Renewable Feedstock Potential: Biomass

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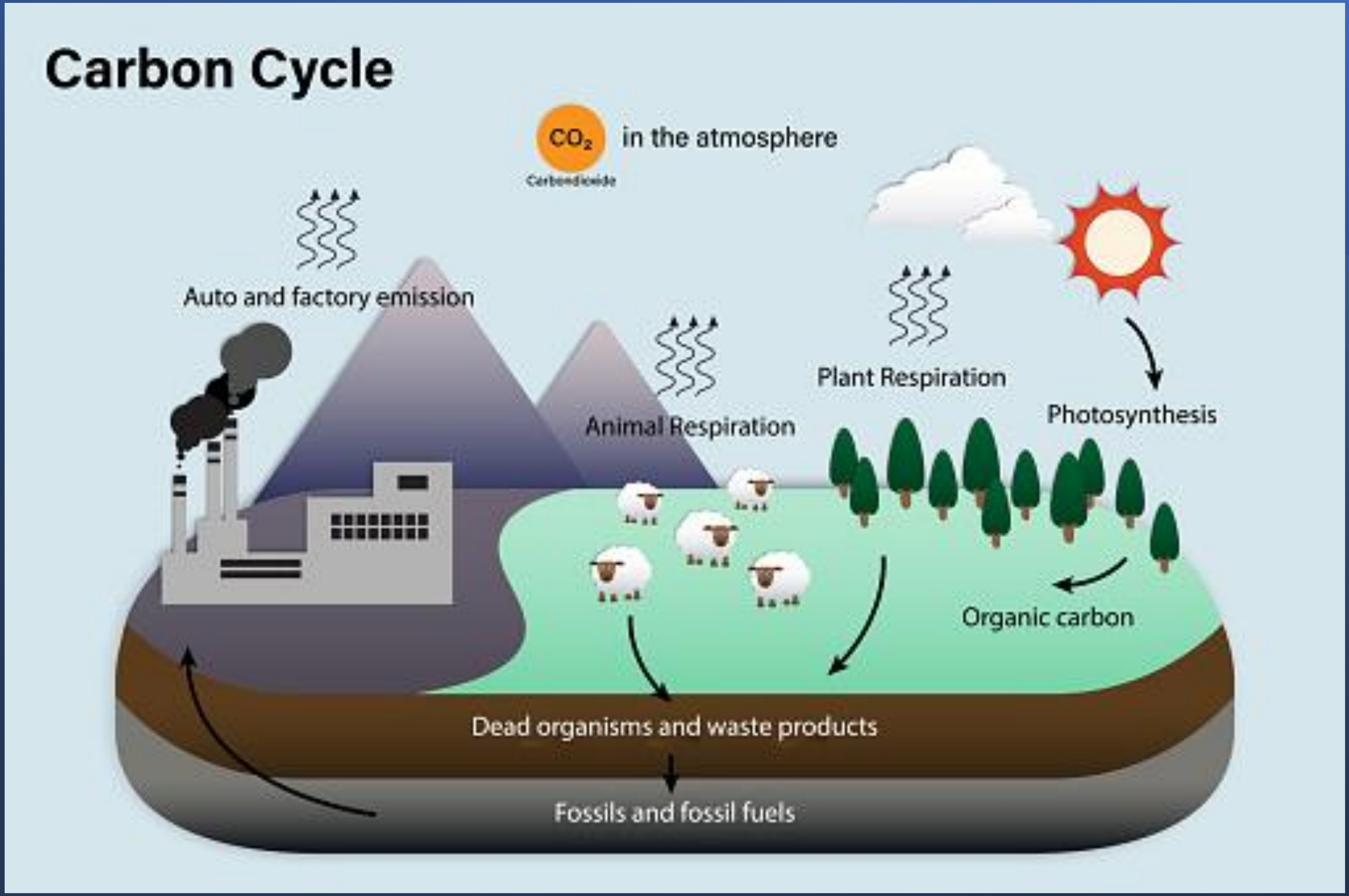
Presentation Outline

- **Introduction**
  - Carbon Cycle
- **Shifting the Cycle**
  - Biorefinery Support Low Carbon
- **How to convert biomass to products?**
  - Components
  - Processes
- **Top 5 Biomass in Indonesia**
- **Research in Our Lab**
- **Challenges**
- **Conclusions**

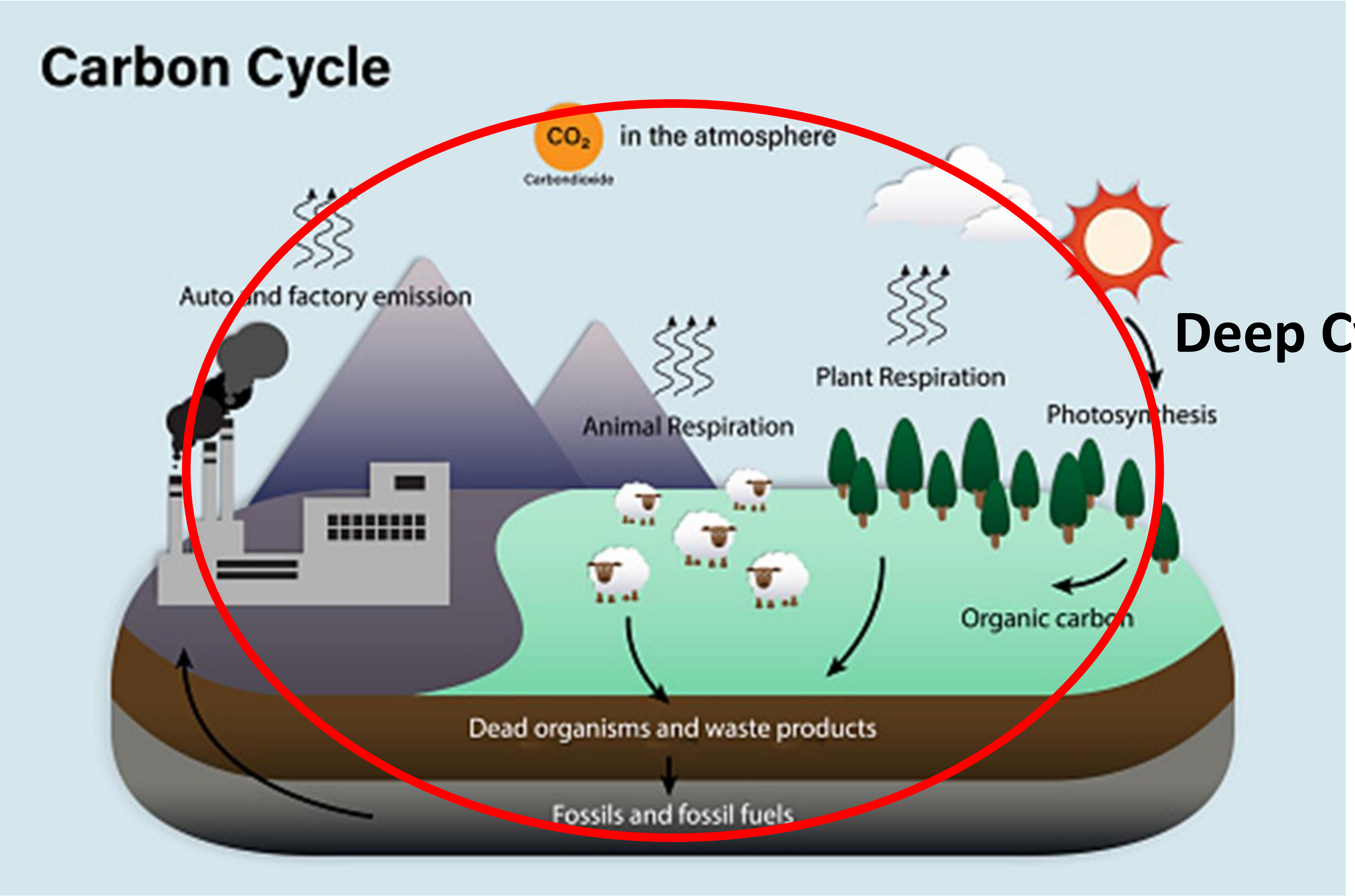
INTRODUCTION



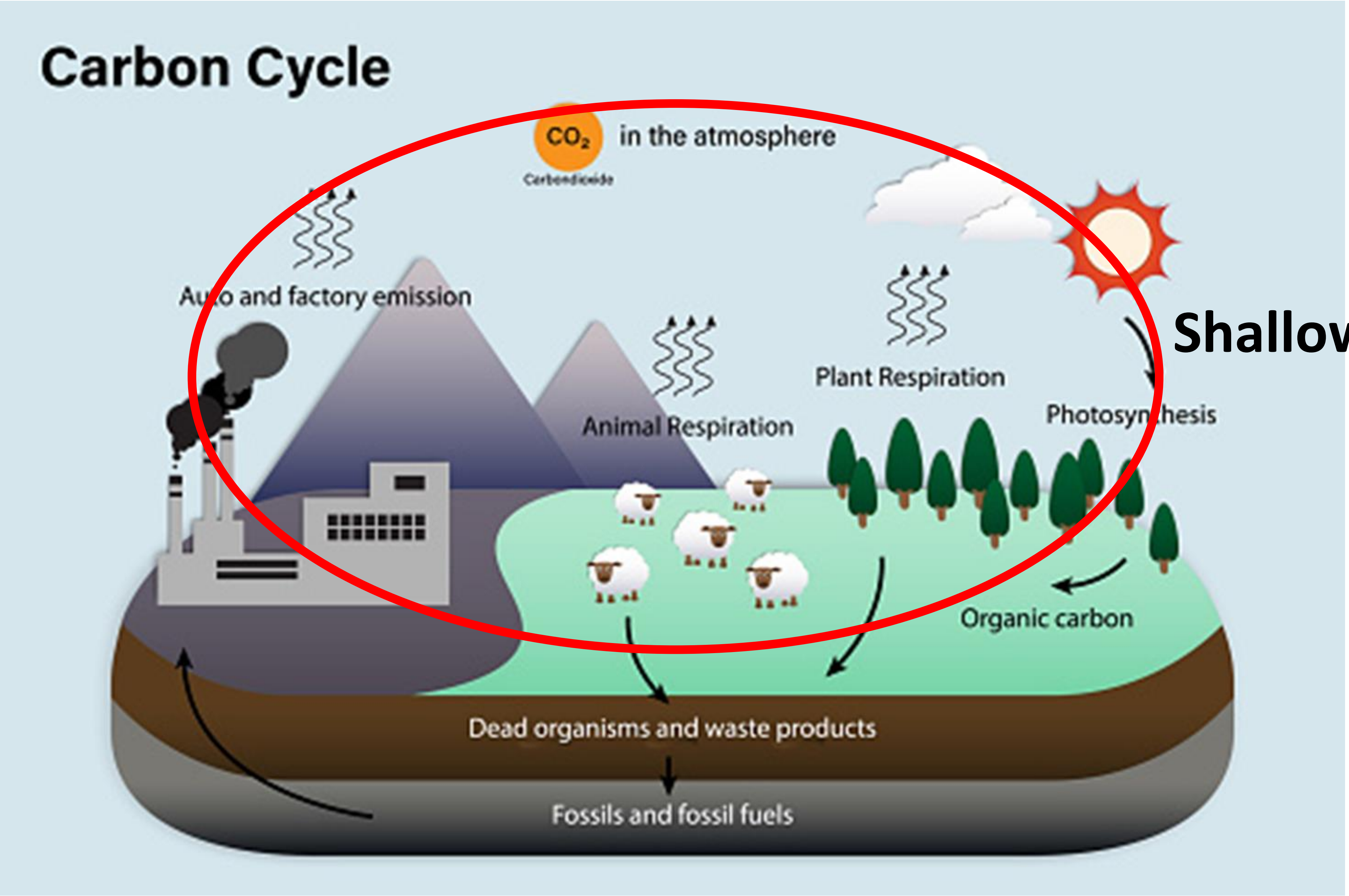
https://www.istockphoto.com/id/vektor/diagram-siklus-karbon-gm1255690592-367419708

Important Key-words

- **Closed System**
- **Carbon Conservation**
- **Carbon Balance**
- **Shifting the Balance**
- **Deep Cycle**
- **Shallow Cycle**
- **Replace the Deep?**


Carbon Cycle
CO_2
in the atmosphere
Carbondioxide
Auto and factory emission
Animal Respiration
Plant Respiration
Photosynthesis
Organic carbon
Dead organisms and waste products
Fossils and fossil fuels

Deep Cycle



Shallow Cycle

SHIFTING THE CYCLE – BIOREFINERY SUPPORT LOW CARBON

Is it possible to shift from Deep Cycle to Shallow Cycle?

Carbon Balance – Point of View

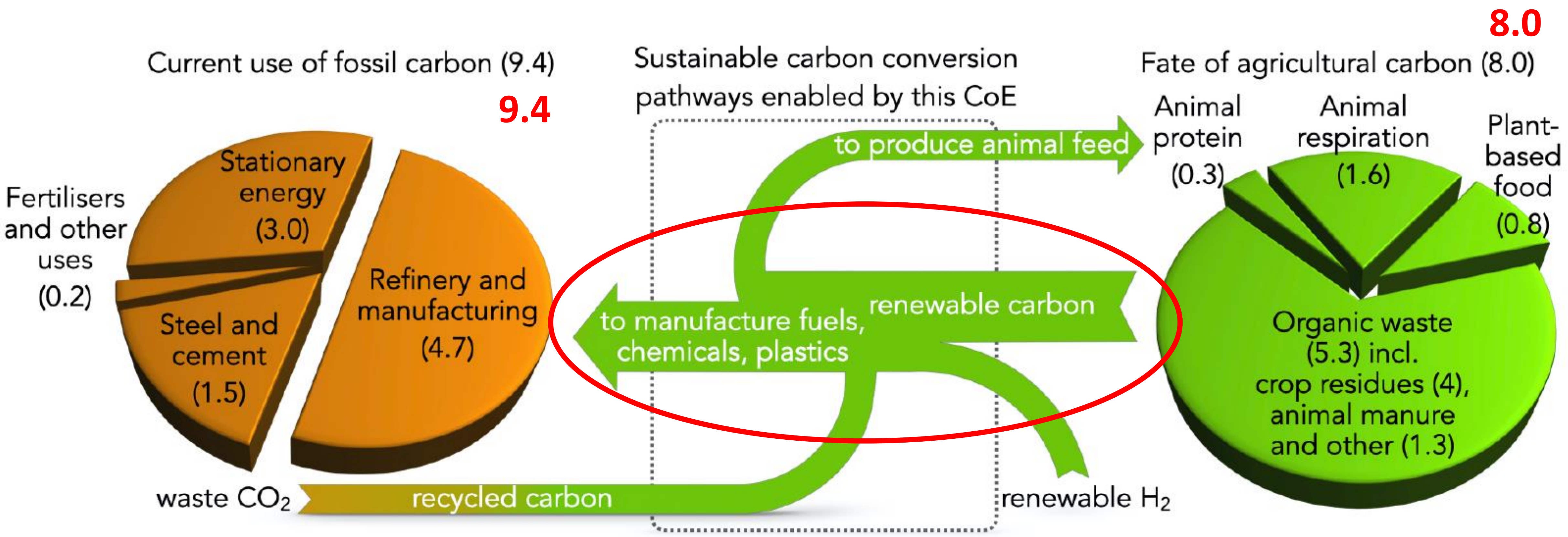
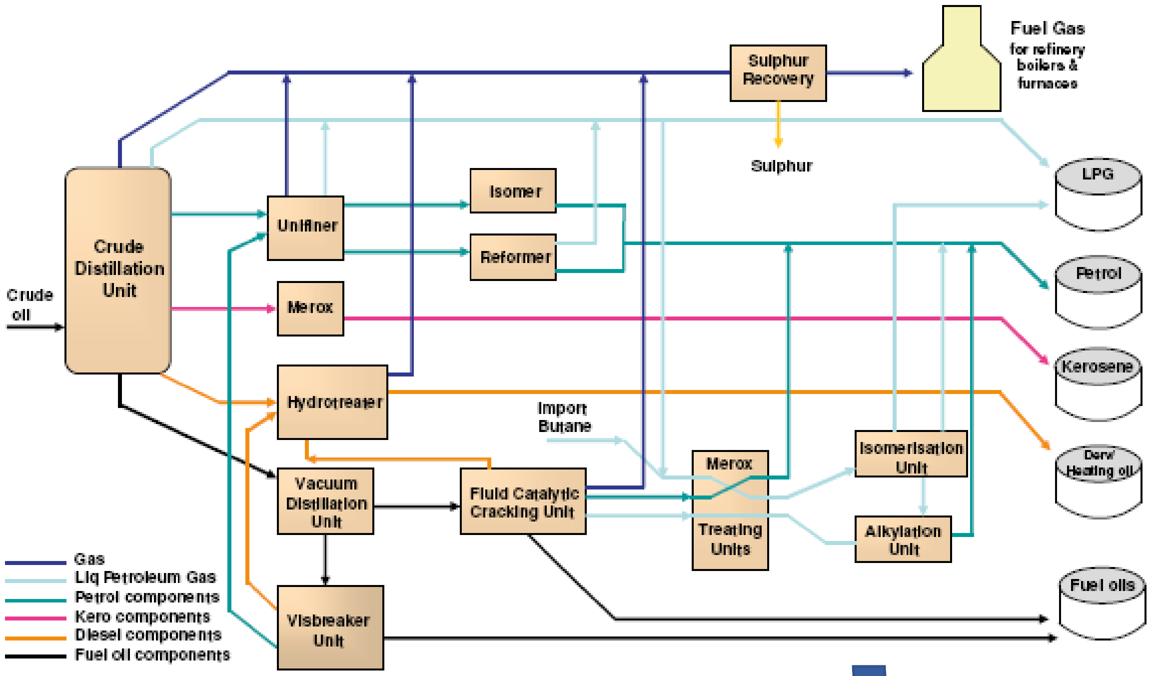


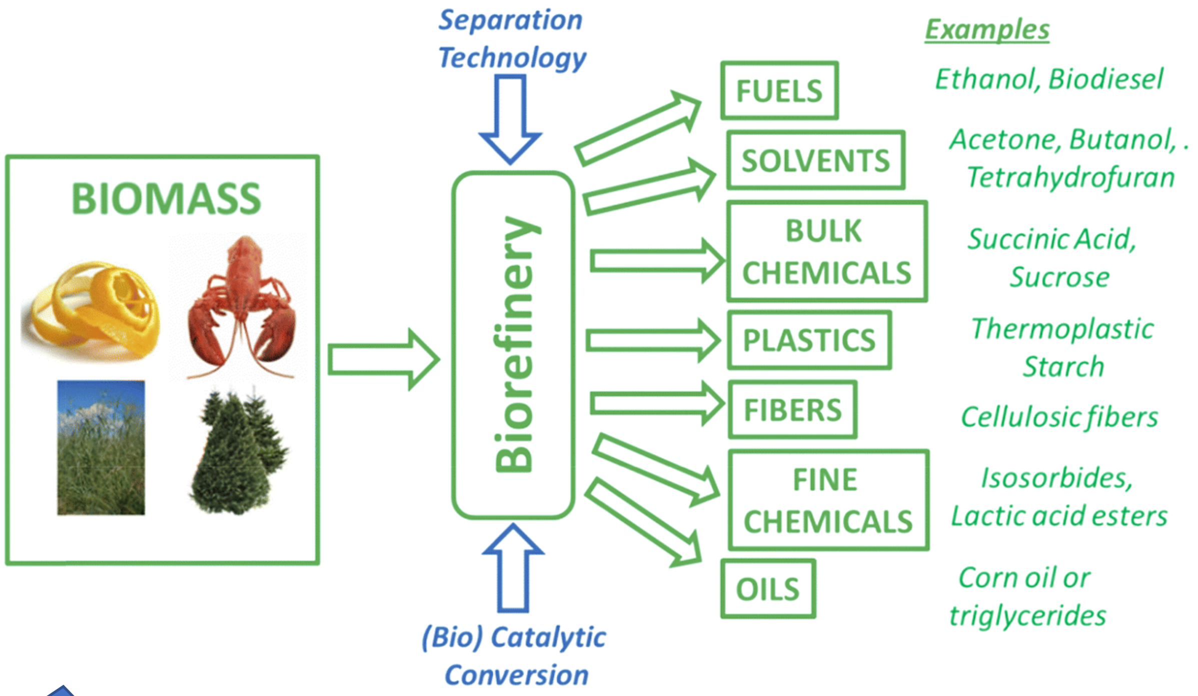
Figure 1: Global fossil and agricultural carbon fluxes [2, 3], and the novel, sustainable carbon conversion pathways envisioned by this Centre. (all units are in GtC/y: gigatonnes of carbon per year)

Ref: Prof. Zhiguo Yuan

What is the biorefinery concept?



Source: *http://www.ukpia.com/*



Source: *http://pubs.rsc.org/*

Petroleum refinery (followed by petrochemical industries)

analogous to

Biorefinery

Biorefinery Definition

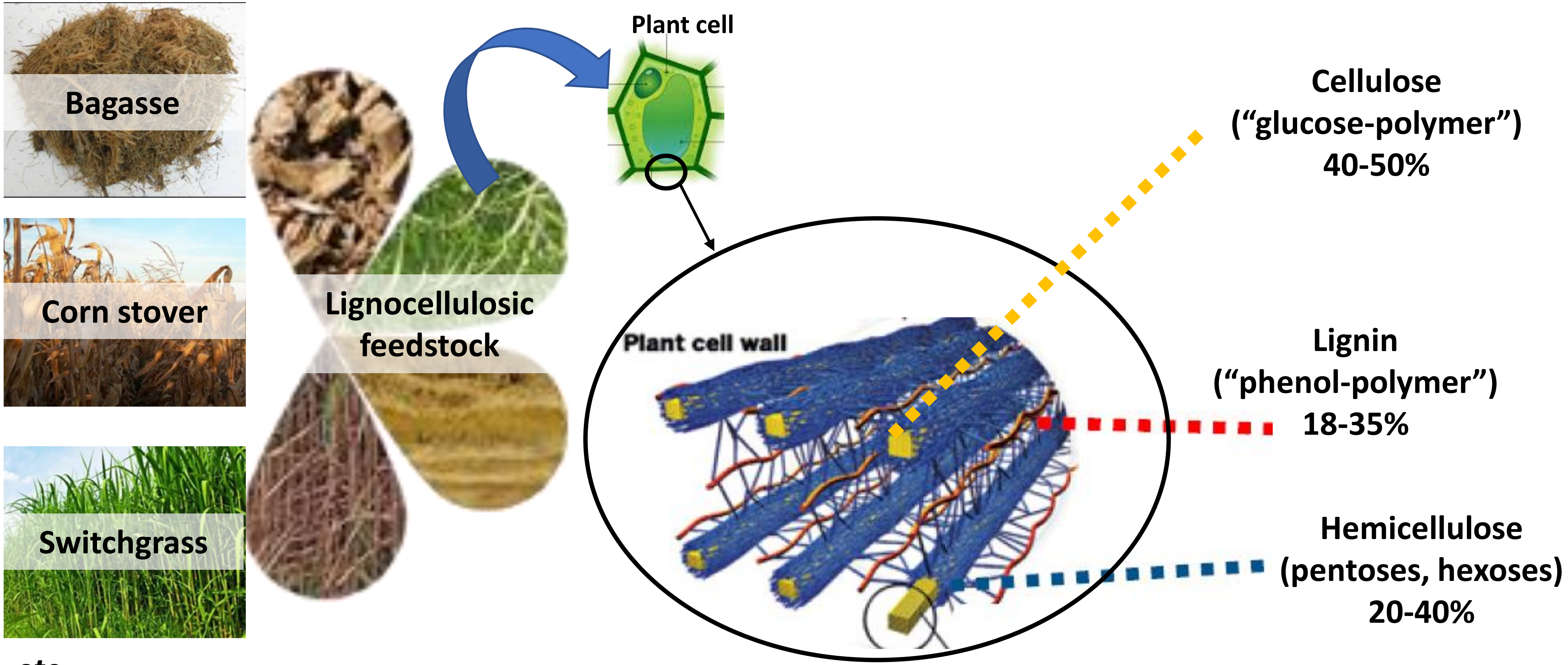
- A **biorefinery** can be defined as a framework or **a structure in which biomass is utilized** in an optimal manner to **produce multiple products** and tries to be **self-sustaining** and **not harmful to the environment** (Hydrocarbon Biorefinery (2022), p 355 - 385

What is Biomass?

- **Biomass** is **organic, non-fossil material of biological origin** (plants and animals) **used as a raw material** for production of biofuels, and chemicals. It can be also called biomass feedstock. It includes wide range of materials harvested from nature or biological portion of waste. **The most typical example is wood** (firewood, wood residues, wood waste, tree branches, stump, wood pellets, ...). Other examples of **biomass are grass, bamboo, corn, sugarcane, animal waste, sewage sludge and algae** (Eurostat)
- **Biomass → Lignocellulosic Materials**

HOW TO CONVERT BIOMASS TO PRODUCTS
- COMPONETS
- PROCESSES

Lignocellulosic biorefinery

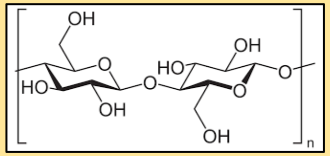


etc.

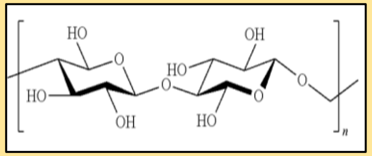
Lignocellulosic biorefinery

Feedstock

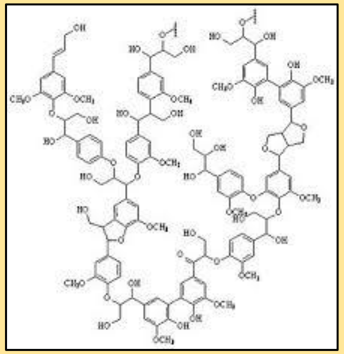
Precursors



Cellulose



Hemicellulose



Lignin

Final products

Fuels
Bioethanol, biobutanol

Thermoplastics
PVC, polyolefins, Polyesters, polyurethanes

Adhesives

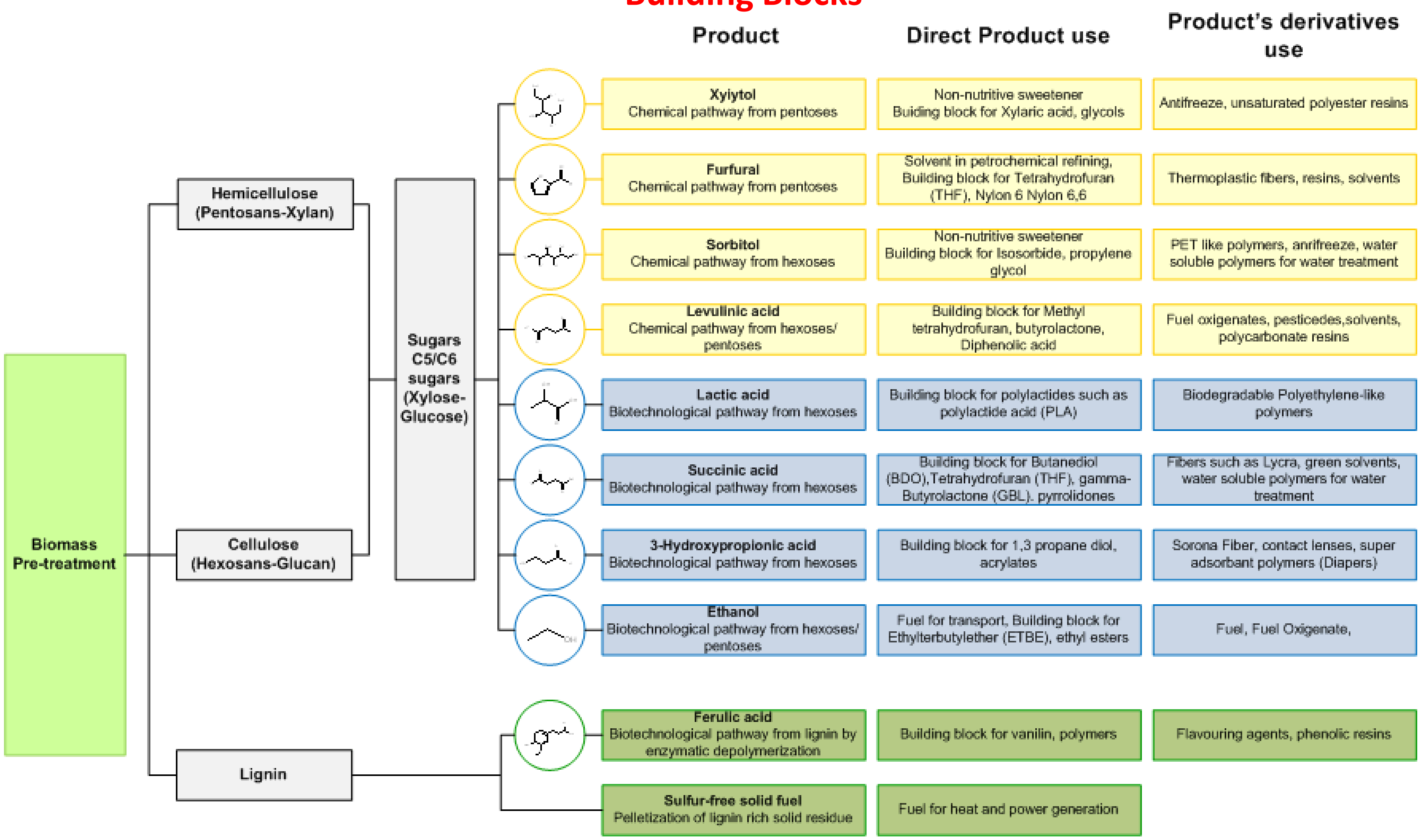
Solvents

Resins

Food additives

etc.

Building Blocks



https://www.epfl.ch/labs/bpe/research/bioenergy/biorefineries/

General process steps in biorefinery

Pre-treatment

- Physical
- (Thermo)-chemical
- Physio-chemical
- Biological

Conversion

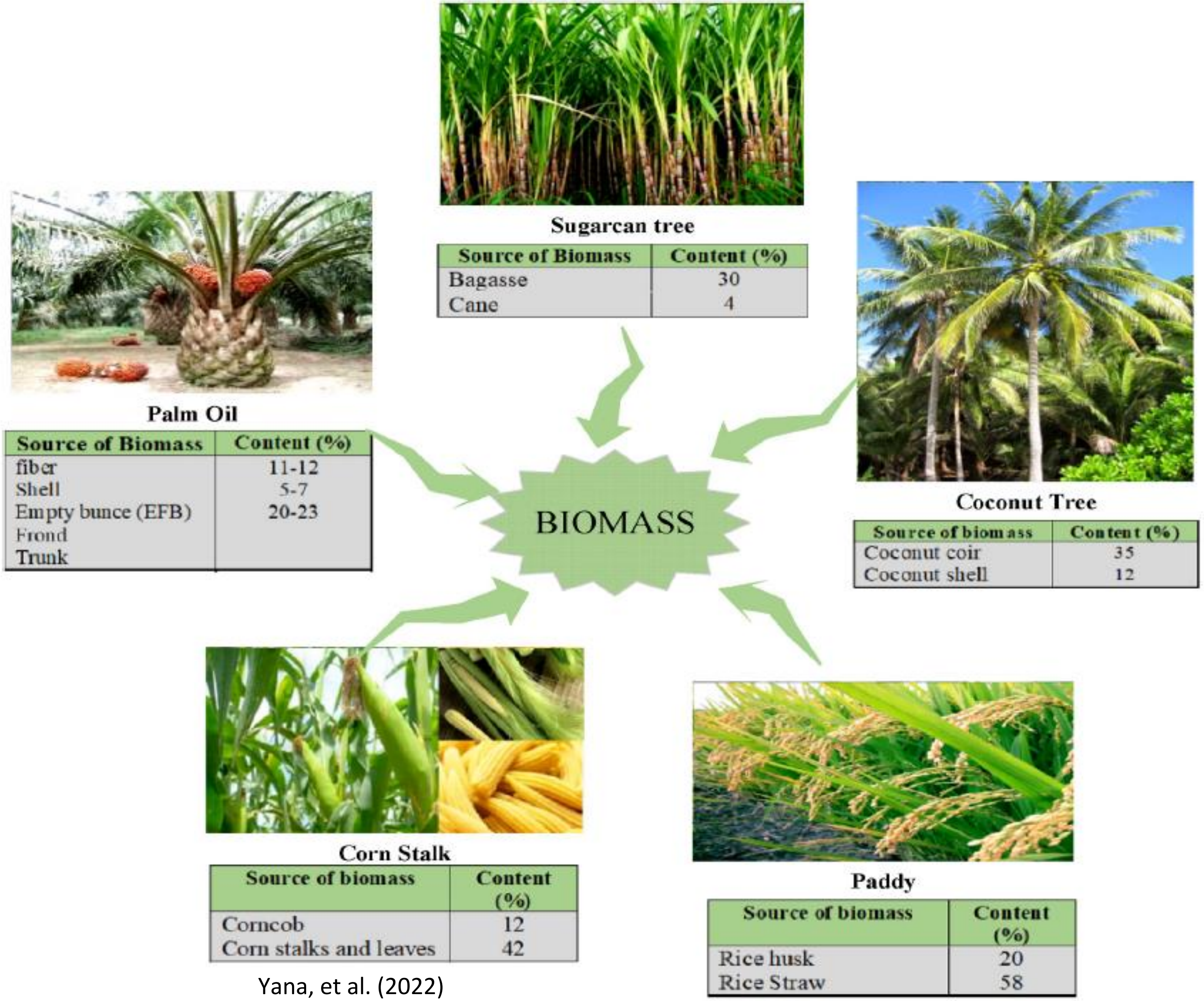
- (Thermo)-chemical
- Biological

Separation

- Physical properties
- Chemical properties

TOP FIVE BIOMASS IN INDONESIA
RESEARCH AT OUR LAB

TOP FIVE BIOMASS IN INDONESIA



Yana, et al. (2022)

Fig. 1. The economic potential of biomass varies according to its origin [19,26].

The Availability of Biomass in Indonesia (2016)

Type of Unused Plant based-biomass	Distribution	Total Quantity (ton/year)
PALM OIL Residues		
Fiber	Sumatera, Kalimantan, Java, Sulawesi, Papua	12.752.453
Shell		6.136.541
EFB		23.841.538
POME		47.876.339
Stem		75.517.083
Re-planting		8.412.853
SUGAR CANE Residues		
Bogasse	Sumatera, Java, Sulawesi	9.559.394
Sugar Cane Leaves and Shoot		7.154.404
COCONUT Residues		
Coconut Fiber	Sumatera, Kalimantan, Java, NT, Sulawesi, Maluku, Papua	2.271.600
Coconut Shell		7.261.864
RICE-PADDY Residues		
Husk	Sumatera, Kalimantan, Java, NT, Sulawesi, Maluku, Papua	12.987.573
Straw		90.166.385
CORN Residues		
Corncob	Sumatera, Kalimantan, Java, NT, Sulawesi, Maluku, Papua	4.263.117
Stems and leaves of corn		14.920.906

Source: Bioenergy Investment Guidelines, Ministry of Energy and Mineral Resources (2016)

RESEARCH IN OUR LABORATORY

Xylitol from oil palm empty fruit bunches

Oil palm empty fruit bunches

Pretreatment

Autohydrolysis
T = 121 ^{o}C;
t = 15 min

Enzymatic hydrolysis

Xylanase
Trichoderma viridae
ITB L.67

Fermentation

Debaryomyces hansenii
ITBCCR85

Xylitol

Evaluation of pretreatment method & operation condition:

- Environmentally friendly
- Low cost
- High xylose recovery
- Low inhibitor generation

To increase the economical value of the process:

- High product yield
- Does not require many process units

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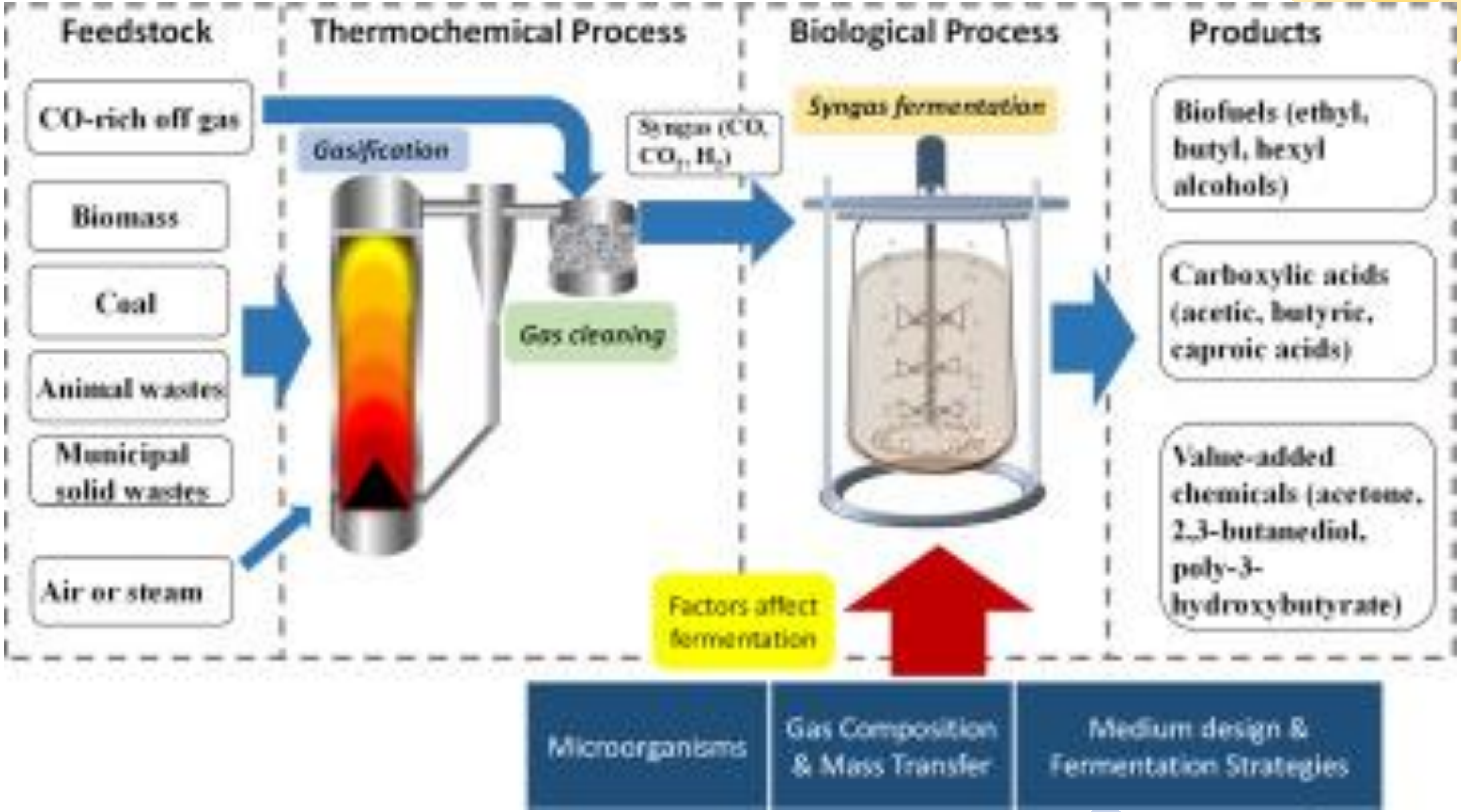
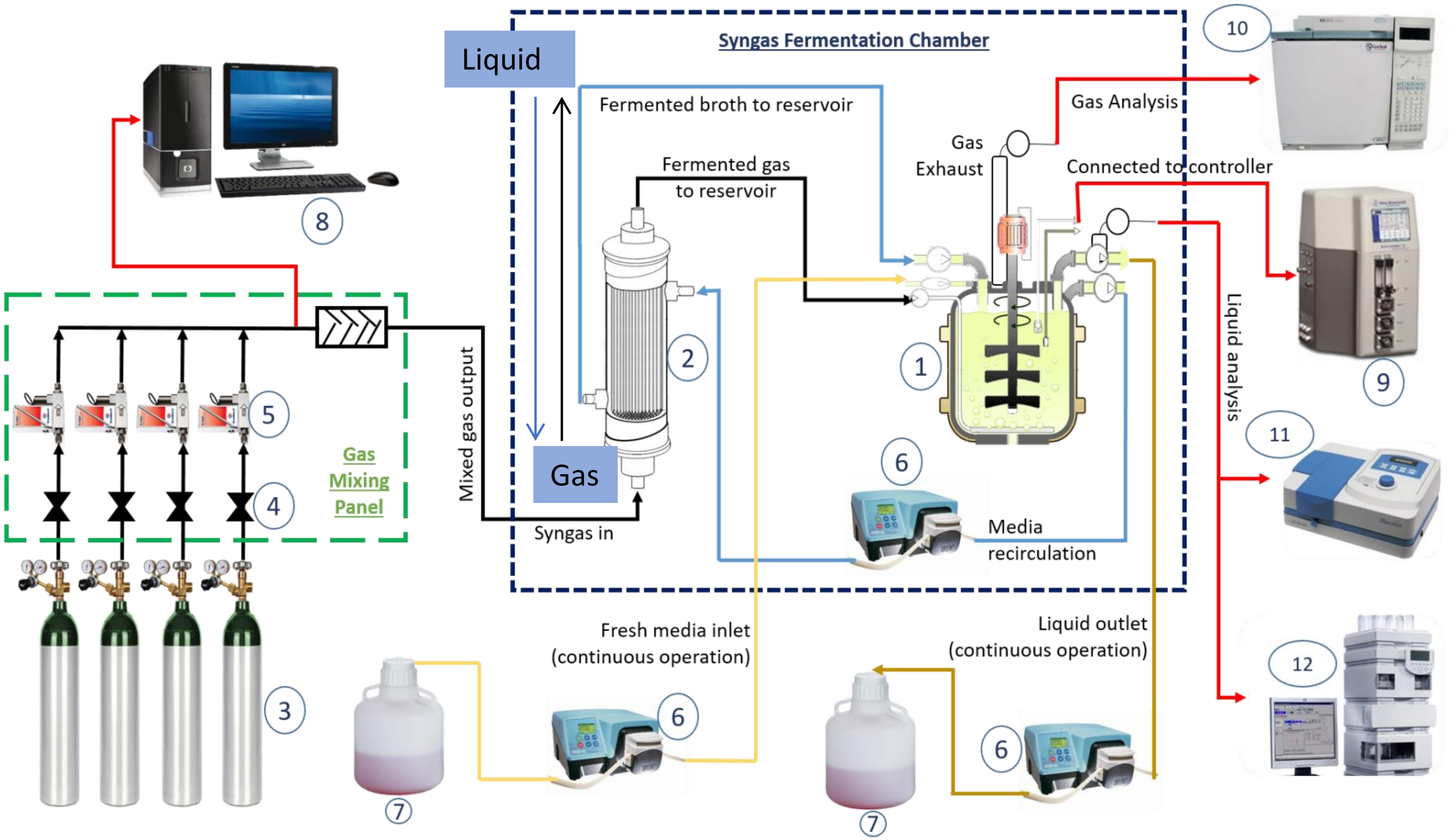
SYNGAS FERMENTATION



Sun et al. (2019)

Bioethanol Production via Syngas Fermentation



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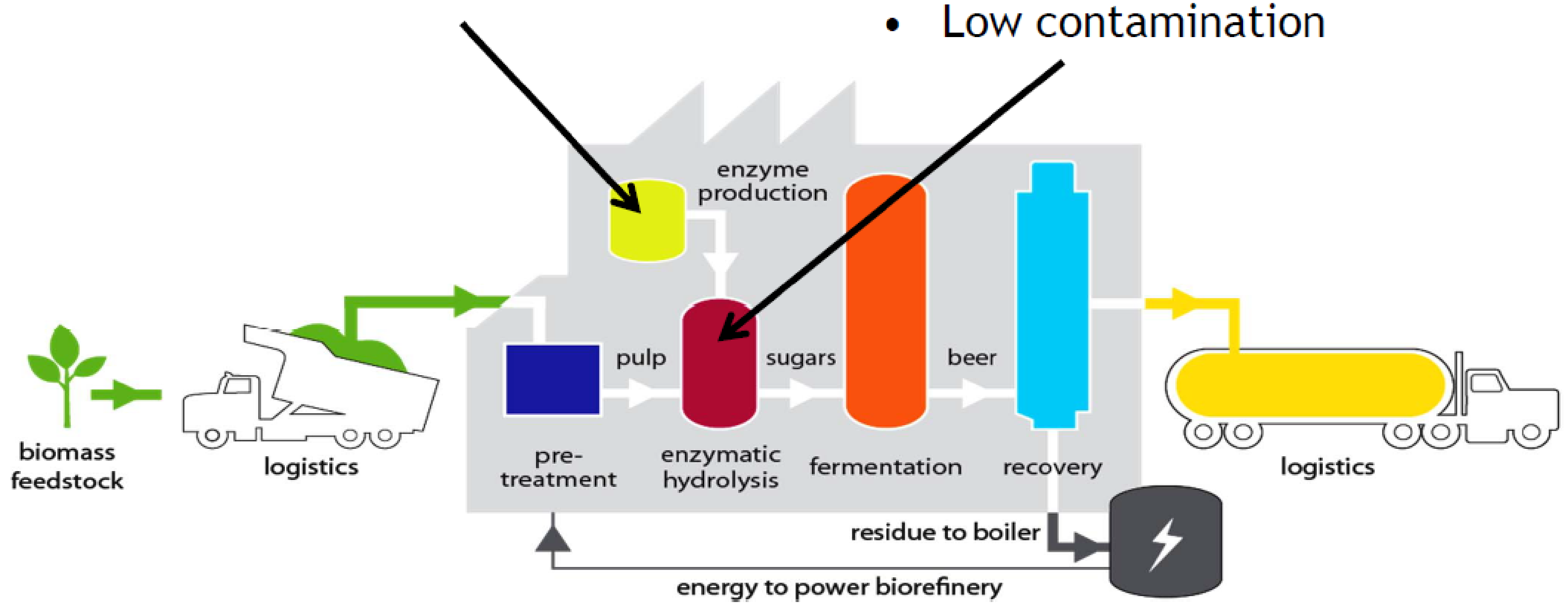
Cellulosic ethanol

Enzyme production process:
- Low cost
- Flexible raw materials

Hydrolysis process:
- High sugar yield
- Fast liquefaction
- Low contamination



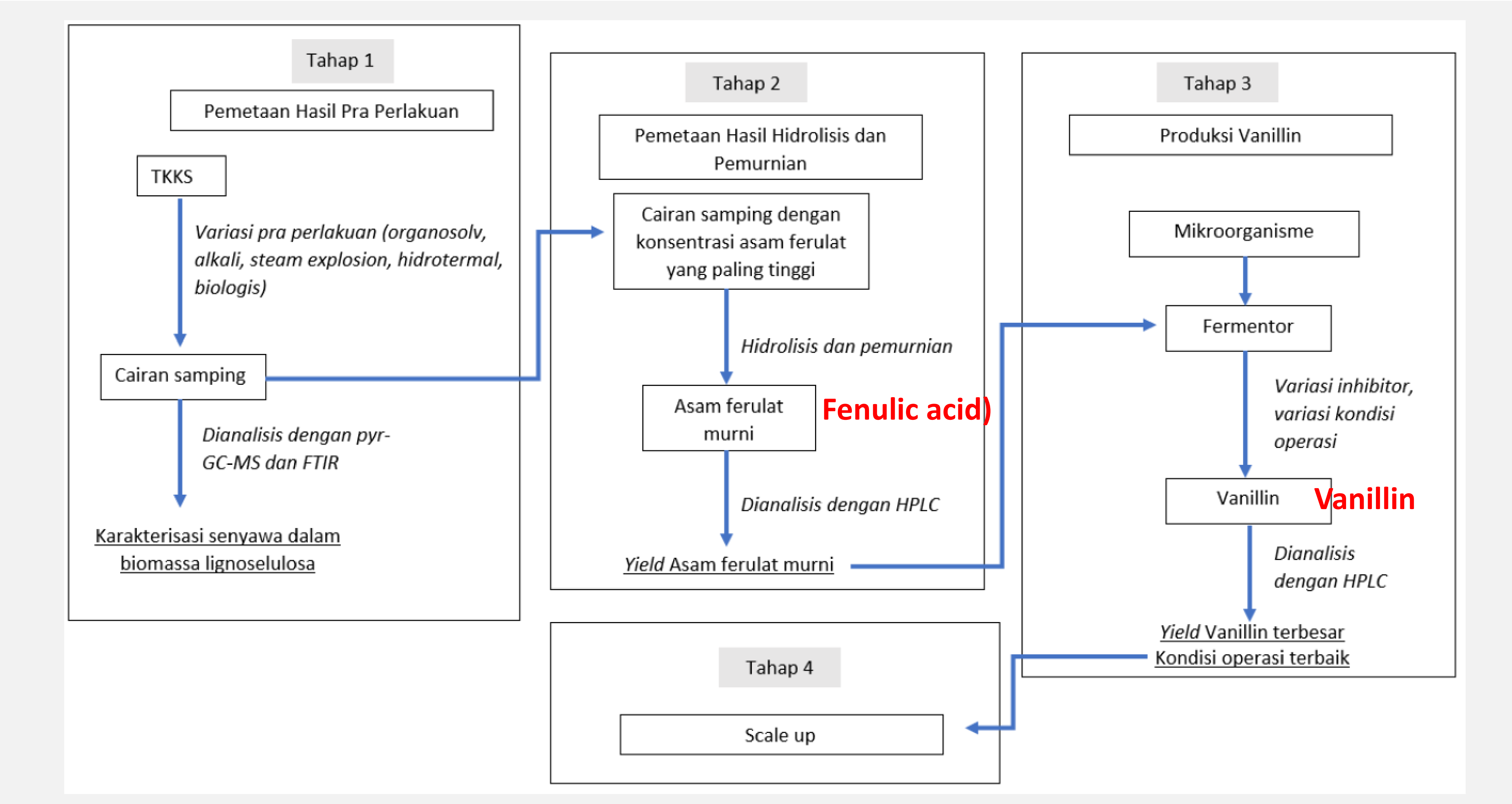
Source: http://www.dsm.com/

Enzyme development target:
- Increased enzyme performance

Enzyme cocktail improvement strategies:
- Classical strain improvement (CSI)
- Enzyme screening
- Protein engineering

Dr. Ronny Purwadi; Dr. MTA Penia Kresnowati

From Empty Fruit Bunches to Vanillin



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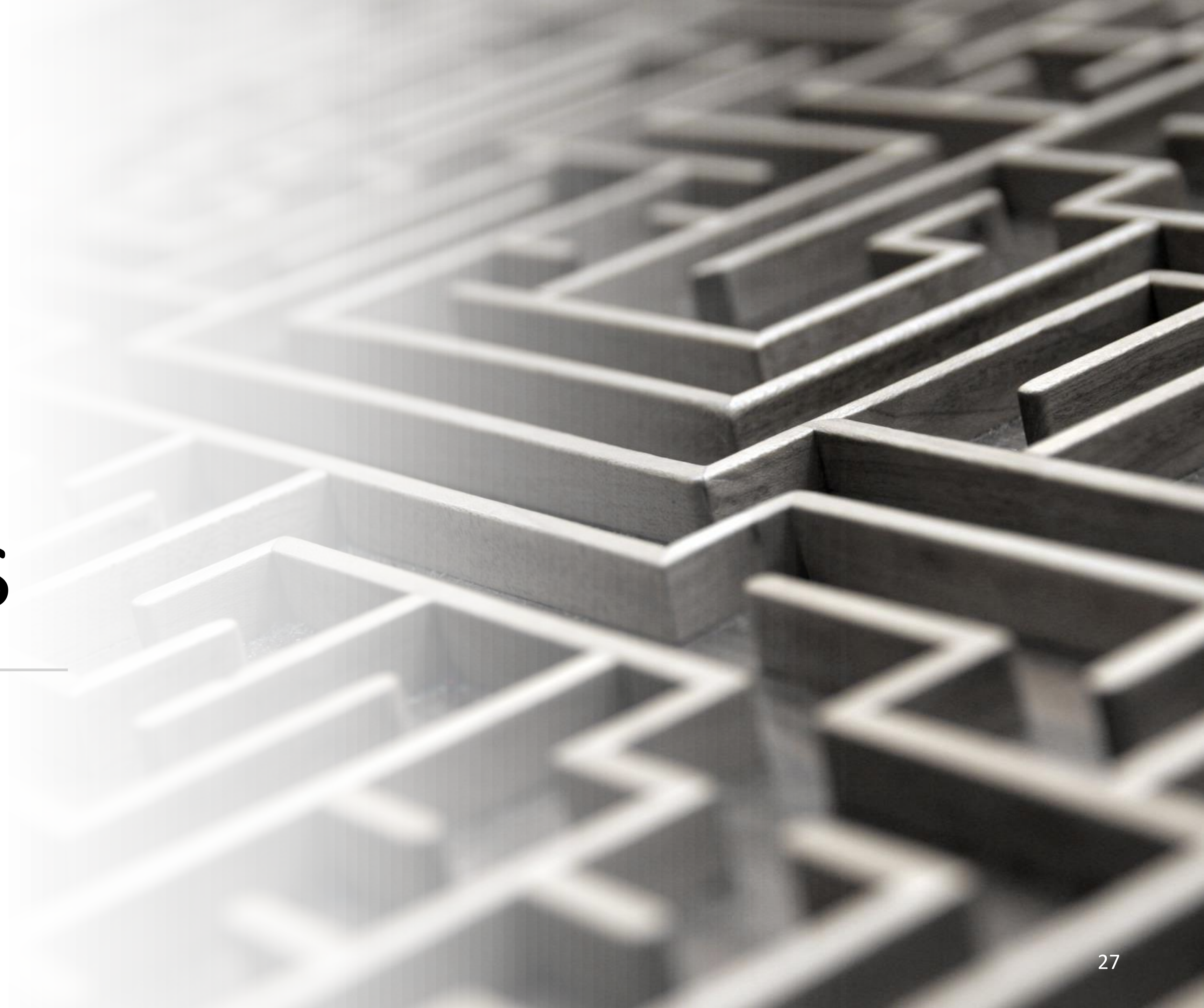
INDUSTRIAL CHALLENGES AND CONCLUSIONS



Industrial Challenges

- **Feedstock Availability**: One of the major challenges is ensuring a consistent and sustainable supply of biomass feedstock for biorefineries. The availability and cost of biomass can vary depending on factors such as geographic location, climate, and competing uses (e.g., food production).
- **Feedstock Composition and Variability**: Biomass feedstocks are diverse and can have varying compositions, which can affect the efficiency of conversion processes. Dealing with the variability in feedstock properties is a significant challenge for biorefineries.
- **Technological Complexity**: Biorefineries require advanced and integrated technologies for the efficient conversion of biomass into various chemicals and biofuels. Developing and optimizing these technologies, as well as integrating different process steps, can be complex and challenging.
- **Product Yield and Quality**: Achieving high product yields and ensuring consistent product quality are essential for the economic viability of biorefineries. Maximizing conversion efficiencies and maintaining high-quality standards are ongoing challenges.
- **Cost Competitiveness**: The cost of producing chemicals and biofuels from biomass must be competitive with conventional fossil-based alternatives. Biorefineries need to achieve economies of scale, optimize production processes, and reduce production costs to ensure commercial viability.

Conclusions

- **Abundant Biomass Resources**: Indonesia possesses rich biomass resources, **offering ample opportunities for biomass feedstock supply**. Proper utilization of these resources can contribute to **reducing waste**, **promoting sustainable land management practices**, and **creating new economic opportunities**.
- To **fully leverage the potential of biomass biorefinery in Indonesia**, it is **important to address the challenges** through supportive policies, research and development initiatives, investment in infrastructure, and capacity building efforts. **The collaboration of various stakeholders**, including government agencies, industry players, research institutions, and local communities, will be crucial in realizing the opportunities presented by biomass biorefinery in Indonesia and driving the transition towards a more sustainable and bio-based economy.

THANK YOU!

Renewable Raw Materials as strategic lever to reduce product carbon footprint

June 2023

Yoshi Kashiwagi
Country Development ASEAN / BASF Thailand

More and more market leaders in important BASF customer industries are committing to reducing their Scope 3 emissions

FMCG

Apparel

Automotive

Electronics

Packaging

>70%

of the top 20 companies in relevant customer industries

had **committed to CO_2 emission reduction targets**[1] by 2021;

almost half have defined **Scope 3 emission targets**

First movers in decarbonization set to profit from strong market pull for low-PCF products

[1] Source: CapIQ, Science-Based Targets Initiative, CDP Worldwide, McKinsey ESG Solutions / Sustainability Insights.
Customer industries: apparel, automotive, electronics, FMCG and packaging

Circular feedstocks – Recycled / Renewable raw materials

Recycling-based feedstock

Chemical Recycling for “hard to recycle plastic waste“

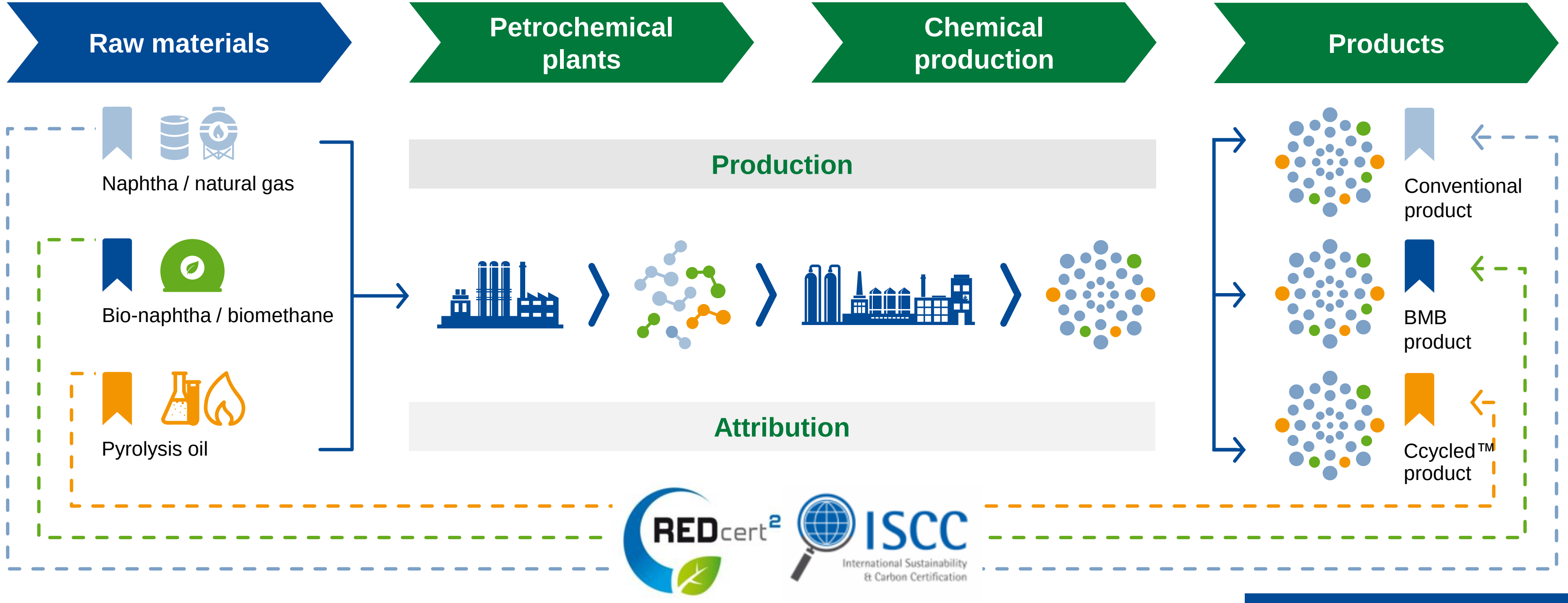
Renewable feedstock

Biomass Balance portfolio replacing fossil

Dedicated bio-based portfolio

BASF
We create chemistry

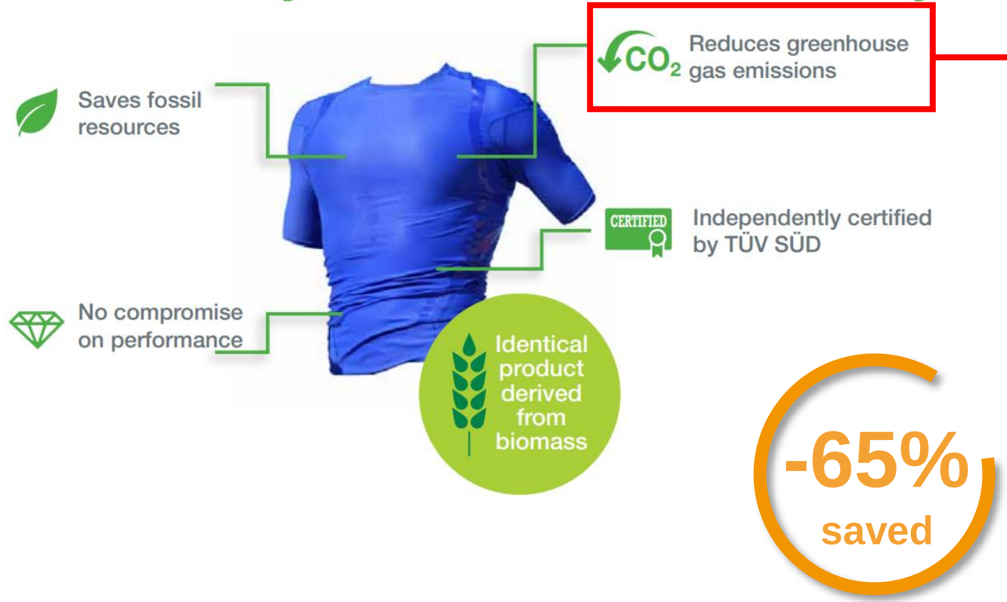
The alternative feedstock is attributed through the mass balance approach (credit method)



Third-party certification

Example of PCF – Ultramid Biomass Balance

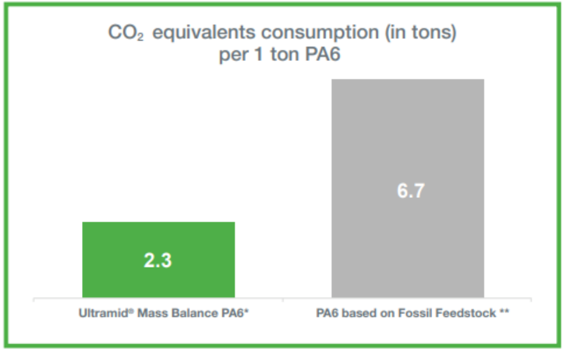
Value added solution to meet sustainability trend in the textile industry



Sustainably produced feedstock[1]

- ☑ Sustainable use of land
- ☑ Protection of natural biospheres
- ☑ Social sustainability

[1] In accordance with International Sustainability & Carbon Certification (ISCC) and European Union Renewable Energy Directive's (RED) requirements.



* Based on LCA report for Ultramid® Mass Balance Polyamide 6
** According to Plastics Europe

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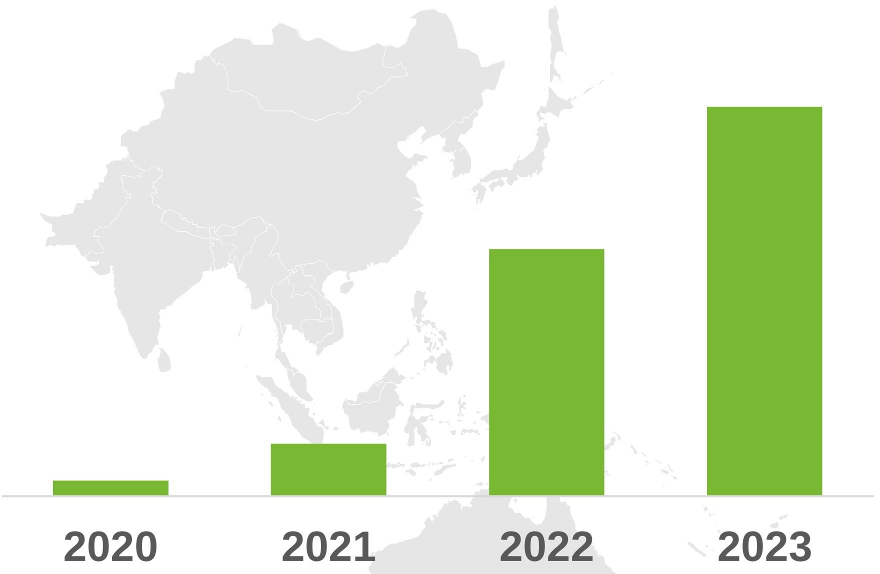
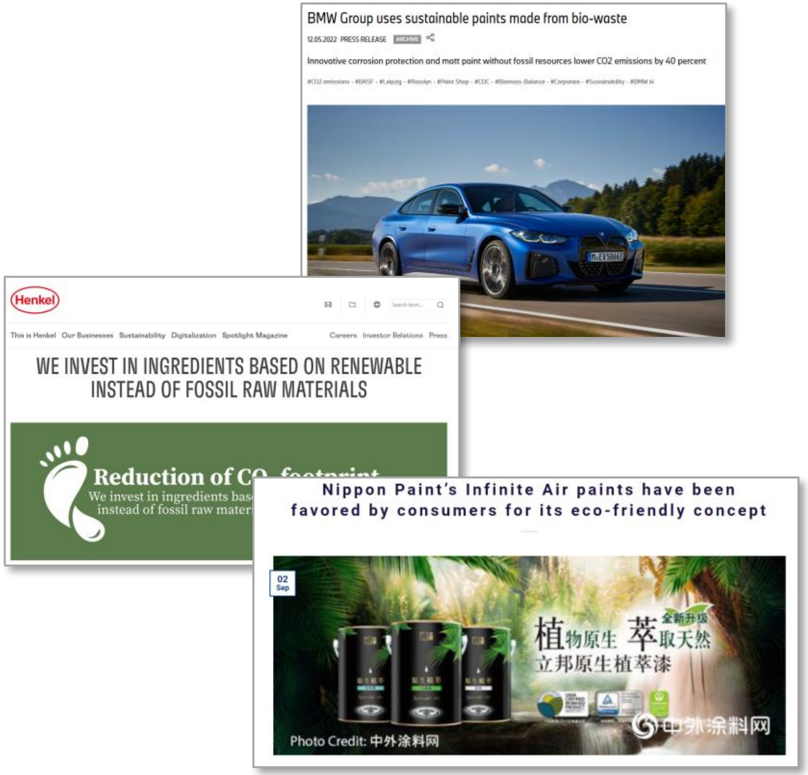
Mass Balance portfolio is expanding along market acceptance
So as importance of “Renewable Feedstock”





Number of BASF’s **Mass Balance** Product Portfolio

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Internal

Consumers will drive demand for net-zero and low-PCF products

Transformation enabled by BASF

- **Chemical raw materials are key contributors to PCFs** of consumer products – in the case of shampoo, more than 90%
- BASF is able to offer its customers **net-zero and low-PCF chemicals** by applying a **toolbox of emission reduction measures** – from raw material choice to green energy
- **End consumers are expected to drive demand** for net-zero and low-PCF products

[1] CO_2e emissions (cradle-to-gate), calculated using a McKinsey methodology for analysis

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