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Biogas plant in biorefinery concept

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WASTE – WHAT TO DO WITH

- **EUROPEAN BIODEGRADABLE WASTE PRODUCTION $13 \cdot 10^9$ t_{TS} IN 2015**
  - agriculture residues, food wastes, biodegradable municipal solid waste, waste biomass from gardens,…
  - Typical usage = landfilling, combustion, composting, remain on field
- **DECRASE IN LANDIFILLED WASTE BY 65 % TILL 2020**

(European Commission, EU 99/31/ES)

WHAT TO DO WITH?

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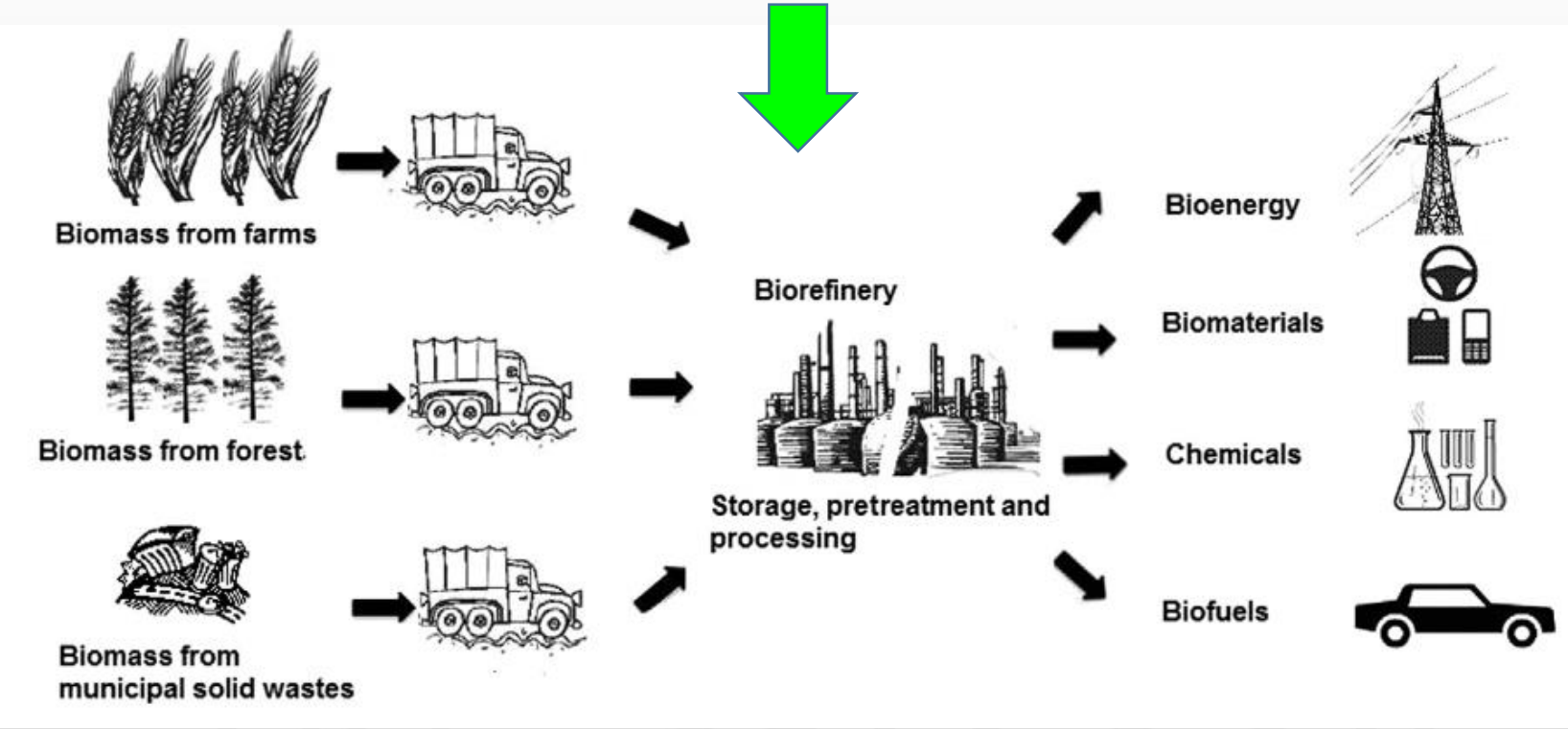
MOTIVATION FOR BIOREFINERY

- **THERMOCHEMICAL** *(GASIFICATION, PYROLYSIS)* **AND BIOCHEMICAL** *(ALCOHOLIC FERMENTATION, BIOMETHANE, BIOHYDROGEN,...)* **TREATMENT OF WASTES**

WHATO TO PRODUCE, HOW TO TREAT IT, LARGE-SCALE APPLICATION?



BIOREFINERY = ENVIRONMENTALLY FRIENDLY MULTI TECHNOLOGICAL TREATMENT PARALELLY PRODUCING BIOPRODUCTS, BIOFUELS AND BIENERGY

WASTE – HOW TO USE IT?

- **WASTE BIOMASS => ALTERNATIVE ENERGY *(BIOOIL, SYNGAS, BIOMETHAN, BIOHYDROGEN, BIOETHANOL)* AND BIO-CHEMICALS *(SACCHARIDES, ALCOHOLS, ACIDS, FIBRES, ANTIOXIDANTS, ESSENCIAL PRODUCTS, OILS…)***

EXAMPLES ?

- **PRESSED PEELS OF GRAPES – RICH FOR AMYLACOHOLS AFTER FERMENTATION** *(AMYLALCOHOLS = SOFTENER FOR PLASTICS)*
- **CELLULOSIC FIBRES – REINFORCEMENT OF BIOCOMPOSITES**
- **RICE PEELS – RICH FOR SIO2 –> PRODUCTION OF SILICON CARBIDE FIBRES -> CERAMIC REINFORCEMENT OF COMPOSITES**
- **OIL WEED -> EXTRACTION, BIO-DIESEL PRODUCTION**

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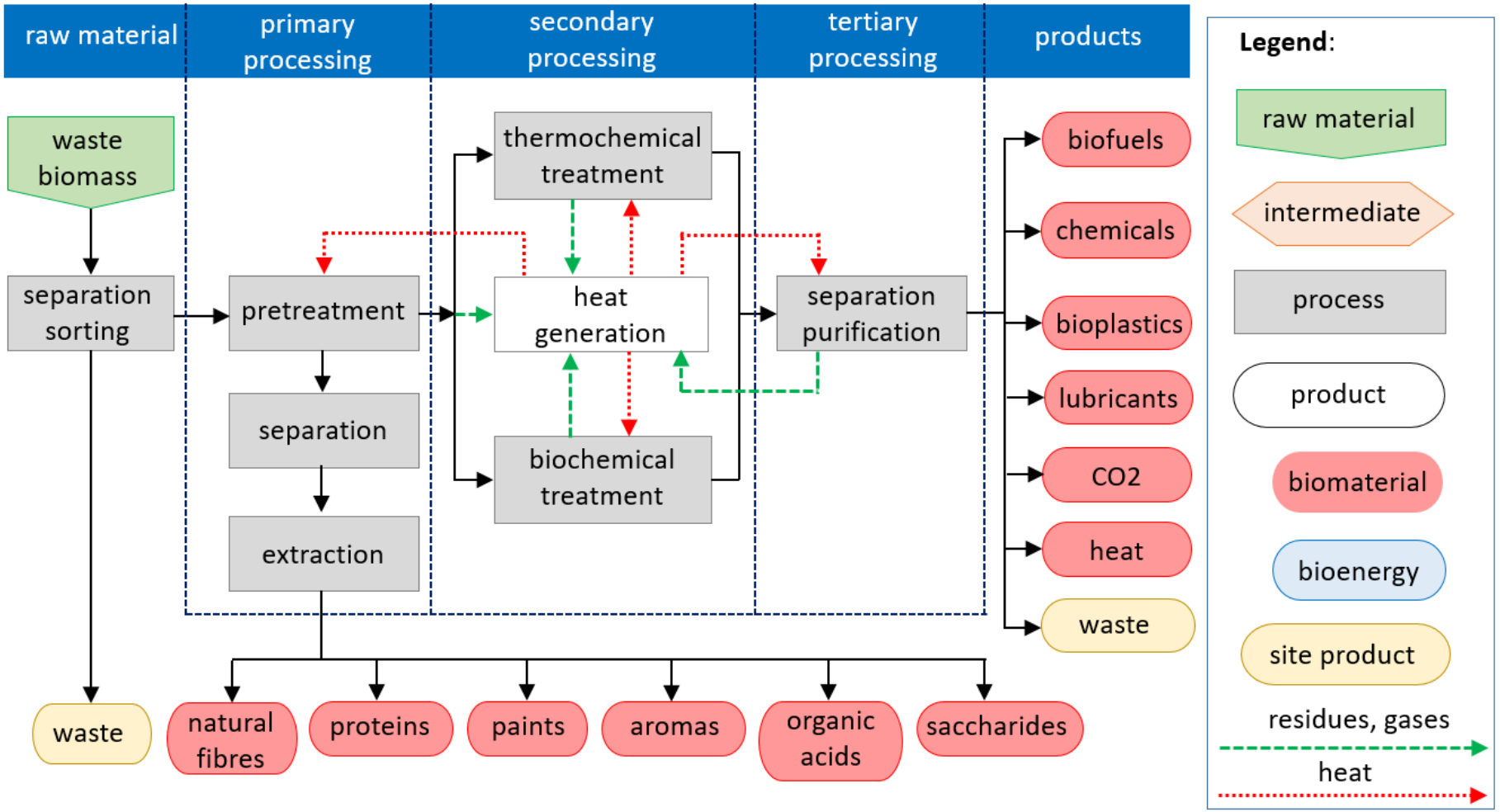
BIOREFINERY CONCEPT



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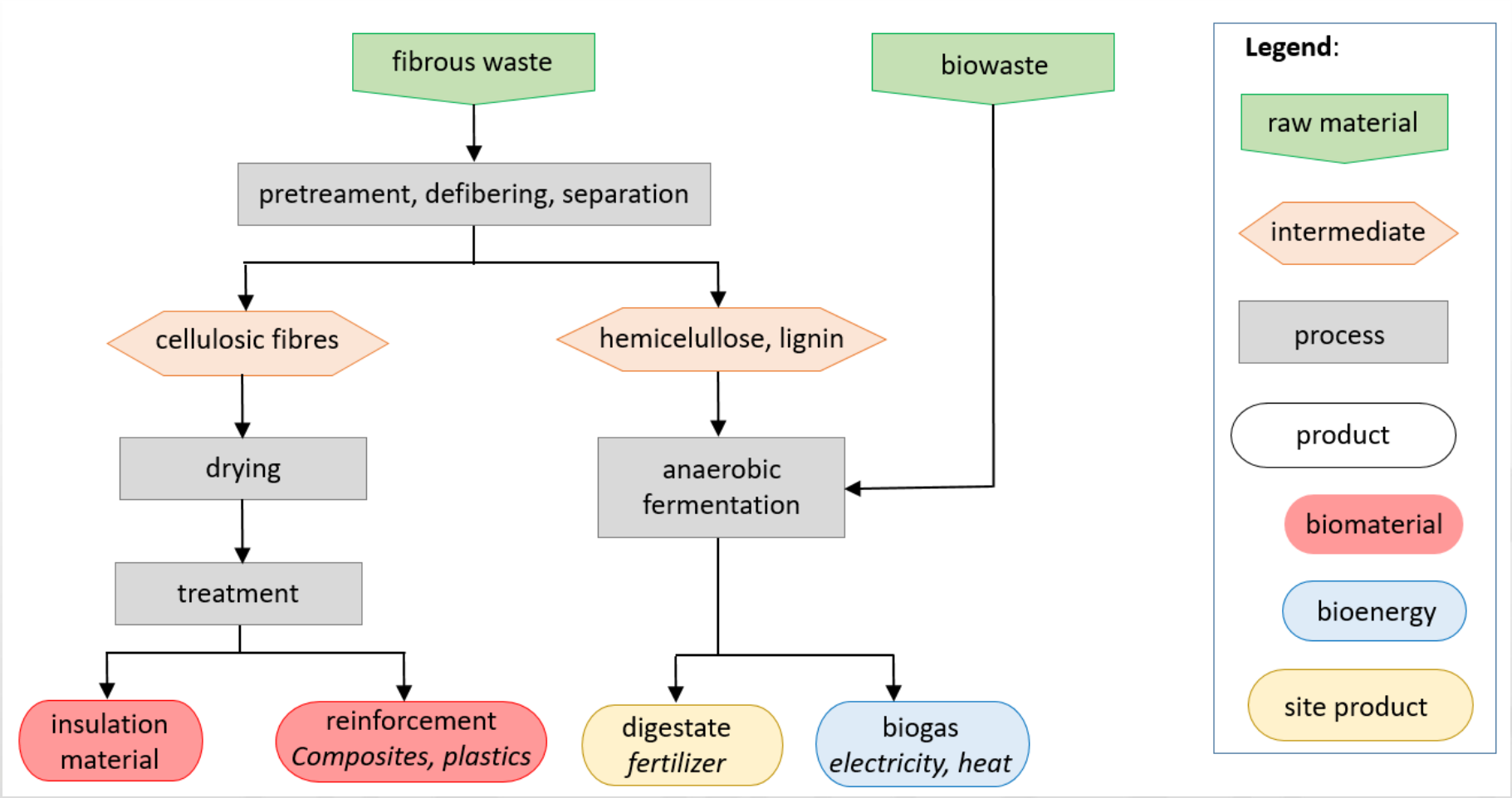

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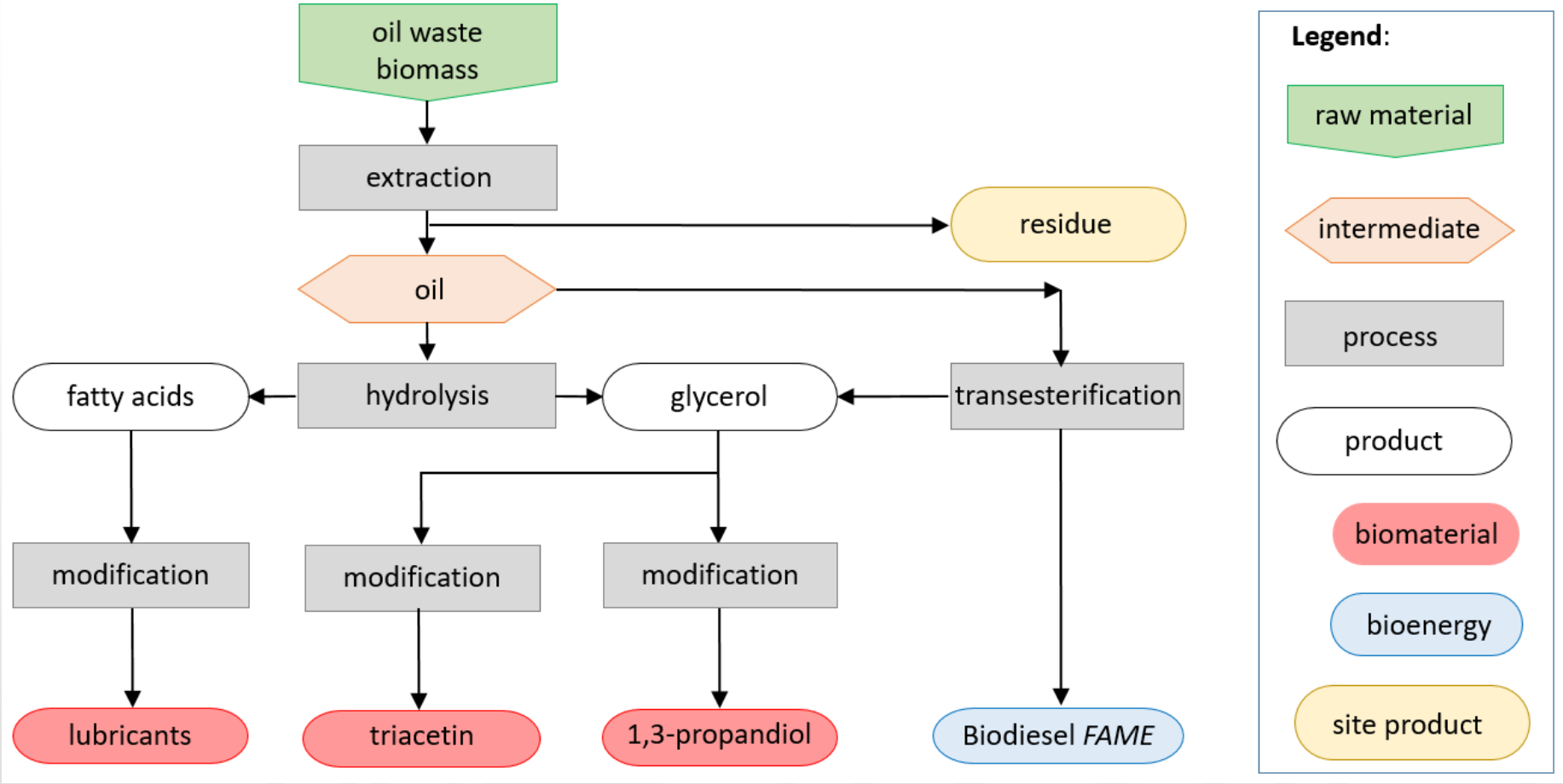

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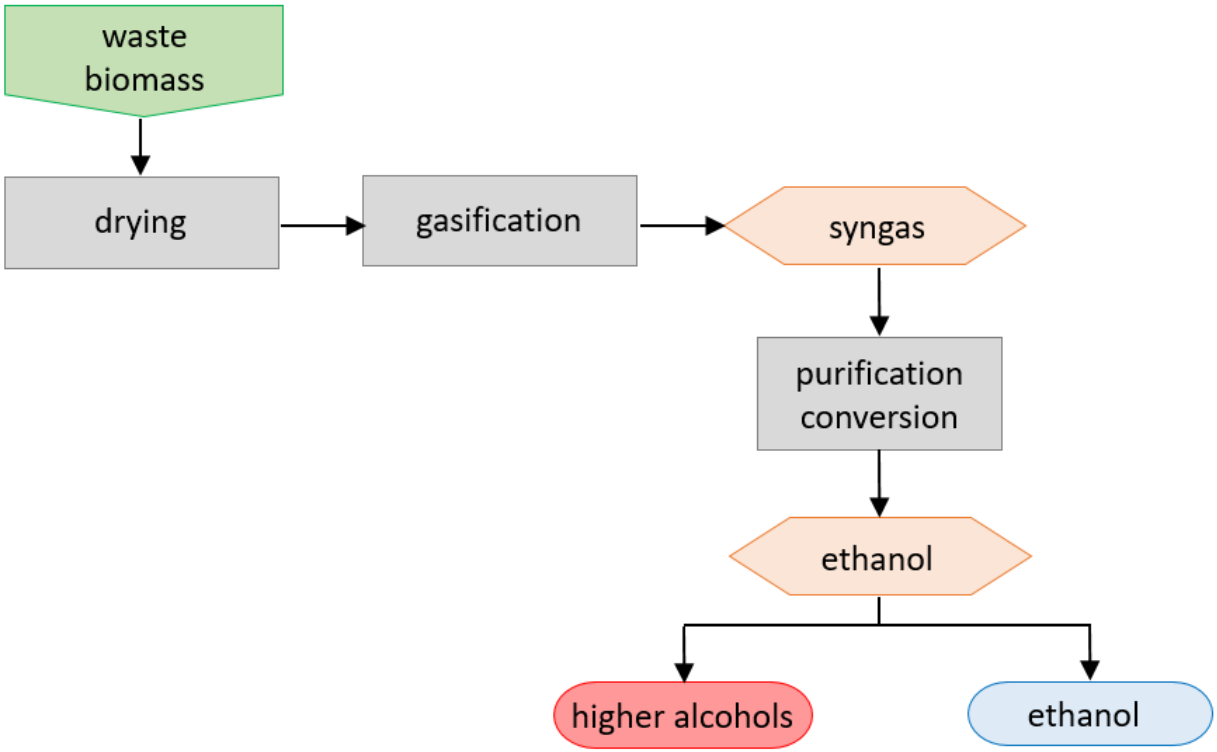

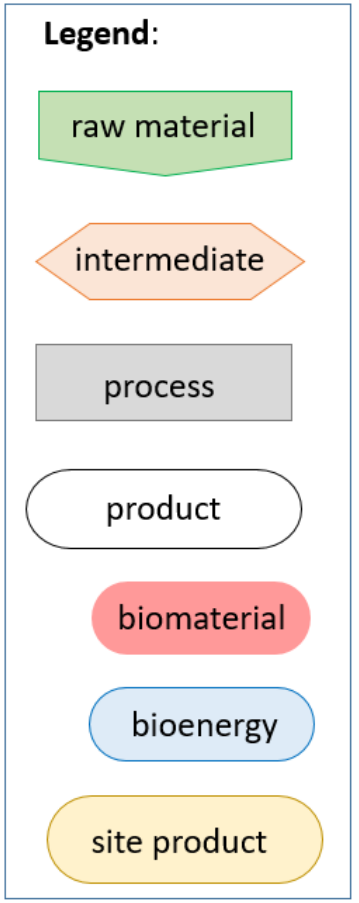

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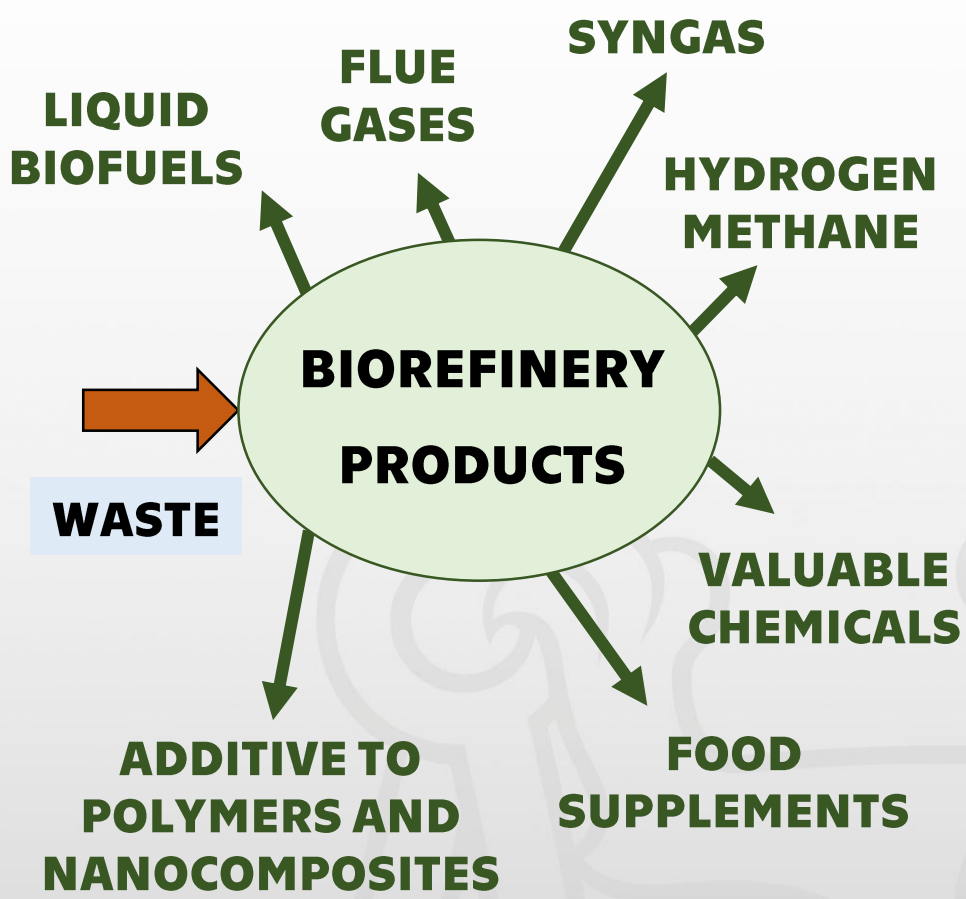
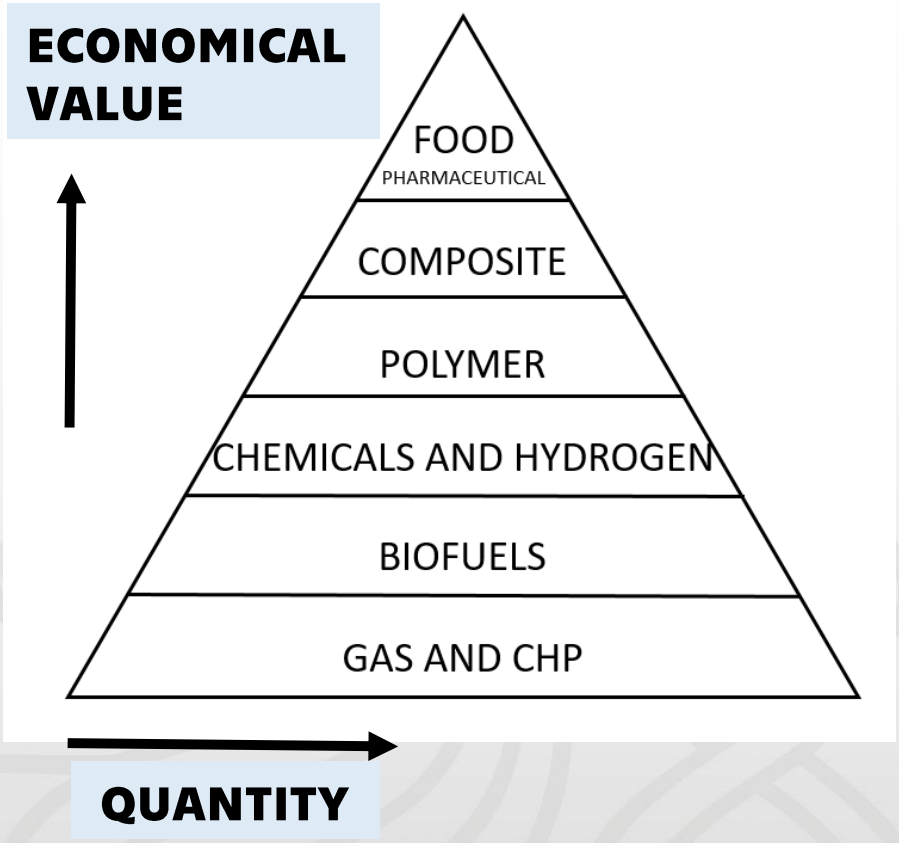
BIOREFINERY´S ECONOMY





HOW TO OPERATE ECONOMIC FEASIBLE TECHNOLOGY WITHOUT SUBSIDIES?

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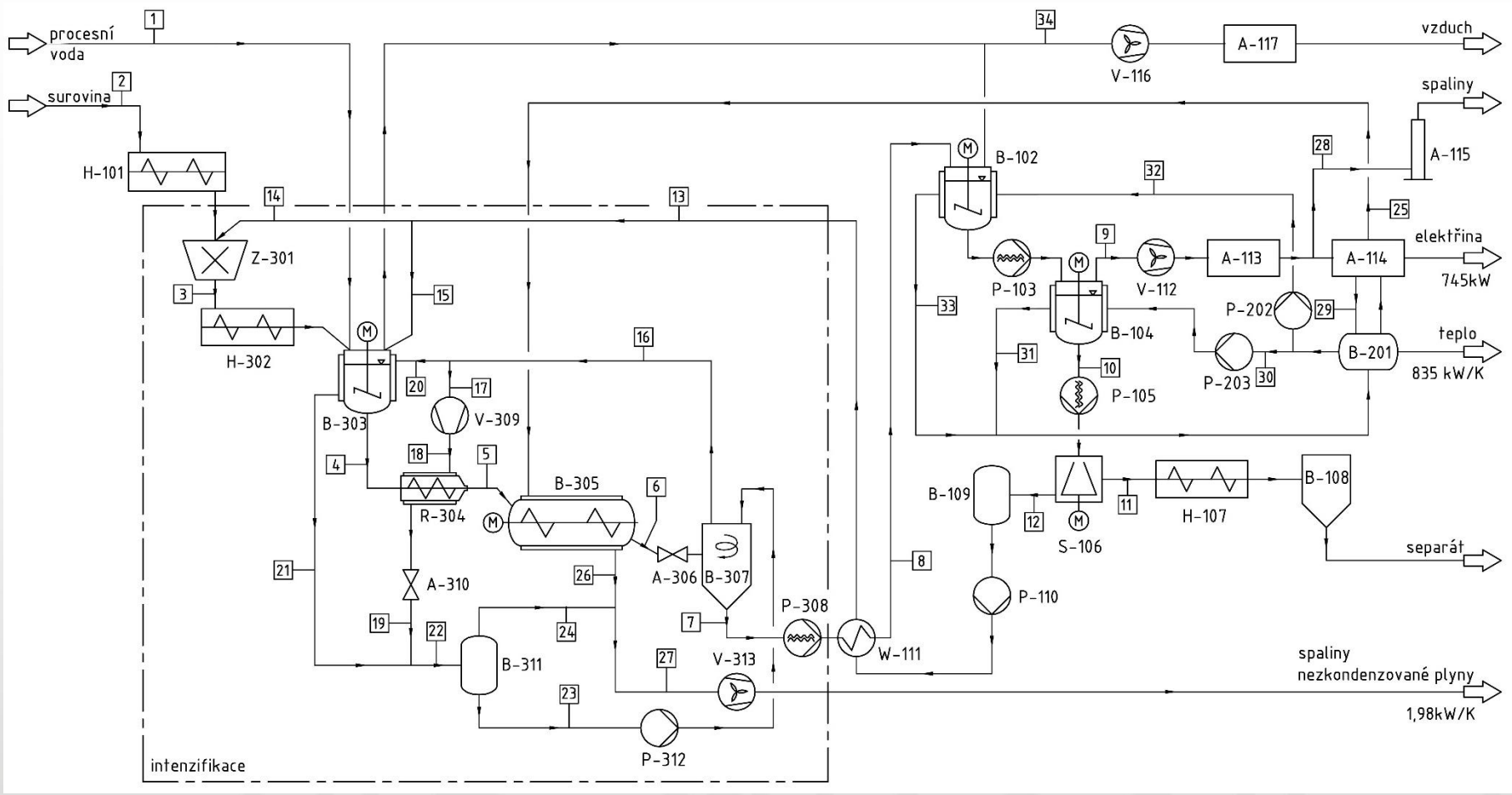
BIOREFINERY CONCEPT



TECHNO-ECONOMICAL FEASIBLE STUDY

BIOREFINERY´S ECONOMY

INVESTMENT COST = ISBL + OSBL + DE + EaE

ISBL – price of apparatuses

OSBL – technology´s installation

OSBL~ 20-40 % ISBL

Piping systems, electricity, engineering networks, building, insulation, paints

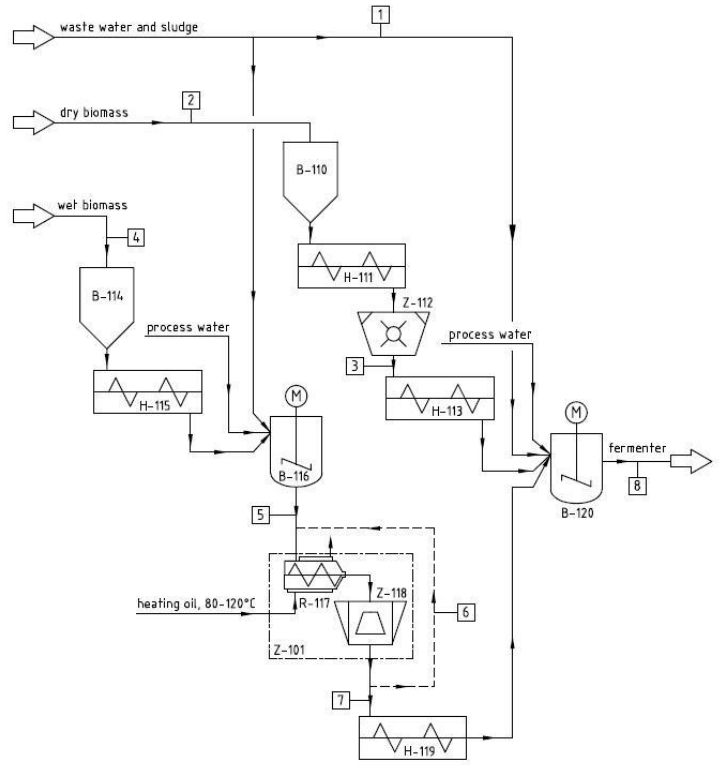
DE – design and realization

DE ~ 0.1*(ISBL+OSBL)

EaE – financial reserve

EaE ~ 0.1* ISBL

Fluctuation in material prices, design and realization work



	PROCESS STREAMS							
	Biomass input 1	Biomass input 2	Milled biomass 3	Biomass input 4	Biomass extrusion 5	Circulation loop 6	Milled biomass 7	Biomass to process 8
moisture (%hm)	–	4–20	4–20	>20	>30	–	–	88–92
dry matter (%hm)	–	80–96	80–96	<80	<70	–	–	8–12
particle size (mm)	–	–	1–2	–	–	>10	< 10	<10
temperature (°C)	–	–	–	–	–	–	50–80	30–40

BIOREFINERY´S PRODUCT COST

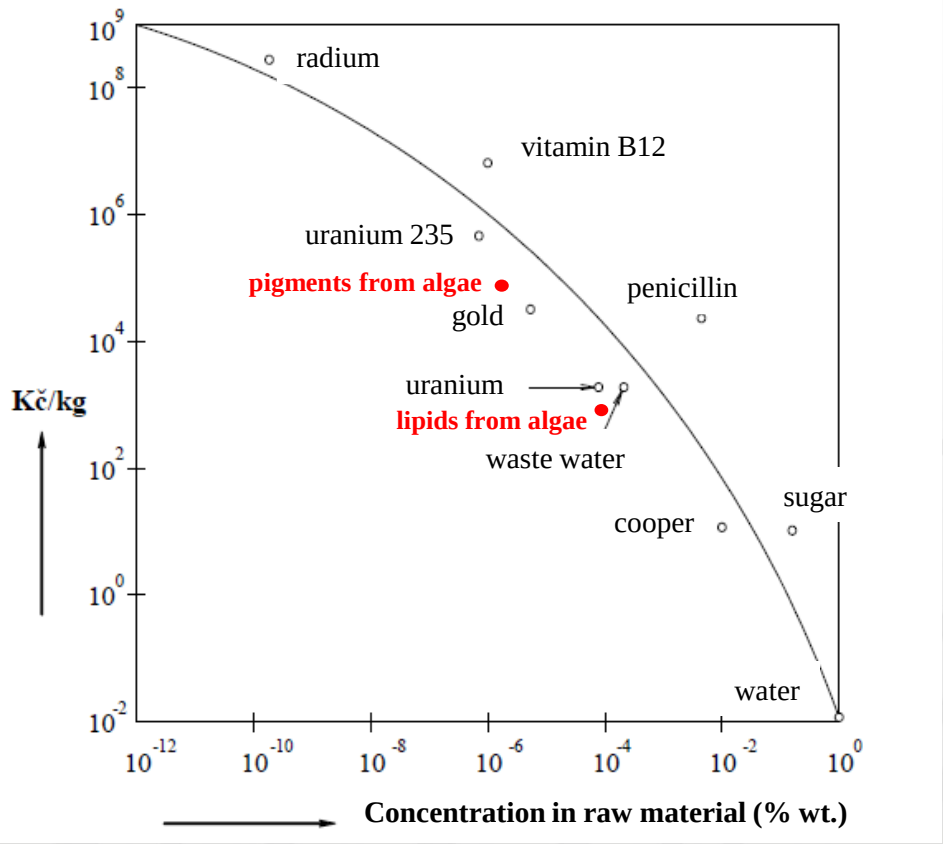
TOTAL PRODUCT COST = OP + GEN

OP- OPERATIONAL COST

- *consumables, operating, supervision, energy, service and maintenance, insurance, rates, rents and taxes…*

GEN- GENERAL COST

Wages, advertising, transport,…



SIMPLE PAYBACK TIME = INV/CSF

INV=INVESTMENT COST; CSF=ANNUAL CASH FLOW

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BIOREFINERY´S COST

DEMAND TO TECHNOLOGY

- **HIGH CONVERSION EFFICIENCY**
- **EASY PROCESS,** ***NO OR SIMPLE PRETREATMENT***
- **NO DEGRADATION OF PRODUCTS**
- **MINIMUM WASTE GENERATION**
- **MINIMUM ENERGY DEMAND**
- **HEAT RECOVERY SYSTEM**
- **MINIMUM USAGE OF CHEMICALS**

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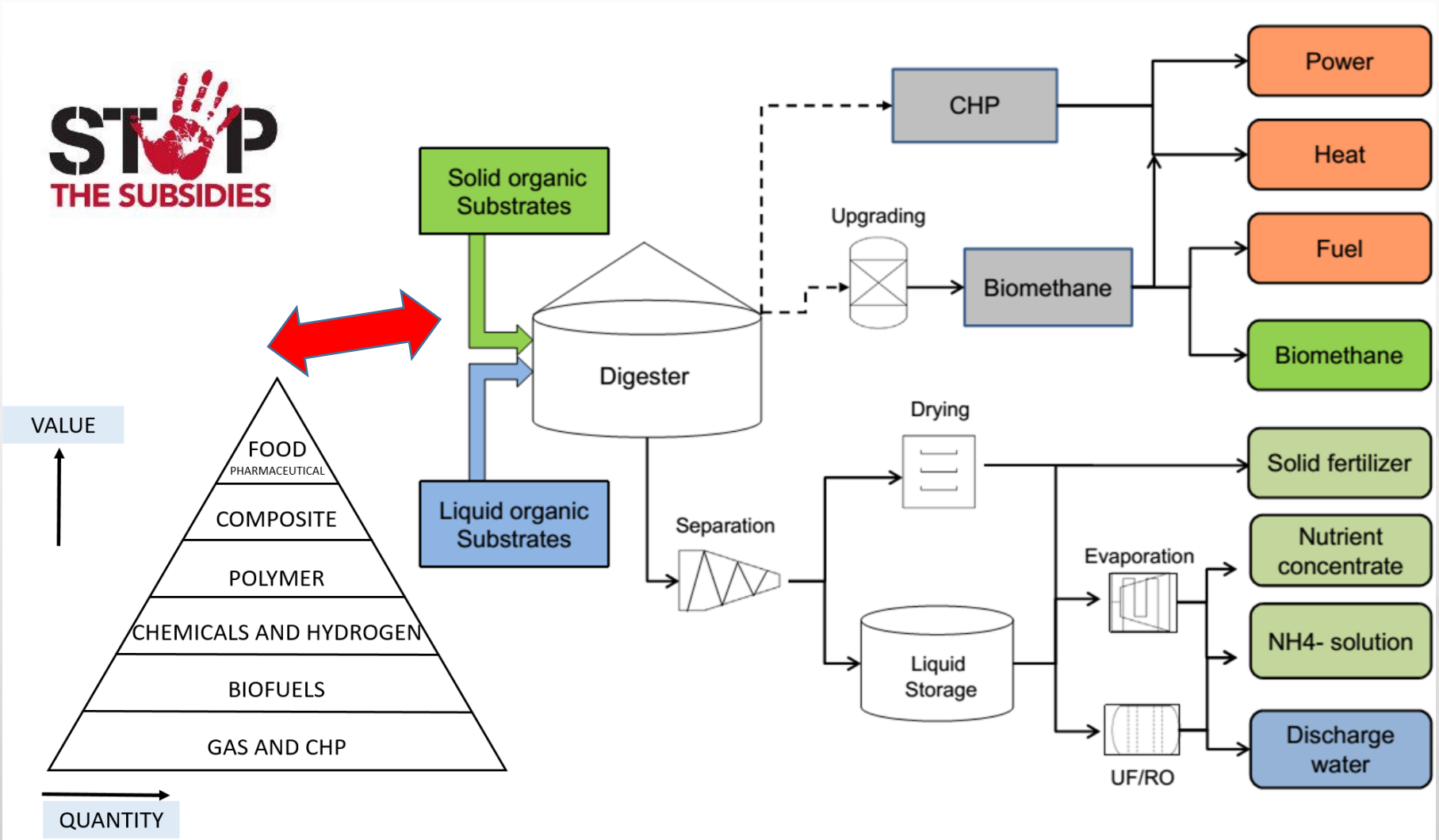
BIOREFINERY´S COST

DEMAND TO APPARATUSSES

- EASY CONTROL, SERVICE AND MAINTENANCE
- CORROSION RESISTANCE
- MINIMUM OF EXPENSIVE MATERIALS AND SPECIAL PARTS
- COMPROMISE – WORKING VOLUME TO PRICE OF EQUIPMENT
- LOW FINANCIAL DEMAND IN INVESTMENT AND OPERATION

CONVENTIONAL BIOGAS PLANT

IS THERE POSSIBILITY TO REACH PROFIT WITHOUT SUBSIDIES ?



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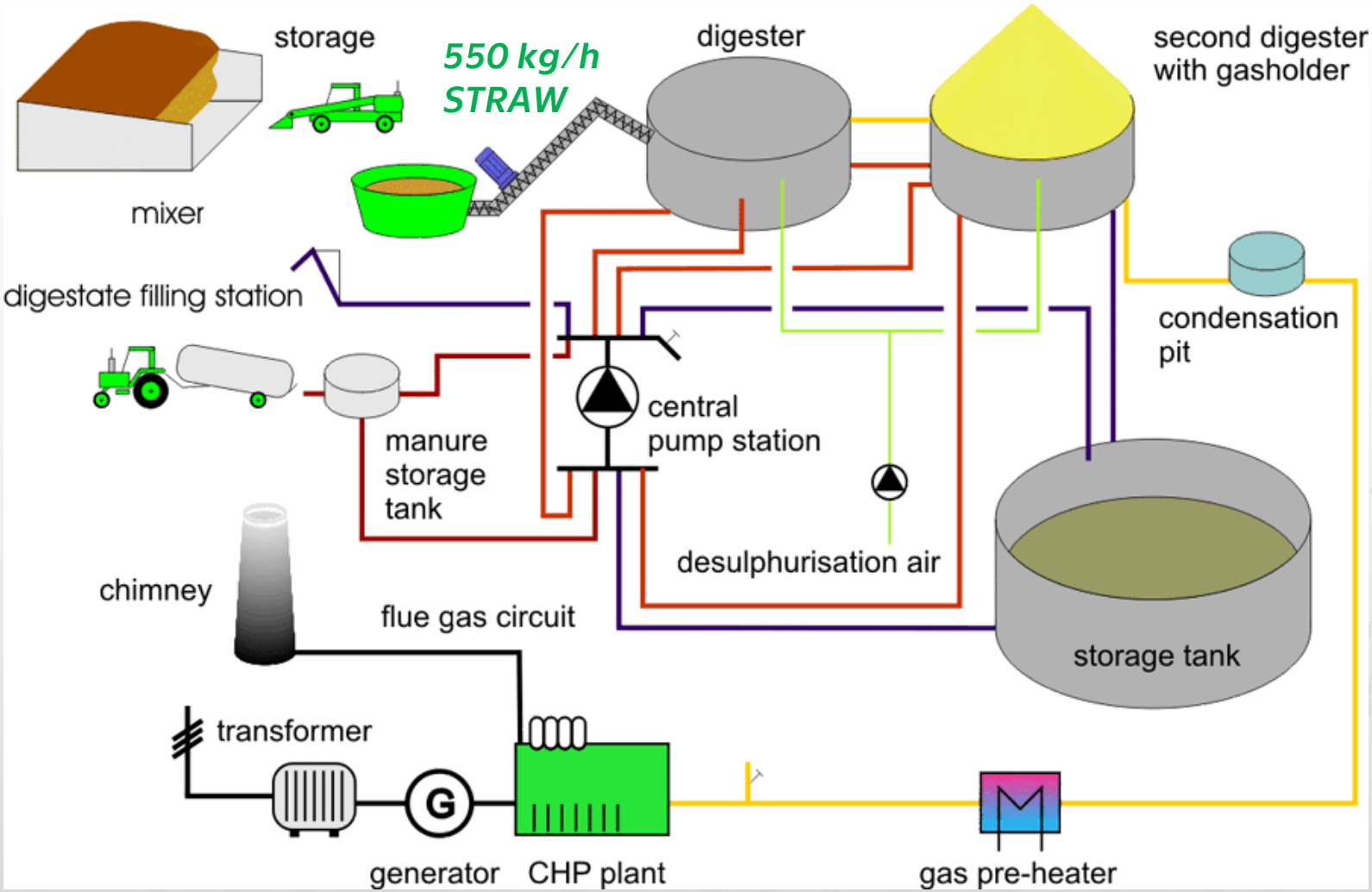
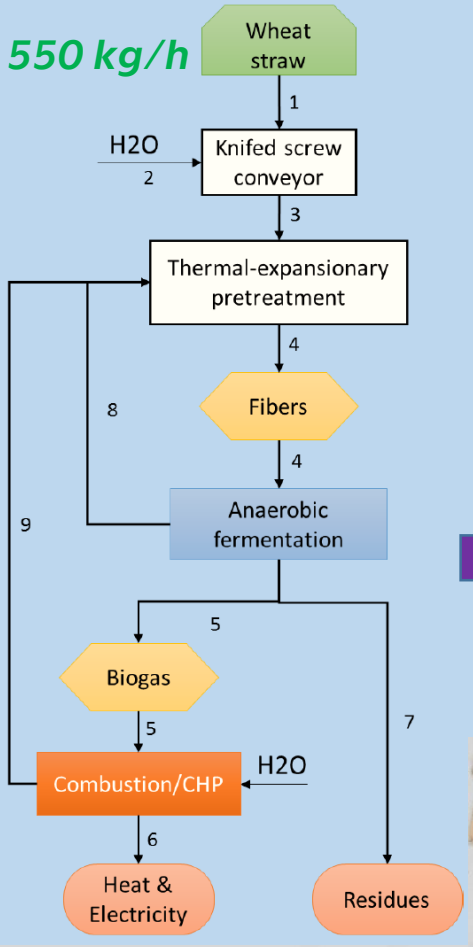
CONVENTIONAL BIOGAS PLANT

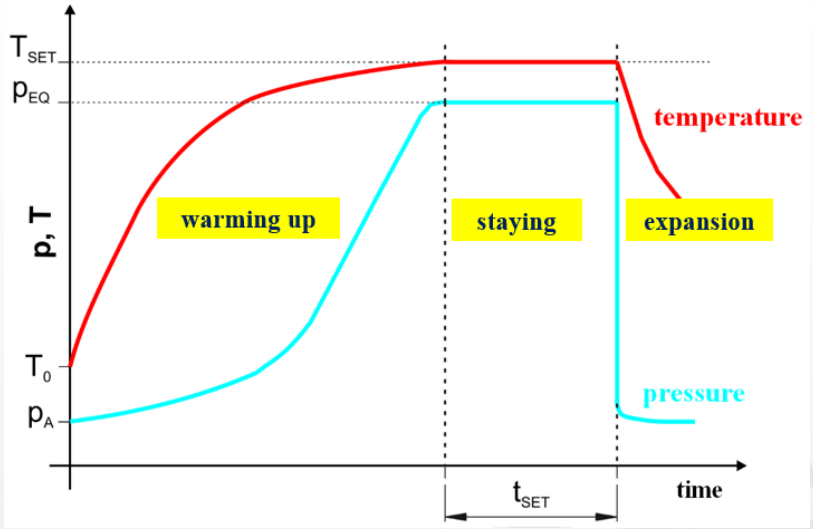


PAYBACK PERIOD = 25 YEARS

UPGRADED BIOGAS PLANT

1ST CONCEPTION





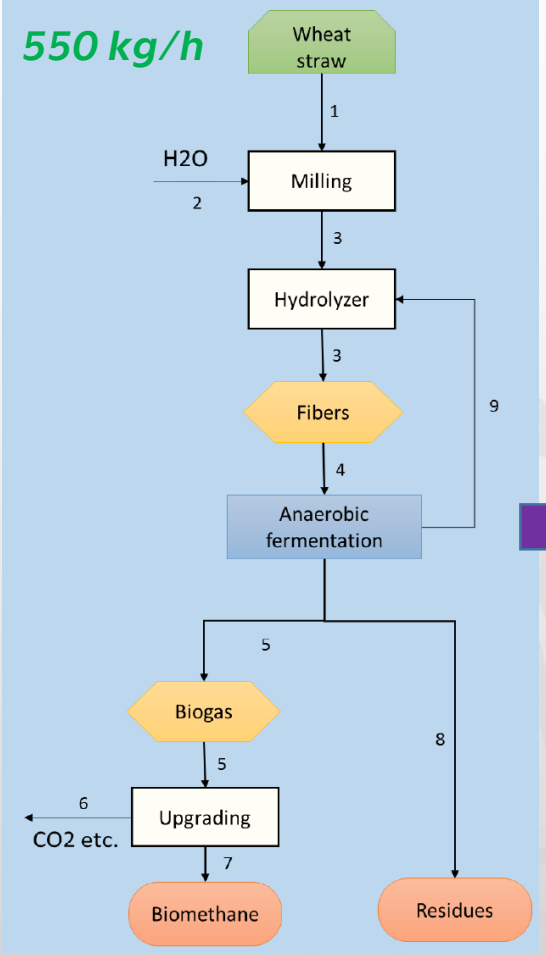
THERMAL EXPANSIONARY PRETREATMENT

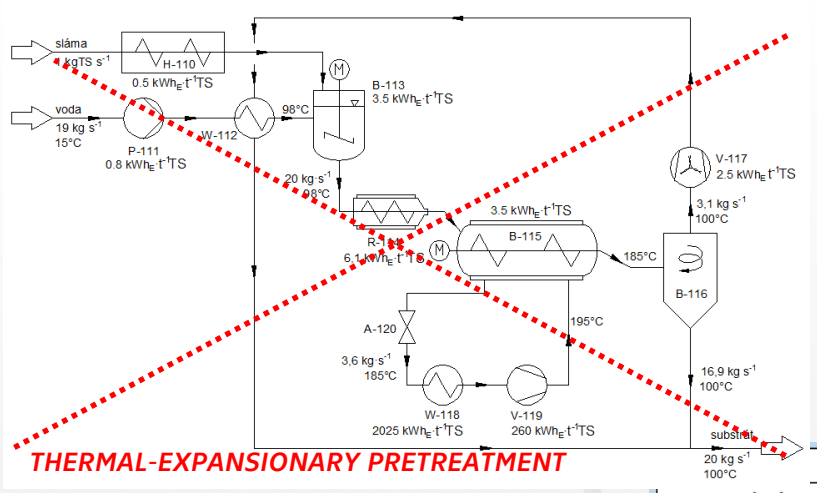
INCREASE IN BIOMETHANE UP TO 50 %

ISBL Capital Cost [$MM year^{-1}]	3.816
OSBL Capital Cost [$MM year^{-1}]	1.562
Engineering Cost [$MM year^{-1}]	1.068
Contingency [$MM year^{-1}]	0.534
Total Fixed Capital Cost [$MM year^{-1}]	**6.945**
Variable Cost of Production [$MM year^{-1}]	0.10
Fixed Cost of Production [$MM year^{-1}]	0.70
Cash Cost of Production [$MM year^{-1}]	**0.80**
Gross Profit [$MM year^{-1}]	0.20
Total Annual Capital Charge [$MM year^{-1}]	1.44
Total Cost of Production [$MM year^{-1}]	2.24
Pay-back period [year]	**30**

UPGRADED BIOGAS PLANT

2ND CONCEPTION



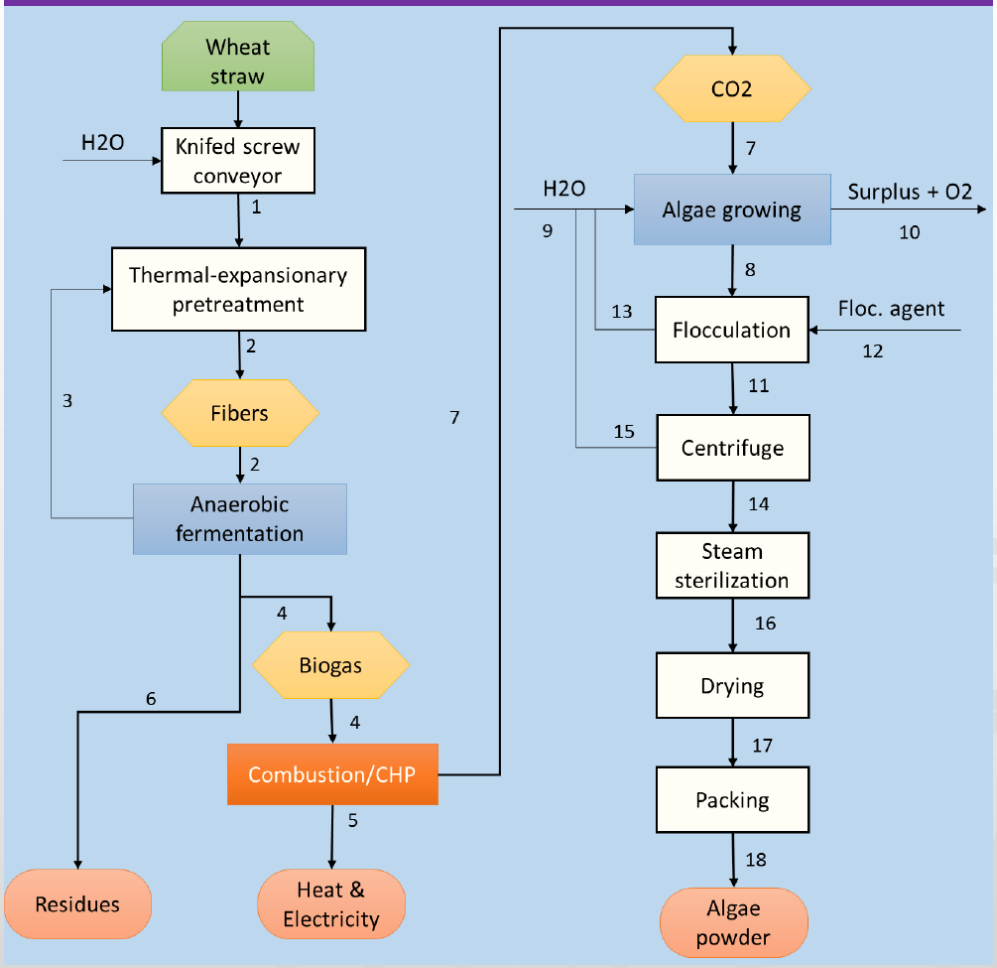


MECHANICAL SIZE REDUCTION INCREASES BIOMETHANE YIELD UP TO 40 %

ISBL Capital Cost [$MM year^{-1}]	2.59
OSBL Capital Cost [$MM year^{-1}]	1.04
Engineering Cost [$MM year^{-1}]	0.72
Contingency [$MM year^{-1}]	0.36
Total Fixed Capital Cost [$MM year^{-1}]	**4.71**
Variable Cost of Production [$MM year^{-1}]	0.16
Fixed Cost of Production [$MM year^{-1}]	0.53
Cash Cost of Production [$MM year^{-1}]	**0.69**
Gross Profit [$MM year^{-1}]	0.18
Total Annual Capital Charge [$MM year^{-1}]	0.98
Total Cost of Production [$MM year^{-1}]	1.66
Pay-back period [year]	**25**

BIOGAS PLANT AS BIOREFINERY

3TH CONCEPTION



EMISSION GASES AND WASTE HEAT FOR ALGAE PRODUCTION

ISBL Capital Cost [$MM year^{-1}]	11.142
OSBL Capital Cost [$MM year^{-1}]	4.457
Engineering Cost [$MM year^{-1}]	4.145
Contingency [$MM year^{-1}]	3.611
Total Fixed Capital Cost [$MM year^{-1}]	**23.356**
Variable Cost of Production [$MM year^{-1}]	4.58
Fixed Cost of Production [$MM year^{-1}]	1.69
Cash Cost of Production [$MM year^{-1}]	**6.27**
Gross Profit [$MM year^{-1}]	0.19
Total Annual Capital Charge [$MM year^{-1}]	4.84
Total Cost of Production [$MM year^{-1}]	11.11
Pay-back period [year]	**59**

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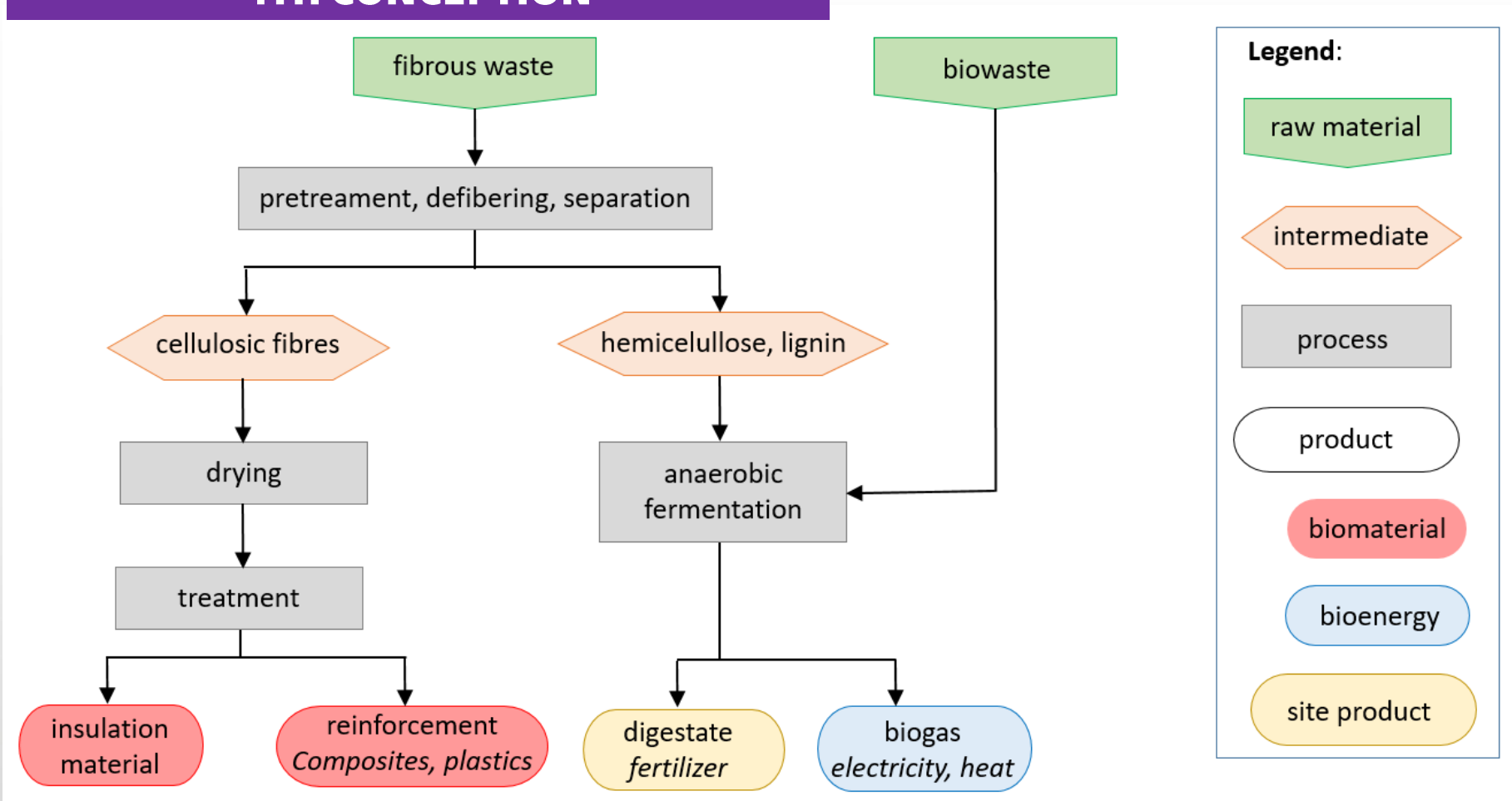
BIOGAS PLANT AS BIOREFINERY

4TH CONCEPTION



PAYBACK PERIOD = 4 YEARS

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FUTURE OF BIOREFINERY

- **THOUSANDS OF STUDIES HOW TO TREAT WASTES**

APPLICABILITY IN INDUSTRIAL SCALE ?

- **INDUSTRIAL BIOREFINERY**

TECHNO-ECONOMICAL STUDIES ARE URGENT + SCALE UP RULES DEFINITIONS FOR APPARATUSES