



**POWER4BIO**  
REGIONS FOR  
BIOECONOMY



*POWER4BIO webinar series: Food & Feed, session 2. 28 October 2020, 10 am CET*

Technical examples on added value generation

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# Added value generation

- Value generation through:
  - cost price reduction (cheap sourcing from biomass side streams, waste reduction)
  - new application with higher value (e.g. feed → food, healthier)
- Valorising food processing side streams:
  - feed
  - food ingredients: extractions of valuable compounds
  - biobased applications
- Some examples with oil to start with
  - Residues from feed to added value



# Cake and meals from oils seeds oil extraction (soy bean, rape seed, palm, ...)



## Common solution!

### Drivers:

- feed demand (increasing livestock production in Europe),
- nutritional value for feed (including complete amino acid composition of soybean proteins),
- attractive cost price (economic value of extracted soybean oil is approximately equal to that of the cake),

### Success conditions:

large volume (economies of scale), commodity market or direct link to local market, cheap protein source (farmer benefits)

### Drawback/hurdles:

antinutritional factors, which limit dosage per ingredient: already partly solved by e.g. toasting

## Potential following steps:

- separate protein from fibre fractions (however, not economical feasible for animal feed).
- upgrading the use: application in food instead of feed. Current drawbacks:
  - consumer appreciation; strategies: product development
  - suboptimal efficiency of protein extraction/isolation; strategies: separation technology development, using less purified ingredients

# Valorisation of residues from fish processing



- High-fat fish: rendering (current practice)
  - fish oil (high value)
  - processes proteins (ingredient for fish and animal feeds)business case: OK

- Lean fish:
  - rendering  
-> low oil yield
  - business case: **not** OKcurrent use: bio-energy  
(= low value)



- Develop alternative valorisation chain:
  - mild separation process for high-quality proteins

## Drivers:

- price of fish protein and hydrolysates

## Success conditions:

- traditional fish oil & meal producer has access to significant volumes of fish residues already gathered
- fish processing residues can be kept food-safe (which is not the case for fish aimed for feed meal)

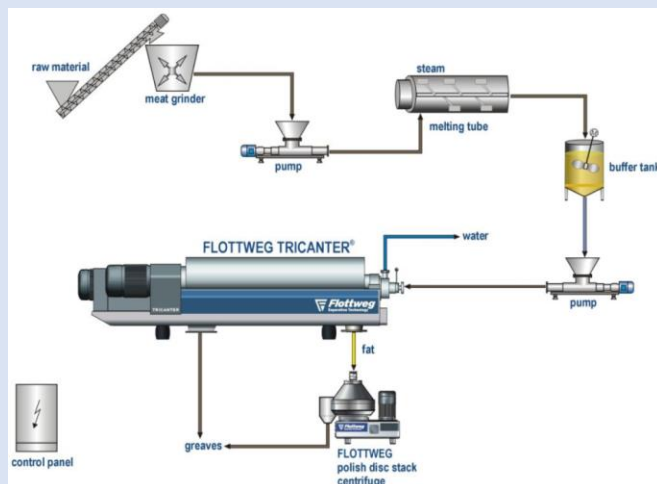
## Drawback/hurdles:

- integral challenge:
  - investing in process
  - developing applications
  - developing market



# Co-production of pig fat and gelatin (Ten Kate & Gelita)

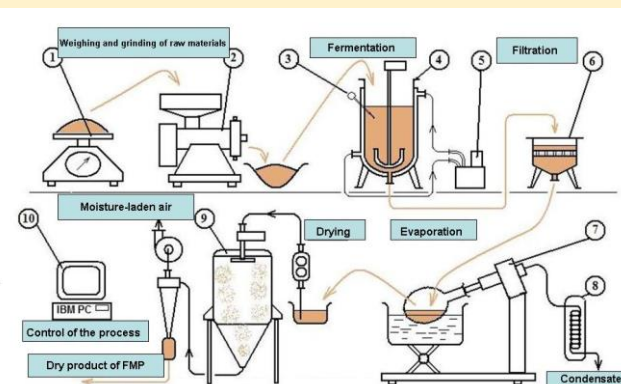
## Traditional fat rendering



High temperatures ->

- high fat yield
- low quality proteins (denaturated)

## Innovative, mild separation



Mild temperatures ->

- high quality fat
- good quality proteins

High water use ->

- protein loss
- high waste water loads resolved:  
recovery of proteins from waste water

## Drivers:

- demand for non-ruminant gelatin (BSE crisis)

## Success factor:

- eager entrepreneur
- patented mild extraction process
- Market demand for non-ruminant gelatin

## Drawback/hurdles:

- -

# Production of avocado oil from reject fruits



## Drivers:

- Large volumes reject avocados
- Added value for farmers

## Success conditions:

- Olive oil extraction process is suitable for avocado oil
- Complementary seasonality
- Using same distribution channel

## Drawback/hurdles:

- Oil quality depends on fruit quality  
-> not all reject fruit can be used

# Citrus feed & oil from juice extraction

## Common solution!

### Drivers:

- feed demand (increasing livestock production in Europe),
- nutritional value for feed,
- creating value from waste
- co-production of citrus oil + feed

### Success conditions:

large volume (economies of scale),  
commodity market

### Drawback/hurdles:

drying costs (energy-efficient process only  
feasible with high volume)

## Innovative solutions:

### • PeelPioneers ([www.peelpioneers.nl](http://www.peelpioneers.nl)):

- citrus oil
- detergent
- food ingredients: dietary fibers (for a.o. meat substitutes and bakery)

### Drivers:

- market demand for specific technical functionality

### Success condition:

- partnering with suppliers & clients/users

# Valorisation of mango stones in Africa



- Common valorisation (countries with large-scale production):
  - oil extraction (kernel oils)
  - cake/meal: animal feeds
- Challenges for smaller production countries:
  - extraction technologies not feasible at small scale size
  - logistic chain does not exist
- Solution pathway:
  - connect to existing processing facilities (for example: shea butter extraction process)
  - connect to that logistic & market channel

## Drivers:

- More value generations

## Success conditions:

- Regional existence of shea butter extraction company:
  - extracting oil
  - marketing the oil

## Drawback/hurdles:

- investment in dedicated extraction plant at small scale not feasible





# Added value generation: side stream of inulin extraction from chicory

## Side stream *chicory root fibre*

- common use:
  - livestock feed
  - fertilizer
- considered alternative:
  - food fiber (satiety in drinks and cereal bars)



## Drivers:

- increasing added value

## Approach:

- scan on valorisation options
- study on added value (satiety) in food

## Drawback/hurdles:

- New product: small market volumes (expensive, lacking economies of scale)

# Food Biorefinery for protein side streams



Side streams from established food industry

Sustainability as additional driver

Cheese making: whey

Potato starch: protein rich liquid

Protein sources that were previously at best regarded as feed

# Potato residues: From waste to product



- AVEBE makes starch from potatoes
- Waste water was discharged into the canals
- Government and industry tried to put an end to the water pollution, technology was insufficient to be economically feasible
- 1900-1950: “Water pollution is part of industrialisation and a price that people pay for prosperity”

A nauseating stench rose from the canals. The watercourses were littered with dead fish floating on their backs, because the water was so filthy that it had become useless for animals and humans alike, even the pumps produce nothing but spoilt liquid

Quote from: Anthony Winkler Prins (1872)



# Potato residues: From waste to product



- Previous attempts were not successful
- New driver for innovation
- After World War II environmental awareness increased.
  - New laws: 1969: “Polluter Pays Principle”
  - Financial aid for research and reorganisation
- Technological progress
  - Traditional process: acid/heat/precipitate
  - New mild process: chromatography → native, high value

# Solanic (AVEBE)

- Driver:
  - Upgrading waste streams to product: reducing (costs) of waste
  - Ambition total valorisation
- Success condition:
  - Technology
- Drawback/hurdles:
  - Market development was very hard



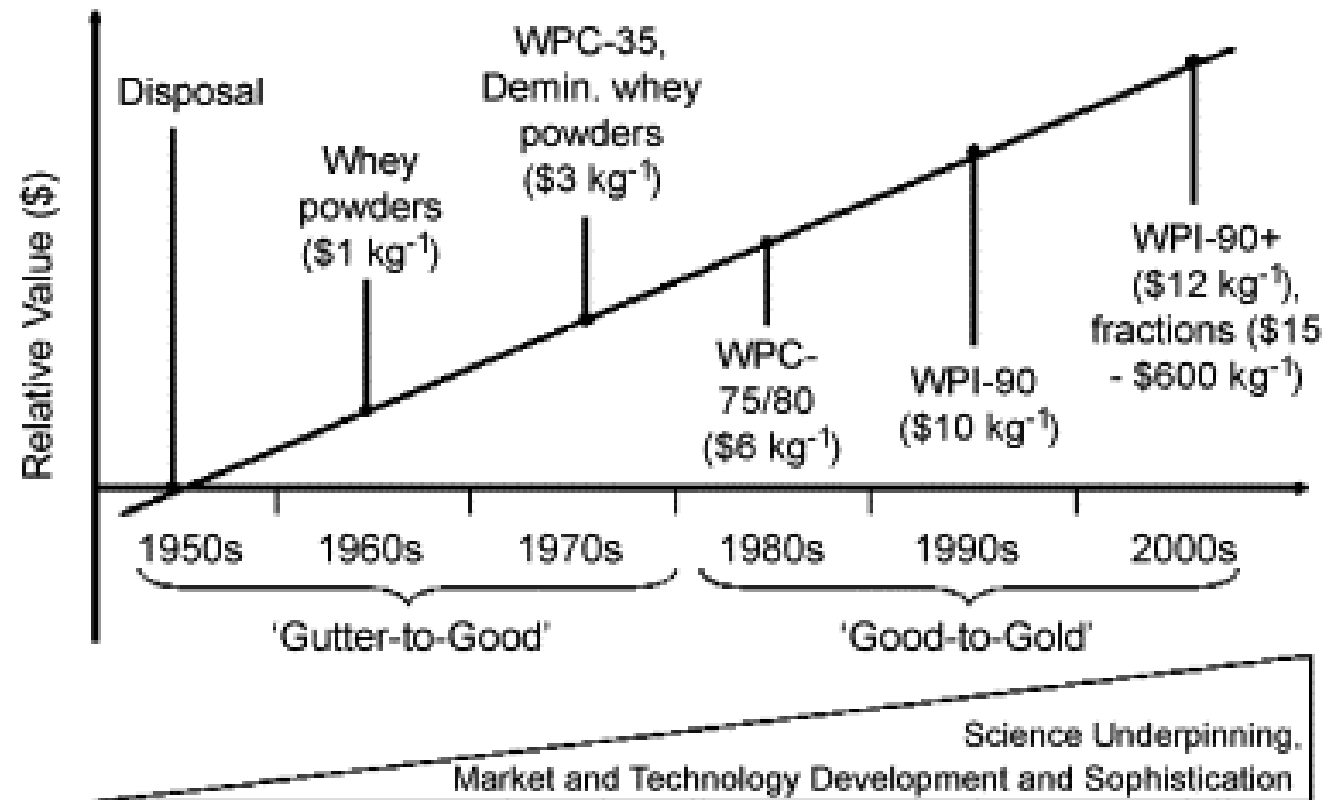
# Whey 'from gutter-to-good'

## Drivers for historic development

- Environmental regulations and legislation
- Scientific and technical advances: nutritional quality, physical and physiological functionality
- Process development: concentration, fractionation and dehydration
- Functional foods 'revolution'

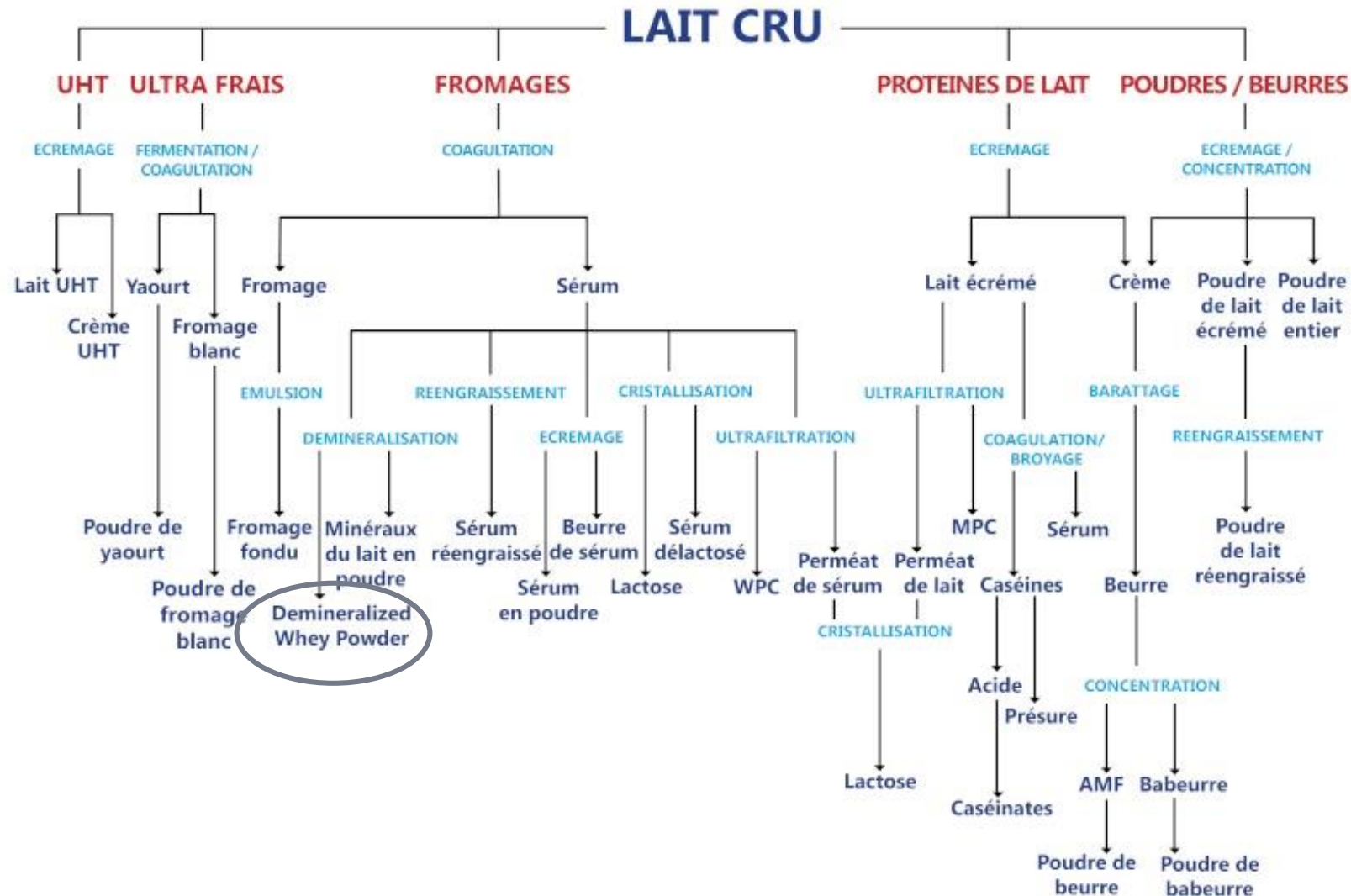


# Whey 'from gutter-to-good'



(Smithers, 2008)

# The milk cracking model



# Concluding: Whey & Potato protein

Protein sources that were previously at best regarded as feed.

Drivers:

- legislation became more strict (tax on bio-waste)
- approval by EFSA

Success factors:

- there were strong players in value chain in place for the crop's main product

Nowadays people want to start things from scratch (e.g. duckweed), this is way more difficult in biorefinery. In these cases it is important to establish the new source as a complete product first, before you can start a biorefinery concept on it.

# The Surplus Food Factory



Driver/inspiration:

- Awareness of impact of food waste of event caterer (initiator)

Success factor:

- Large volume available at one place (processing plant),
- Marketing as a sustainable food product
- Social employment: people who have a distanced relationship to the mainstream labor force

Commercially still challenging





# Sidestreams from food to materials and chemicals





CIRCULAR **CARBON**

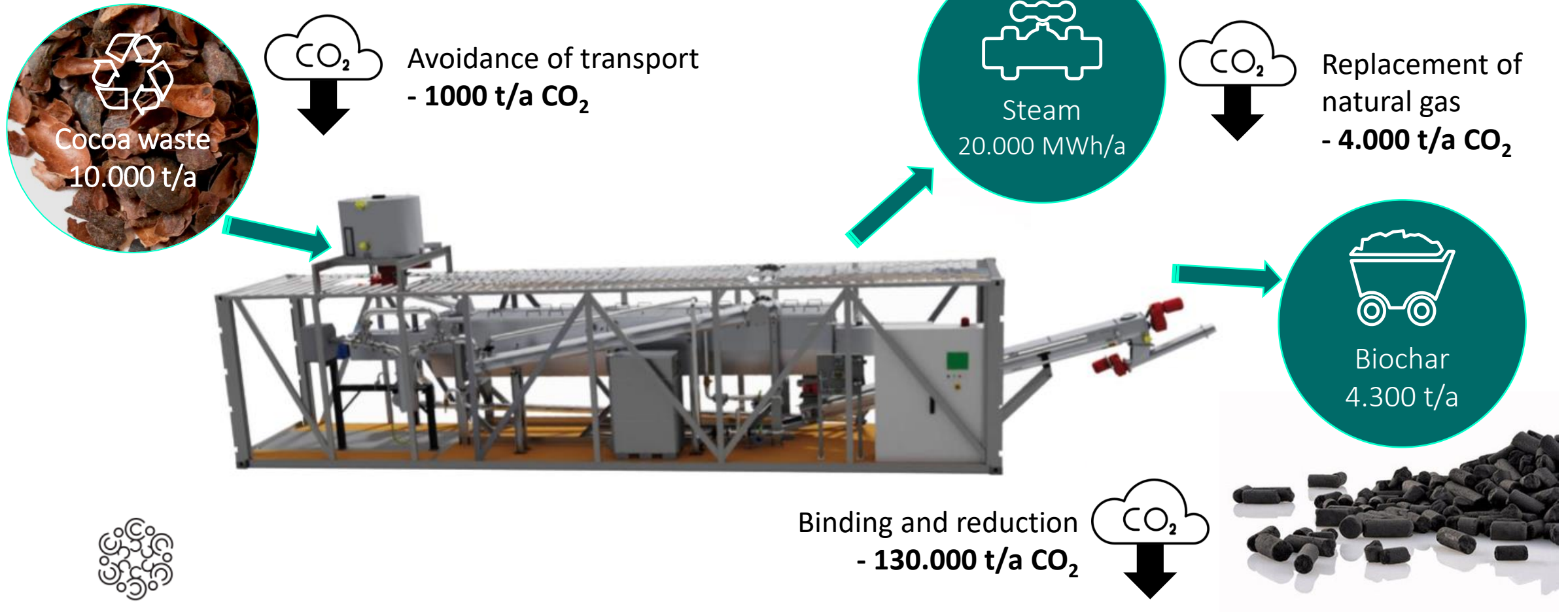


Waste to value in the  
Food Industry



# Energy supply and products made of residual materials - Circular Economy

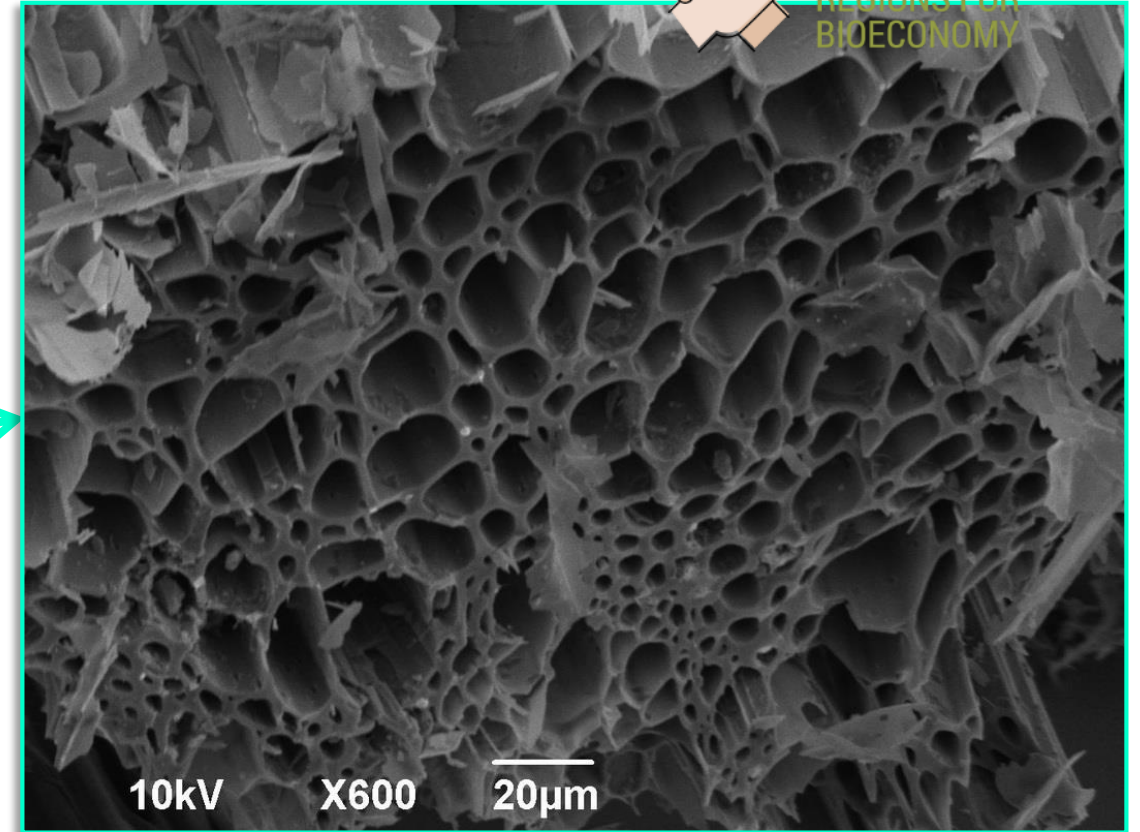
## Carbonation of the cocoa shells



CIRCULAR CARBON

# Biochar stores 5 times its Weight in Water

What is vegetable carbon?



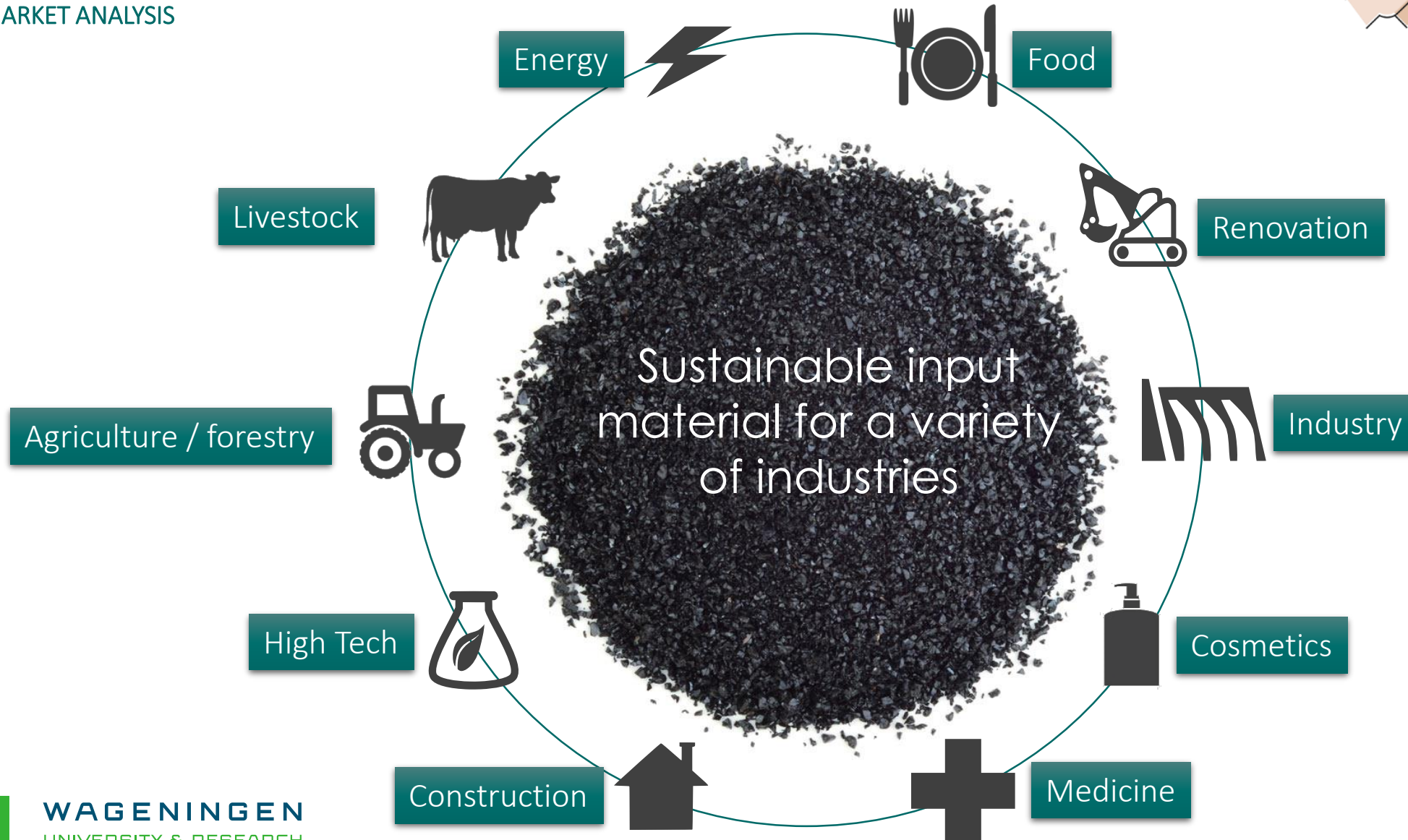
1. Increased **cation exchange effect** → Extended nutrient availability
2. Increased **REDOX potential** → Improved activity of microorganisms
3. High **water absorption capacity** (up to 500%) → Sponge effect

# 52 Applications for Biochar

MARKET ANALYSIS



CIRCULAR CARBON





# Fermentation for fuel and chemicals



- Fuel from seaweed



- High value jet fuel from potato peels (BioJet Fuel project)
- PHA-production from the organic fraction of household waste



# Production of biopolymers from frying oil



- Example of HYDAL technology; Czech researchers and Nafigate
- Fermentation based on used food oil
- Polyhydroxyalkanoates (PHA)
- Polyhydroxybutyrate (PHB)
  - Biodegradable in water
  - Used in cosmetics (UV filter and peeling particles)



Coconut Peeling Milk

# Bio-oils from by-products

- BioOils in Andalusia (<https://bio-oils.com/productos/>)
- Main product: Biodiesel
- The basic raw material are vegetable oils and animal fats
- Bio Oils Huelva where a series of by-products are generated in the biodiesel manufacturing chain, which are also marketed by Bio-Oils: pastes or gums, fatty acids, glycerine.

# Food additives extracted from olive oil industry by-products



- Olive oil industry in Mediterranean: Over 7,000 kton/a of wastes / by-products
- Residues include olive pomace, olive stones and olive leaves. Limited outlets till recently.
- Residues contain high value compounds like polyphenols (Oleuropein), hydroxytyrosol and triterpenes (Oleanolic acid)
- Extracted for application in food, pharma and nutraceuticals.
- Solution based on conventional extraction technology

[https://power4bio.eu/wp-content/uploads/2020/04/POWER4BIO\\_D3.4\\_Best\\_practices\\_of\\_bio-based\\_solutions.pdf](https://power4bio.eu/wp-content/uploads/2020/04/POWER4BIO_D3.4_Best_practices_of_bio-based_solutions.pdf)

<https://bio-based-solutions.eu/#/project/90>

# Black soldier fly larvae & biorefinery

- Products: protein, oil, fertilizer
- Oil can be extracted for feed or transportation fuel production
- Skins of worms (larvae) can be used as fertiliser
- Proteins as a whole
- Converting perishable (GMP+) residue streams into black soldier fly larvae; dry protein rich feed for fish and pet food products with extended shelf life



[https://power4bio.eu/wp-content/uploads/2020/04/POWER4BIO\\_D3.4\\_Best\\_practices\\_of\\_bio-based\\_solutions.pdf](https://power4bio.eu/wp-content/uploads/2020/04/POWER4BIO_D3.4_Best_practices_of_bio-based_solutions.pdf) page 42



# Take home message

- Inspiring examples
- Added value creation
- Waste → Feed → Food
- Success conditions
  - Existing logistics for gathering biomass
  - Existing processing facilities for similar products
  - Existing channels for product sales; market size fits residue size
  - Enthusiast entrepreneur
  - Ability to take a loss in the start-up phase (investor, large company, shared facilities)

Thank you for your attention

Next session at 11 am CET

Session 3. Examples connected to sustainability ambitions,  
upcycling and complete biomass valorisation



More examples on added value in food will be presented in session 5



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# Bonus Material



- CIDAF video
- Product: bioactive compounds for food and pharmaceutical industry
- From food industry by-products (e.g. olive leaves, avocado and mango peels and seeds)

Thank you for your attention

Next session at 11 am CET

Session 3. Examples connected to sustainability ambitions,  
upcycling and complete biomass valorisation



More examples on added value in food will be presented in session 5 (Nov 4<sup>th</sup>)



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