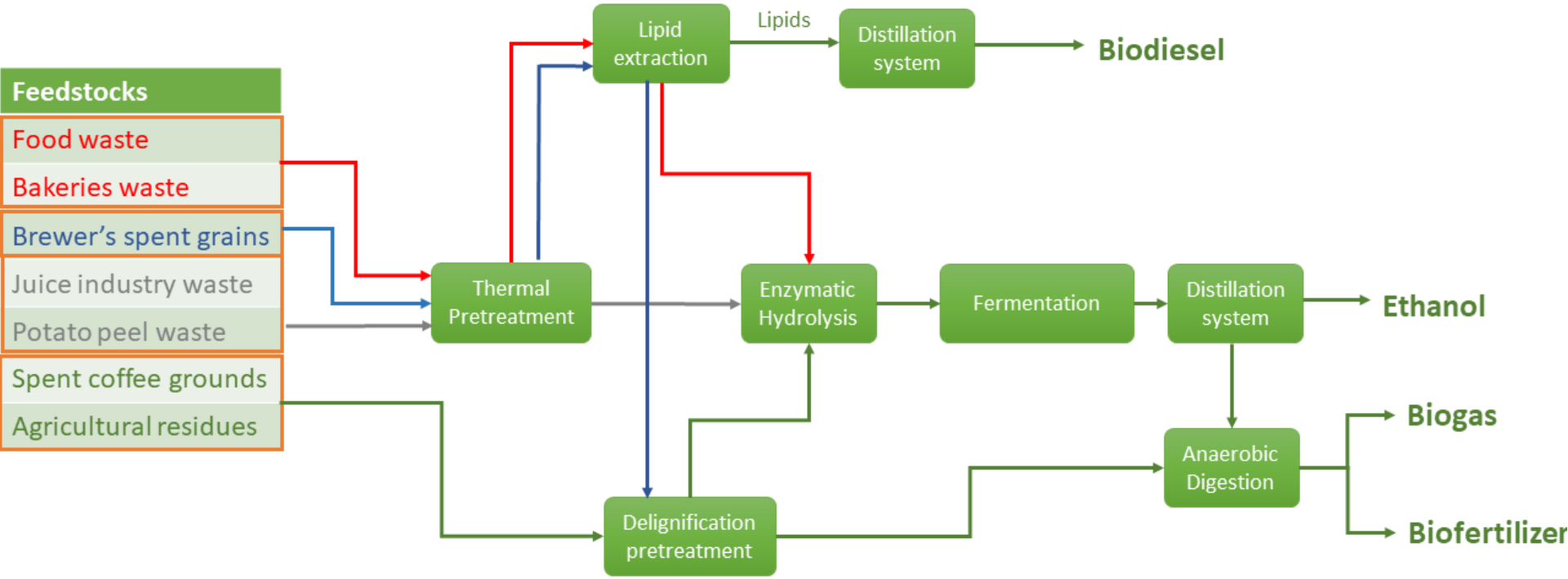
Value chains for disruptive transformation of urban biowaste into biobased products in the city context



HORIZON 2020

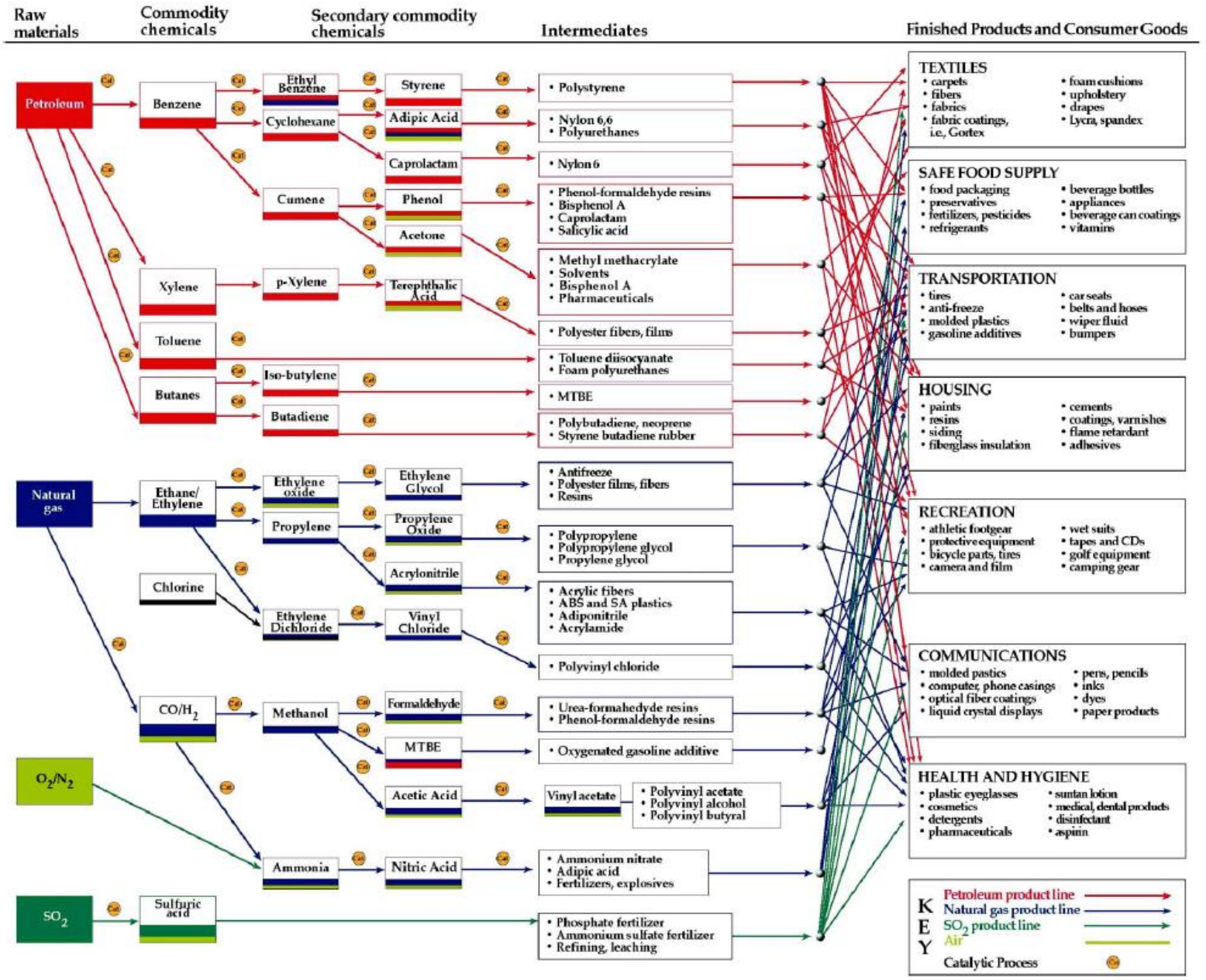
WaysTUP

A circular economy system for multi-source biomass conversion to added value products

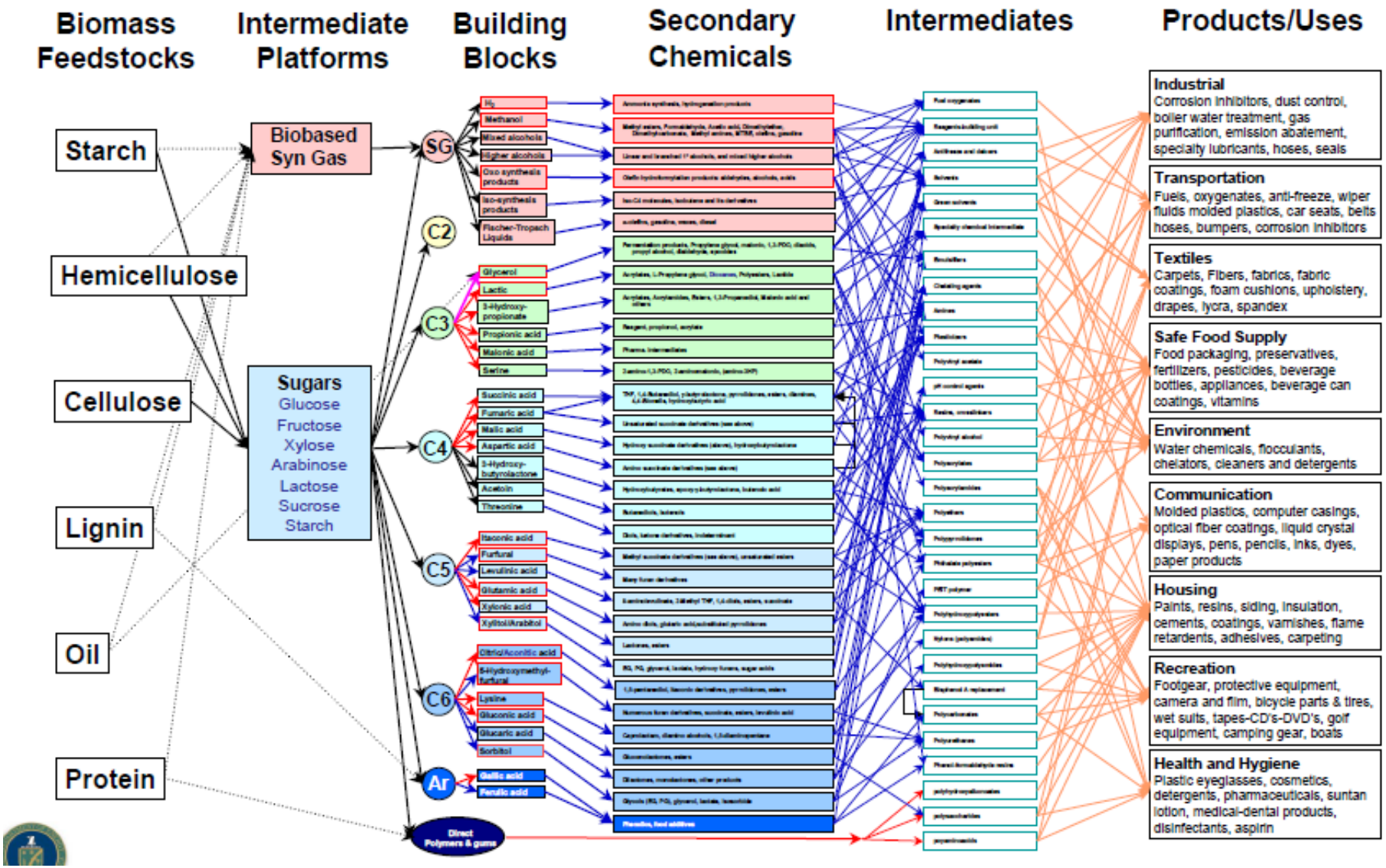


LIFE CIRCforBIO
LIFE18 CCM/GR/001180

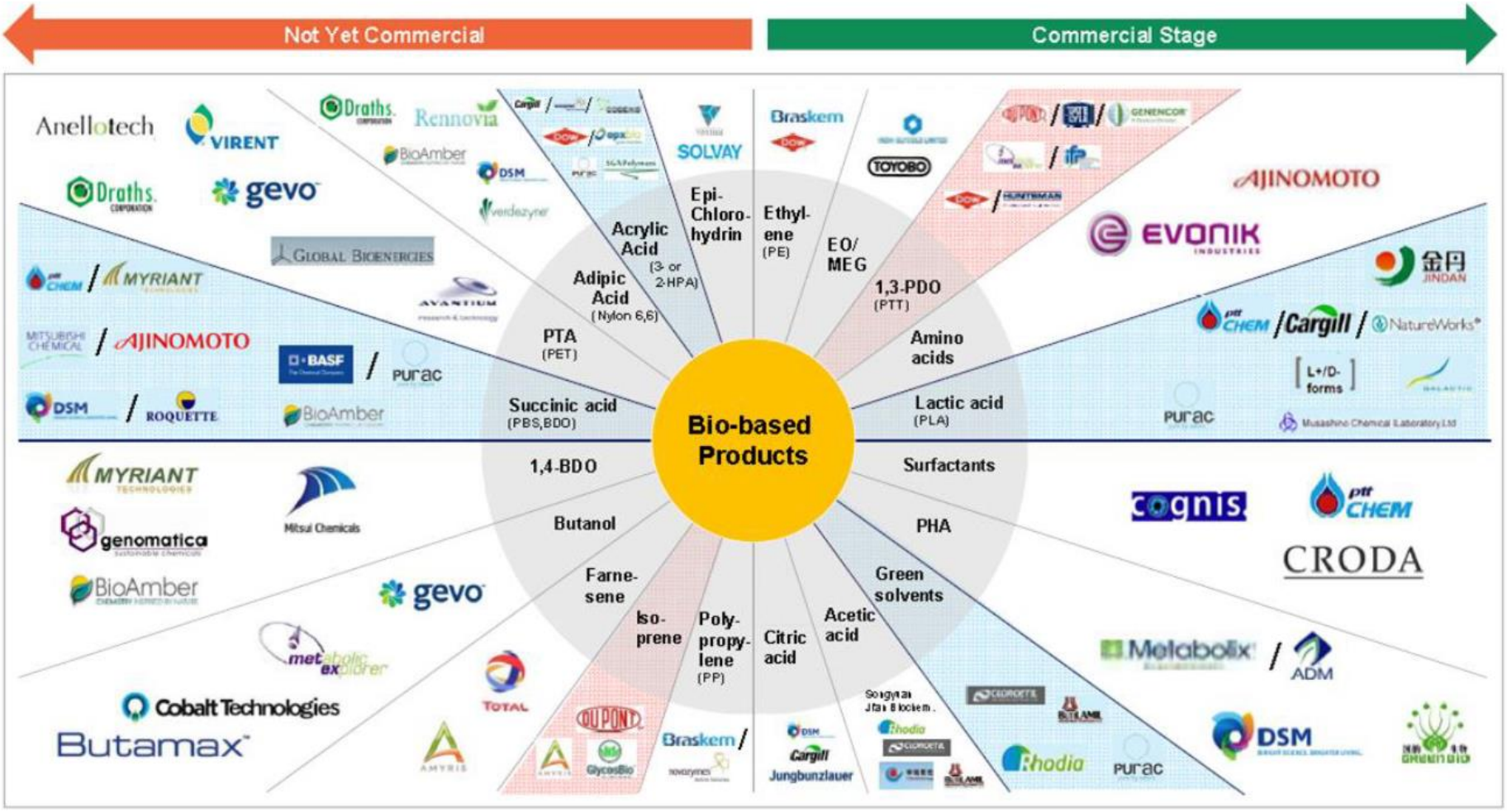
Flow-Chart for Products from Petroleum-based Feedstocks



Bio-based Product Flow-chart for Biomass Feedstocks



Biomaterials competitive landscape



Conclusions

Huge, unexploited flows of biowaste

Development of integrated biorefineries

Appropriate technical, economic and scientific strategies in multi-disciplinary approach can help to develop a sustainable biorefinery by addressing the circular bioeconomy goals and bridging the gap between waste remediation and product recovery.

THANK YOU FOR YOUR ATTENTION!

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