GREENMEUP

Enhancing the uptake of biomethane in Europe

Green MeUp Webinar February 2025

Innovative AD Solutions: Market Perspectives, Industrial Insights, and CO_2 Management Strategies

Date: 17th February, 2025

Presented by: Katja Lyons, BIOGEST

BIOGEST®

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No. 101075676.

Innovative AD Solutions

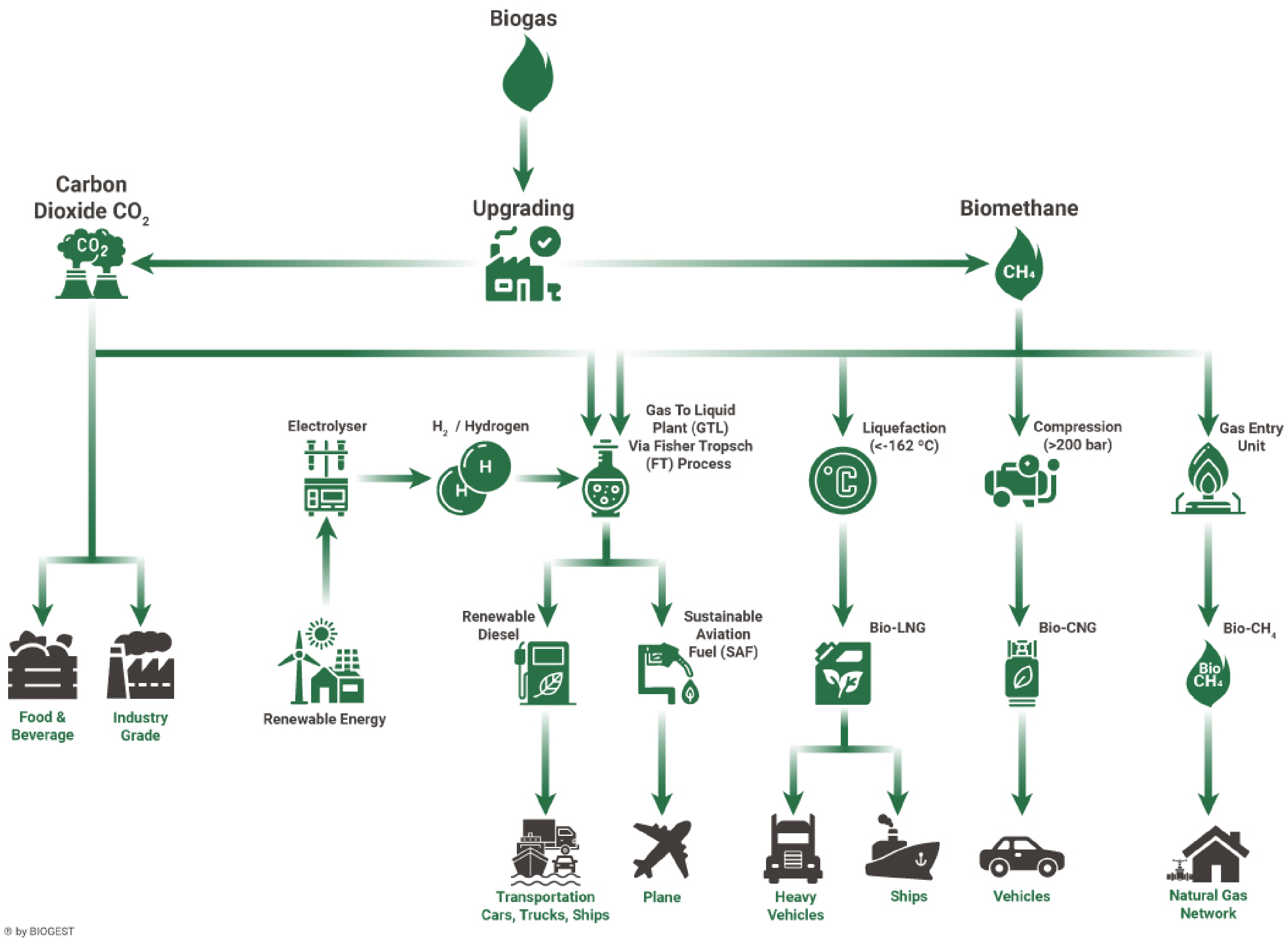
Market perspectives: Technological Advancement for bioCH_4 and bioH_2 production

Industrial Insights: Feedstock and feedstock potentials

Co2 Management Strategies (SAF, Renewable Diesel, Plasma dissociation, H2)

Outlook

220+ BIOGEST Projects worldwide



® by BIOGEST

Technologies to co-produce biomethane and bio-CO2

Mature Technologies for Biomethane & Bio-CO2 Co-Production:

- Sorption methods: adsorption & absorption.
- Separation methods: membrane use & cryogenic techniques.

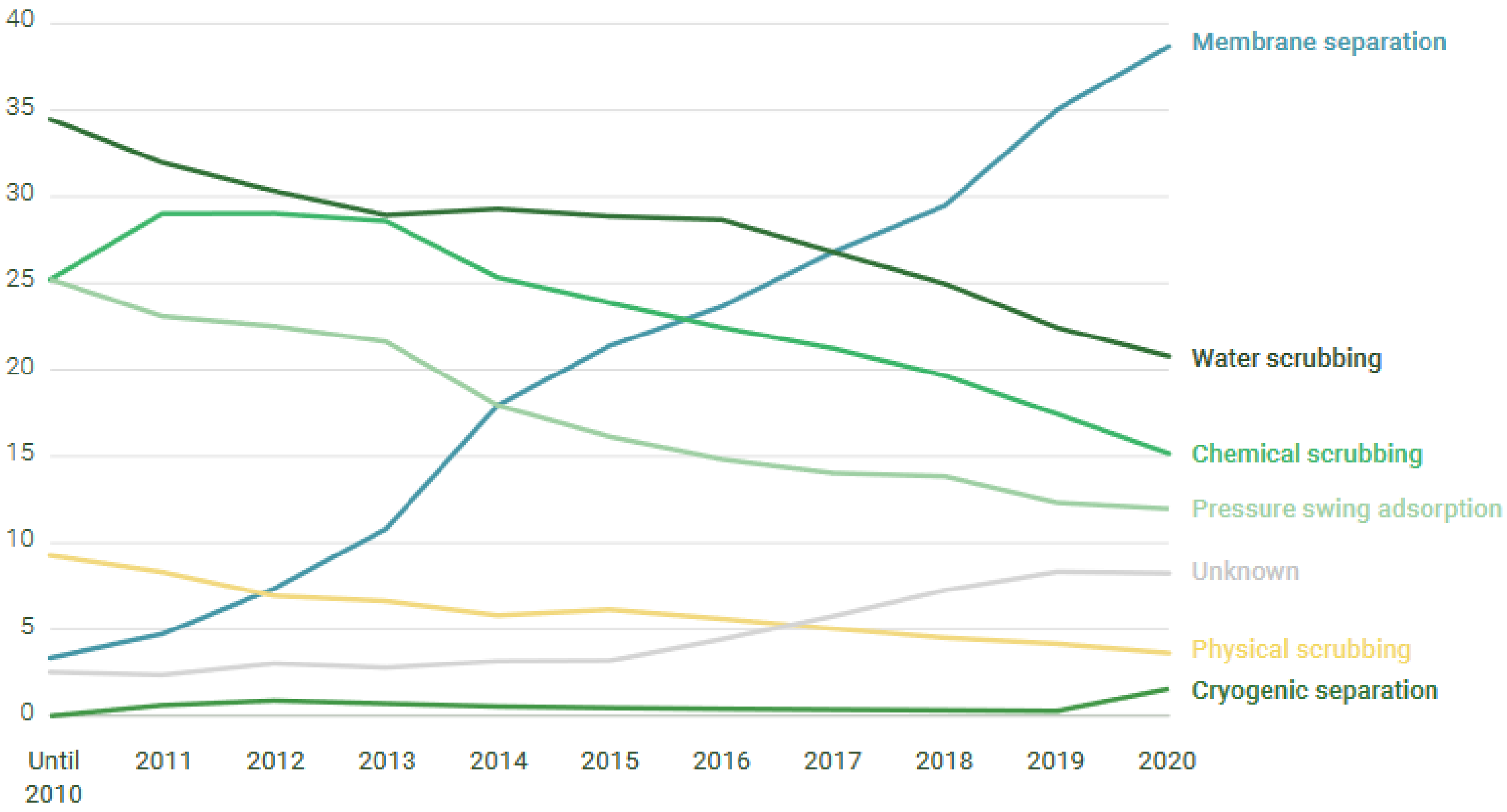
Current Biomethane Upgrading Trends:

- ¾ of plants use either membrane separation (39%), water scrubbing (22%), or chemical scrubbing (18%).
- Since 2013, membrane separation has gained popularity over chemical scrubbing.
- In 2020, 47% of new plants used membrane separation.

CO2 Purity & Recovery:

- All major methods can achieve up to 99% CO2 purity.

Upgrading Technologies



- **Physical/Chemical Absorption**:
  - Amine-based chemical absorption effectively captures CO2 from biogas.
  - Regeneration process liberates CO2 for reuse.
- **Membrane Systems**:
  - Flexible for various gas volumes & CO2 concentrations.
  - Separates methane-rich & CO2-rich streams for recovery.
- **Cryogenic Separation**:
  - Directly produces liquid CO2, ideal for long-haul transport.
  - Energy-intensive due to refrigeration needs.

Marketing

- Premium image impact in value chain
- Biogenic CO_2 vs. fossil-based CO_2

Technical

- High CO_2 purity (>98%)
- No carbon monoxide (biogas inherently CO-free)
- Very low NH_3 & H_2S (<10ppm, typically removed in upgrading)
- Main contaminants (CH_4 & air) are non-toxic

Economic

- Locally produced, decentralized & de-risked supply
- Price stability (exempt from carbon tax & allowances)
- Programmable production & secured supply options

Political

- Supports local bioeconomy synergies

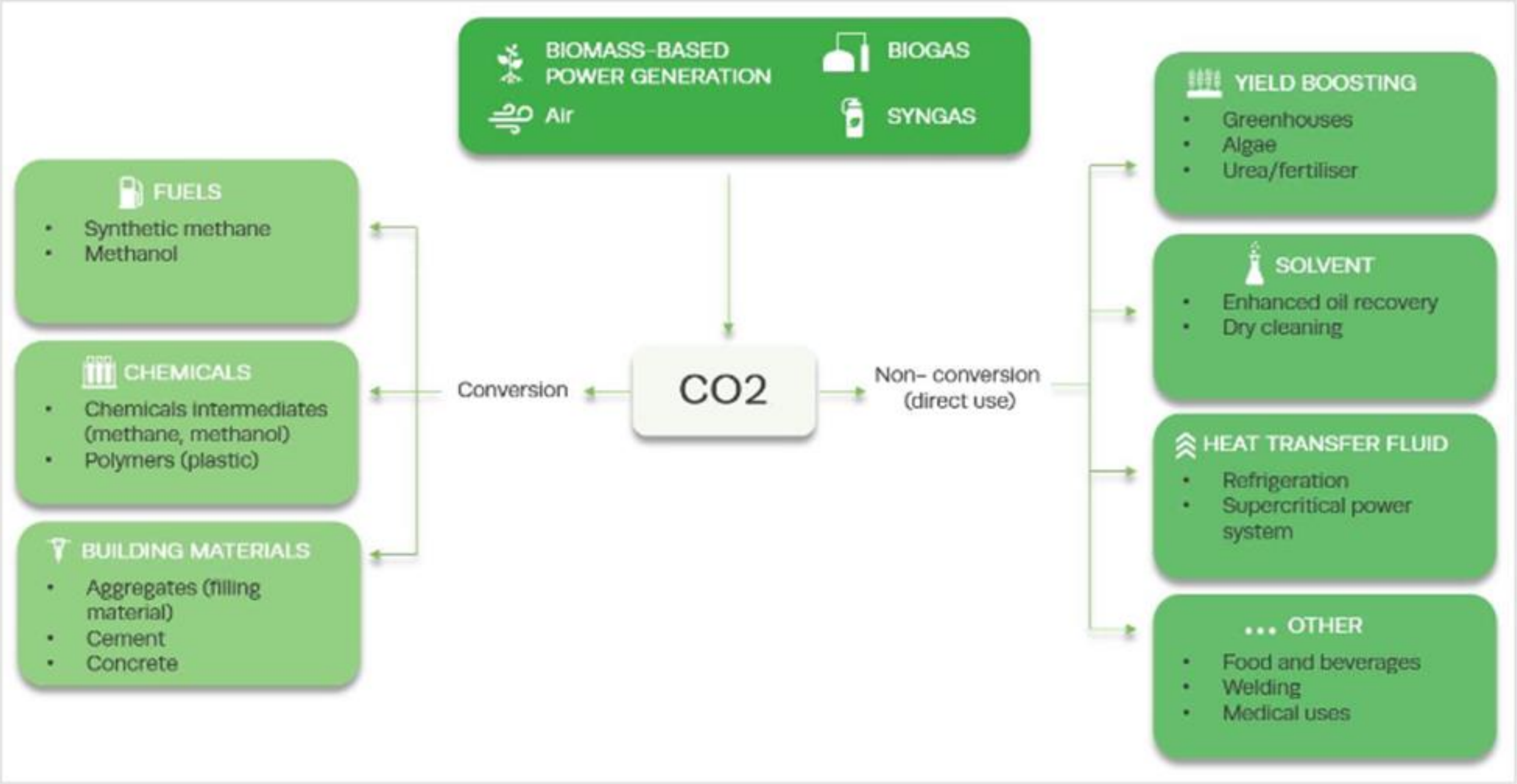
Innovative AD solutions-The Future of the Biogas Industry

•Biogas industry is evolving with new opportunities for growth and sustainability.

•Key trends shaping the future:

- **Integration with Renewables** – Hybrid energy systems combining biogas, solar, and wind for energy stability.
- **Hydrogen Production** – Utilizing biogas for renewable hydrogen via dark fermentation or methane reforming, or plasma dissociation
- **Decentralized Energy Production** – Localized biogas plants reduce transport costs and promote energy autonomy.

Simplified classification of pathways for CO2 use



SAF production with Biomethane to GTL via Fischer Tropsch

Syngas Clean-up can be tailored to feedstock & project needs :

Essential for FT catalyst protection

Combination of commercial & proprietary clean-up steps (biogas or biomethane)

•Removes key contaminants to ppb levels

•Extends catalyst lifespan significantly

Air Separation for Syngas Production

•Oxygen supply options:

- Cryogenic Oxygen & Vacuum Pressure Swing Adsorption (VPSA)
- Vendors: Praxair, Air Products, Air Liquide, Matheson

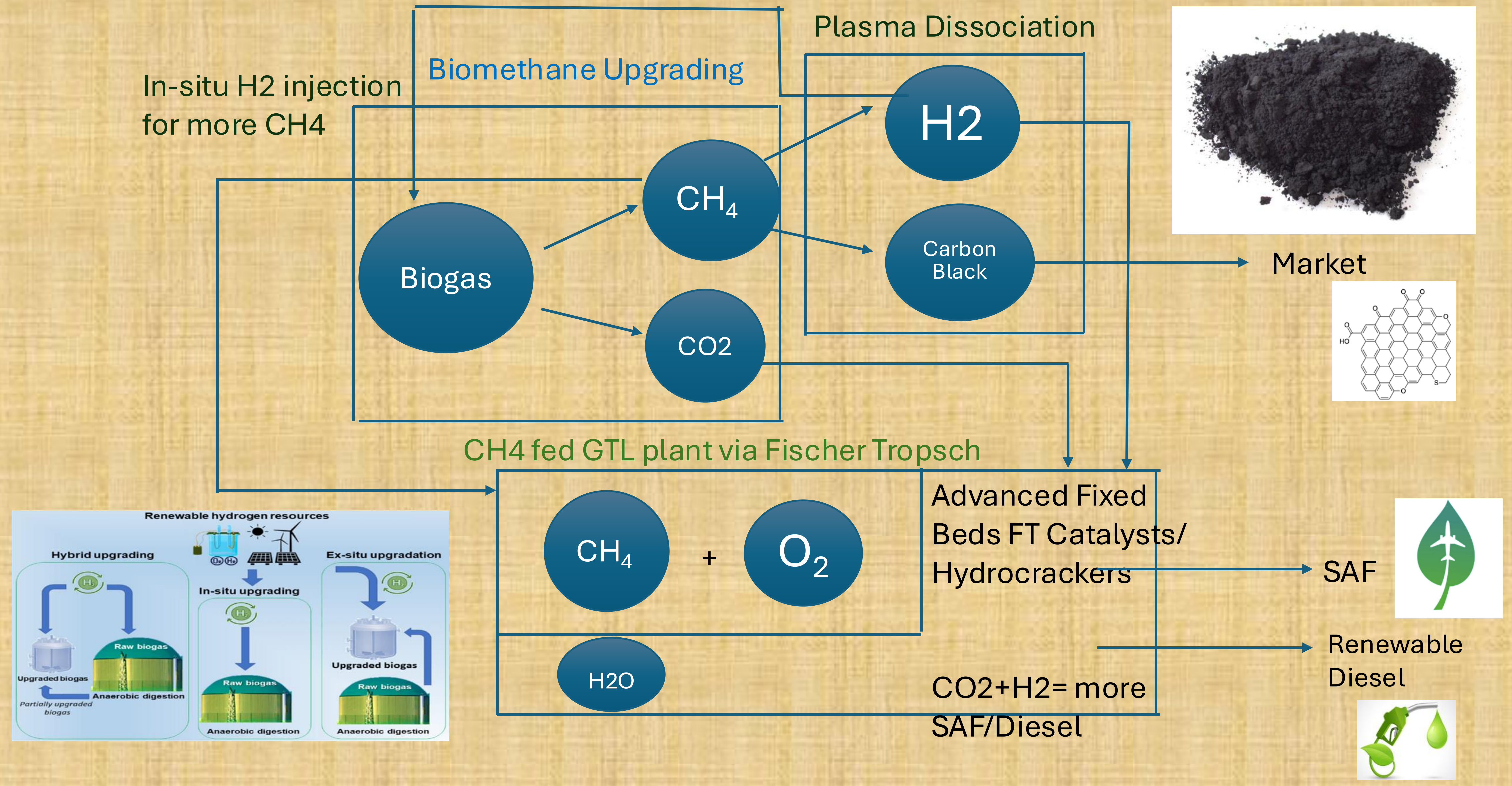
"Over the fence" oxygen supply or on-site units

Advanced Fixed Bed FT Catalyst/Reactor System

Key Performance Metrics:

- Methane Selectivity: <8% (vs. 12-16% conventional reactors)
- Alpha (Chain Growth Probability): >0.92 (higher middle distillate yield)
- Productivity: 2-3x conventional fixed bed reactors

Biogas Upgrading-Plasma Dissociation-SAF/renewable Diesel production



Production of Green Hydrogen-Plasma Dissociation

- Alternative to electrolyser
- Green H2 process in which we treat methane by plasma dissociation.
- pyrolysis process in which we rely on renewable energy and biomethane as feedstock
- cheaper and more efficient than with conventional electrolysis.
- Decarbonizing biogas (CH4) into hydrogen (H2) & carbon (C)
- Plasma arc breaks methane without combustion, avoiding CO_2 emissions
- Thermal energy generated for additional applications

Hydrogen's Role in Energy Transition

- Odorless, non-toxic, and lighter than air
- Stores and releases energy without CO_2 emissions
- Key applications: energy storage, power generation, automotive industry

Projected Hydrogen Demand

- Global demand forecasted at 117M metric tons by 2030 (Air Liquide, 2020)
- Current electrolysis methods are unsustainable for meeting demand
- SFI plasma methane pyrolysis as a scalable solution

Key take away from SAF production

- GTL via FT process produces synthetic paraffinic kerosene (SAF) drop in Jet A fuel (ASTM D16555)
- Biogenic CO_2 + renewable hydrogen improve carbon efficiency
- Hydrogen & carbon black co-production via plasma dissociation
- Liquefied biogenic CO_2 for use in e-methanol and SAF

Advantage of Plasma H2 production vs Electrolyser

Electrolysis is currently considered the most efficient solution for the production of green hydrogen. Hydrogen is produced from renewable energy (electricity) and water. From an economic point of view, however, this process offers a decisive disadvantage:

To produce 1 kg of hydrogen (calorific value 33.33 kWh), electrolysers require about 53 kWh of electricity. If this 1 kg of hydrogen is now converted into electricity by means of a fuel cell, about 25 kWh of energy are obtained.

- **This corresponds to an energy loss of more than 53%!**
- In addition, a water consumption of 9 l ultrapure water (up to 21 l water) has to be added.
- **SFI plasma methane pyrolysis process requires only 10 kWh of electrical energy for the same amount of hydrogen.**

Feedstock Diversification

- Moving beyond agricultural waste & manure (65% of EU resource)
- **New feedstocks:**
  - Food waste, industrial organic waste, and energy crops
  - Secondary waste like lignocellulosic biomass (straw, husks, pulp)
- **Challenges:**
  - Complex cell structures require specialized pre-treatment
  - Investment in tailored equipment and co-digestion techniques

The Future of the Biogas Industry
Straw technology

Pelletec D8.0 Efficiency:

•Uses less than a third of the energy compared to other systems.
•Higher output per hour, suitable for both mobile and stationary operations.
Cost Savings:
•Pays off within two years by reducing labor, time, energy, transport, storage, and space costs.
•Enhances performance, product quality, output, versatility, and usage time.

Pelletec-Straw technology

Energy and Production:

•Energy consumption kept below 3% during pelletizing.

•Production capacity of up to 8 tons per hour, depending on material.

Smart and Flexible Design:

•Modular design for use on a truck, tractor-mounted trolley, or stationary unit.

•Operates year-round with minimal energy and space.

Mobile Pelletizing:

•Minimizes logistics costs by pelletizing at the source (field or fixed location).

•Processes a variety of materials (straw, hay, alfalfa, energy crops, cotton stalks, field residues).

•Adjustable pellet sizes, adaptable to various needs.

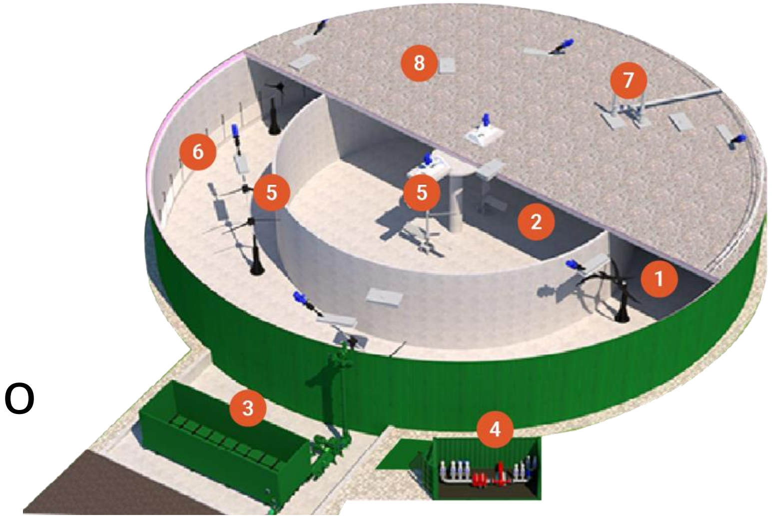
•**Pre-treatment:** Hydrothermal processing boosts methane yield (Extruder-process (heat)

•**Co-digestion:** Increases methane yield and reduce retention times

Technology advancement-Optimizing Biogas Production

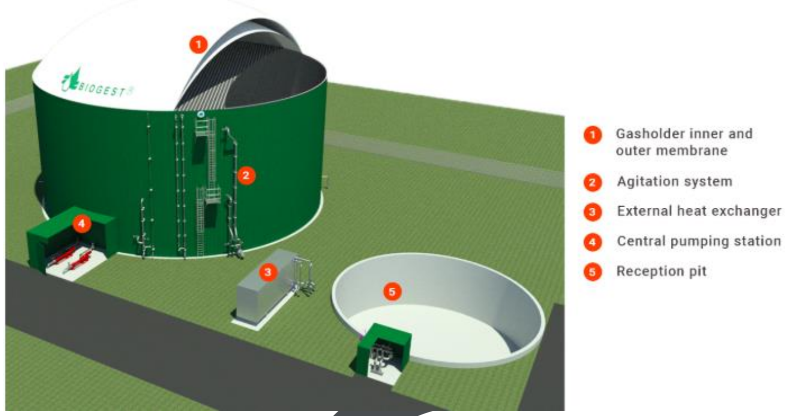
•Factors affecting efficiency:

- Substrate type and nutrient availability meets right reactor type
- Digester temperature and retention time
- Acidity level (pH) and carbon-nitrogen ratio
- Mixing, inoculants, and volumetric load

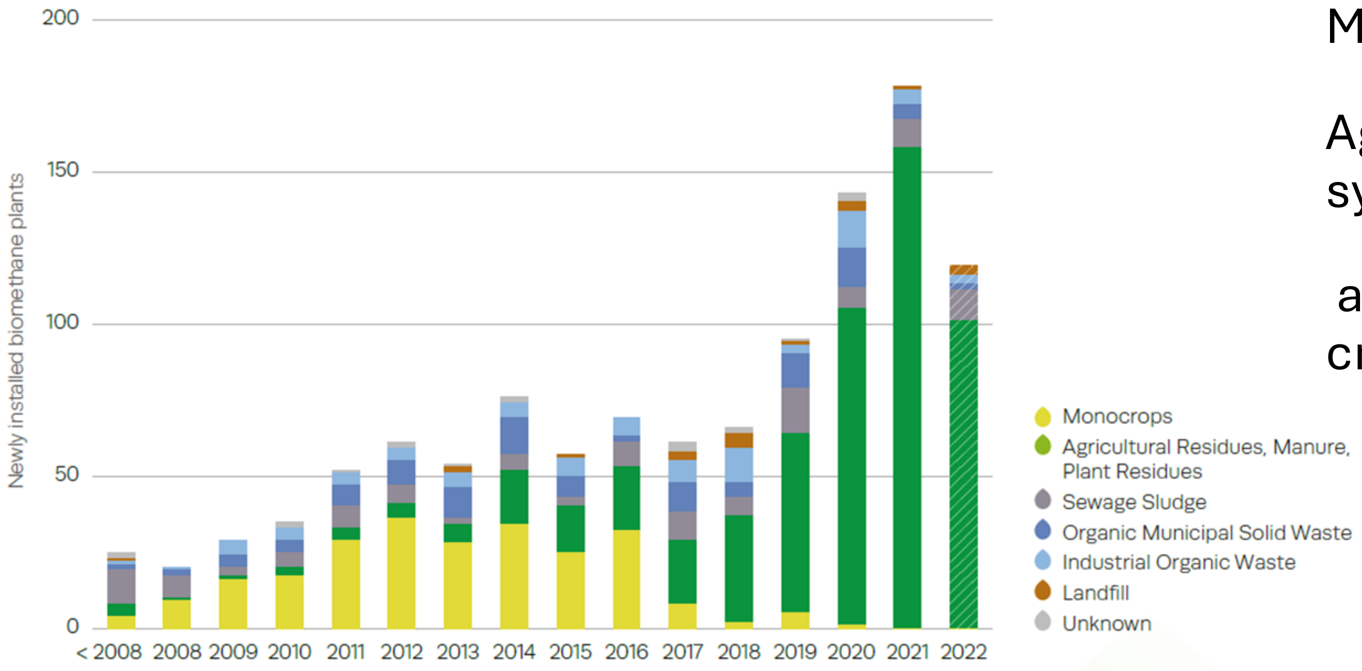


•Improvement strategies:

- Advanced pre-treatment techniques for feedstock utilization (thermal, mechanical, enzymatic, etc)
- Co-digestion with diverse organic materials
- Monitoring and control systems for process optimization



Technological developments on feedstock and feedstock potentials



More focus on:

Agricultural Residues ready to be used in AD systems (straw technology)

and integration of sequential crops/energy crops

Source: EBA Statistical Report 2022

Feedstock availability for biomethane production

Feedstock Potential and Challenges

•Livestock Manure & Food Waste:

- These feedstocks could produce 23.14 bcm of biomethane, bringing the EU closer to its 2030 target of 35 bcm.

•Cereal Straw:

- Despite technical challenges (e.g., for anaerobic digestion), cereal straw has significant potential as a feedstock, with advancements in pelletizing and disintegration technologies.

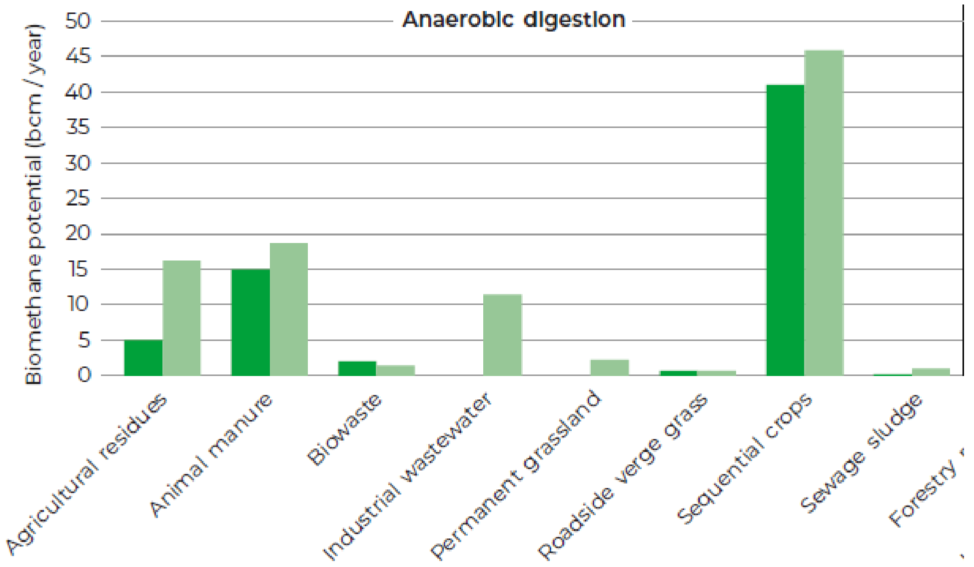
•Sewage Sludge:

- Sewage sludge from municipal wastewater treatment plants presents high biogas generation potential with limited competition for AD use.

•Sustainable Cropping Systems:

- Research is underway into sustainable cropping systems like sequential cropping (ca.50% feedstock supply between 2030&2050) and utilizing marginal lands for energy crop cultivation, which could play a vital role in green fuel supply, such as SAF.

Biomethane potential in 2050 per technology and feedstock



Agricultural residues FOOD & Energy crops

- Circular economy farming as keystone for Food and fuel supply
- Soil health, Nutrient integrity of Plant-root-soil systems
- Carbon Sequestration & Marginal Land utilisation

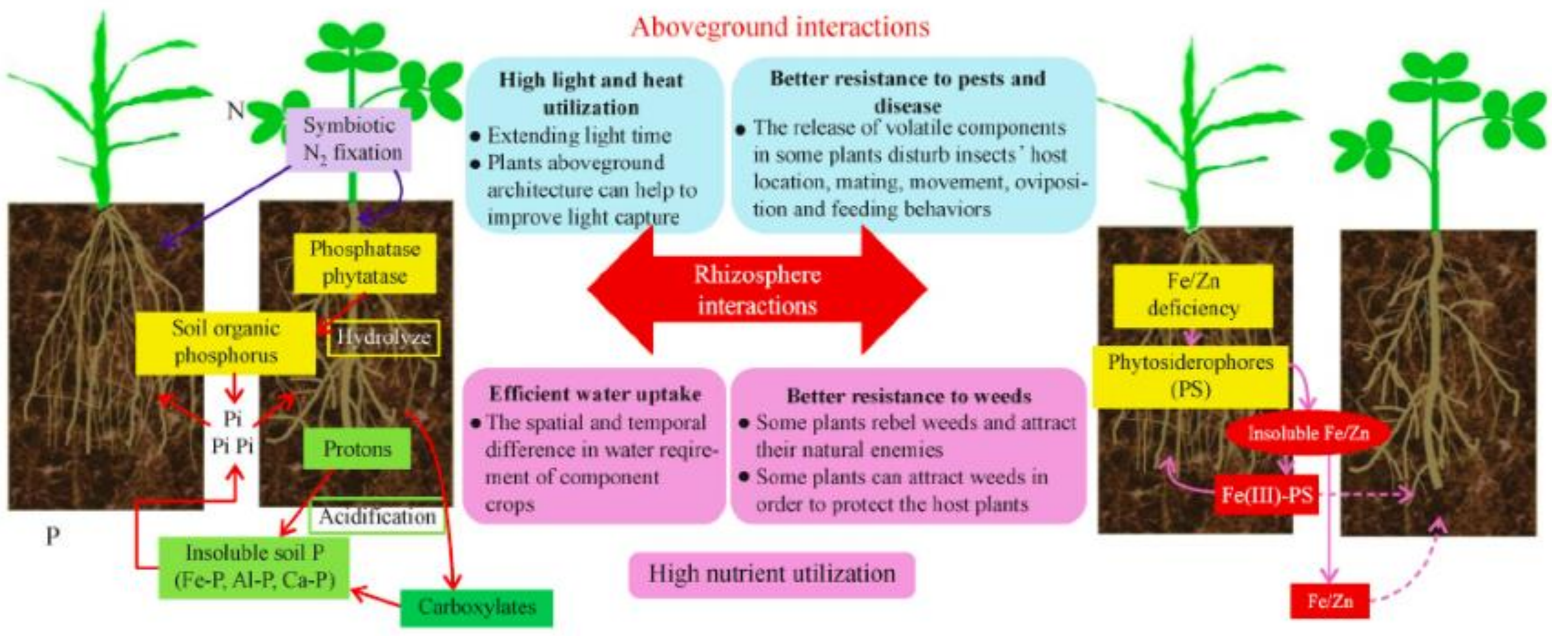


Fig. 1 Biological mechanisms of improving resource use efficiency in intercropping system

Agricultural Benefits of Intercropping

•**Higher Yields**:
- Wheat/maize (+48-56% wheat yield), maize/beans (+26%), faba bean/maize (+21-23% & 6.5-11.8%)
- **Nutrient Boost**: Iron & zinc levels improve in wheat/chickpeas

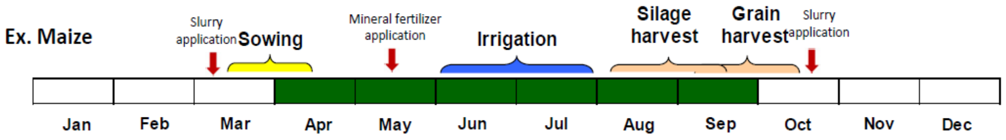
•**Disease Resistance**: Mixed rice varieties reduce blast disease (−94%) & increase yield (+89%)

•**Weed & Pest Control**:
- Banana/maize/soybean intercropping suppresses weeds & boosts yield
- Controls striga & stemborers in maize, sorghum, millet

- ➲ The BiogasDoneRight concept
- ➲ More soil biology amendment and mandates for enhanced soil health, monitoring and sequestration standards and shared lessons learnt of intercropping, nutrient uptake , soil carbon increase (up to 15t/ha x3,67=55t CO2 sequestered per hectare)

Conventional Agriculture

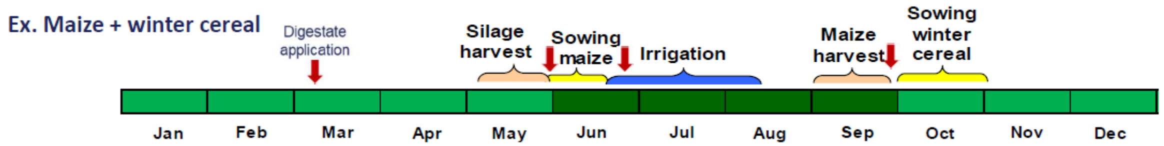
- Dairy farm, crop production to feed/food
- Arable crops, one-two crops per year (mainly maize)
- Fertilisation based on livestock manure + mineral



- ✓ Soil covered **6 months** per year
- ✓ Total above ground biomass around **23 DM t/ha/year (grain 13)**
- ✓ Irrigation: **necessary**
- ✓ Herbicides: **necessary**
- ✓ Soil tillage: **heavy (ploughing)**
- ✓ Organic matter level in soil: **steady or slightly down**

BiogasDoneRight® concept

- Dairy farm, crop production to feed/food/energy
- Arable/no till crops, two crops per year (several)
- Fertilisation based on digestate



- ✓ Soil covered **12 months** per year
- ✓ Total above ground biomass around **30 DM t/ha/year (maize 18 + triticale 12)**
- ✓ Irrigation: **necessary**
- ✓ Herbicides: **reduced** (especially if agricultural work happens quickly)
- ✓ Soil tillage: **reduced**
- ✓ Organic matter level in soil: **increasing**

Conclusions

Waste-to-Energy & SAF Policy Outlook

•Maximizing Waste-to-Energy Potential:

- Waste-to-energy projects will be explored to their full potential, contributing to green fuel production and carbon sequestration.

•European SAF Mandates:

- SAF production will rely on countries with abundant land, ensuring scalability and sustainability in meeting SAF targets.

•Utilizing Marginal Land and cover it 365 days:

- Maximizing the use of marginal and abandoned land for energy crop cultivation is crucial to meeting global SAF and renewable fuel targets.

•Carbon Sequestration through SAF Plants:

- SAF plants have the potential to become carbon sinks by integrating energy crop cultivation with nutrient dense food crops, improving land productivity and carbon capture.

•Reevaluating Sustainable SAF Production:

- Ongoing reevaluation is needed to unlock the full potential of SAF production, ensuring that all available feedstock and technologies are fully utilized.

Thank you!

greenmeup.eu

@greenmeup

greenmeup

info@greenmeup.eu

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No 101075676