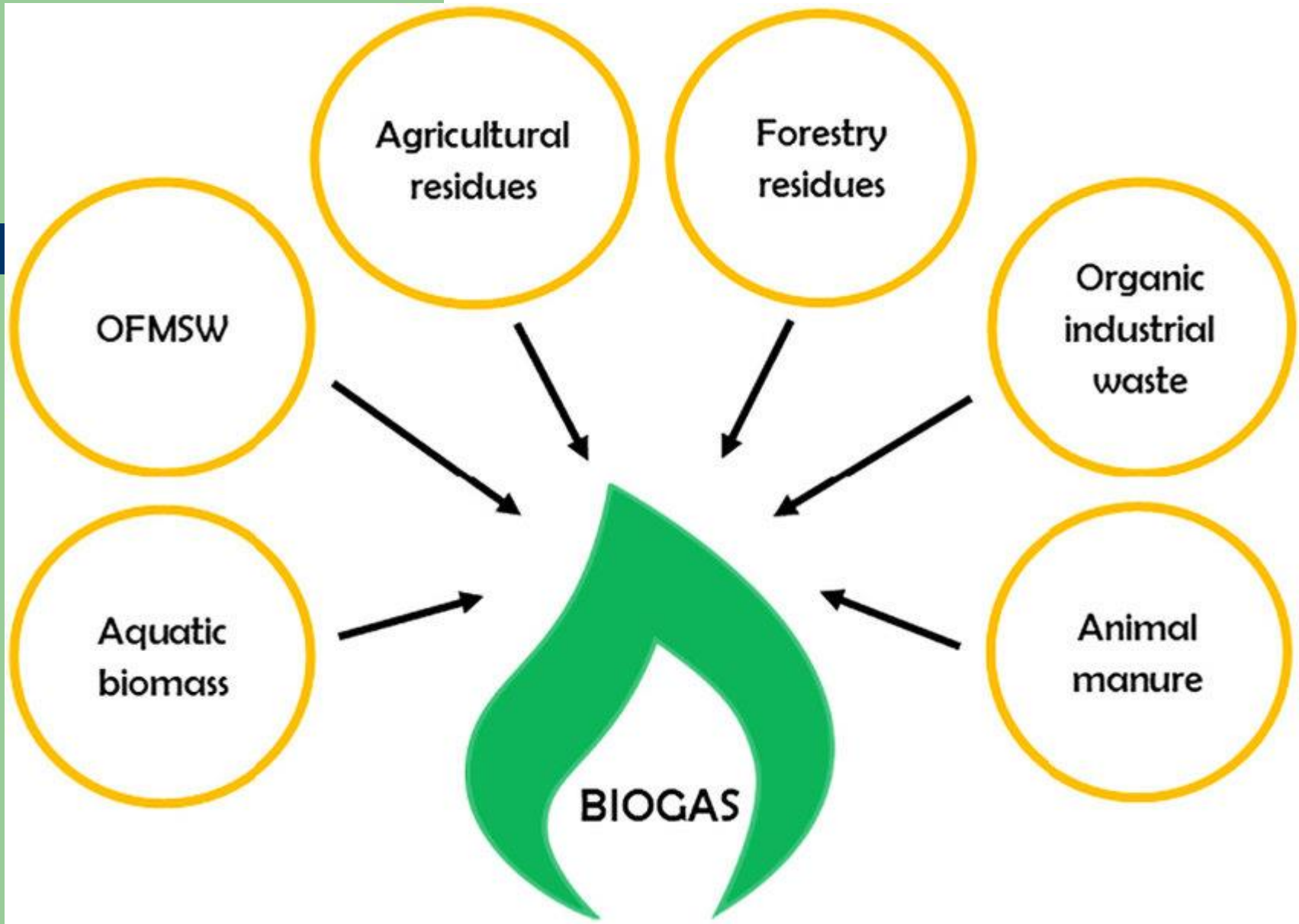
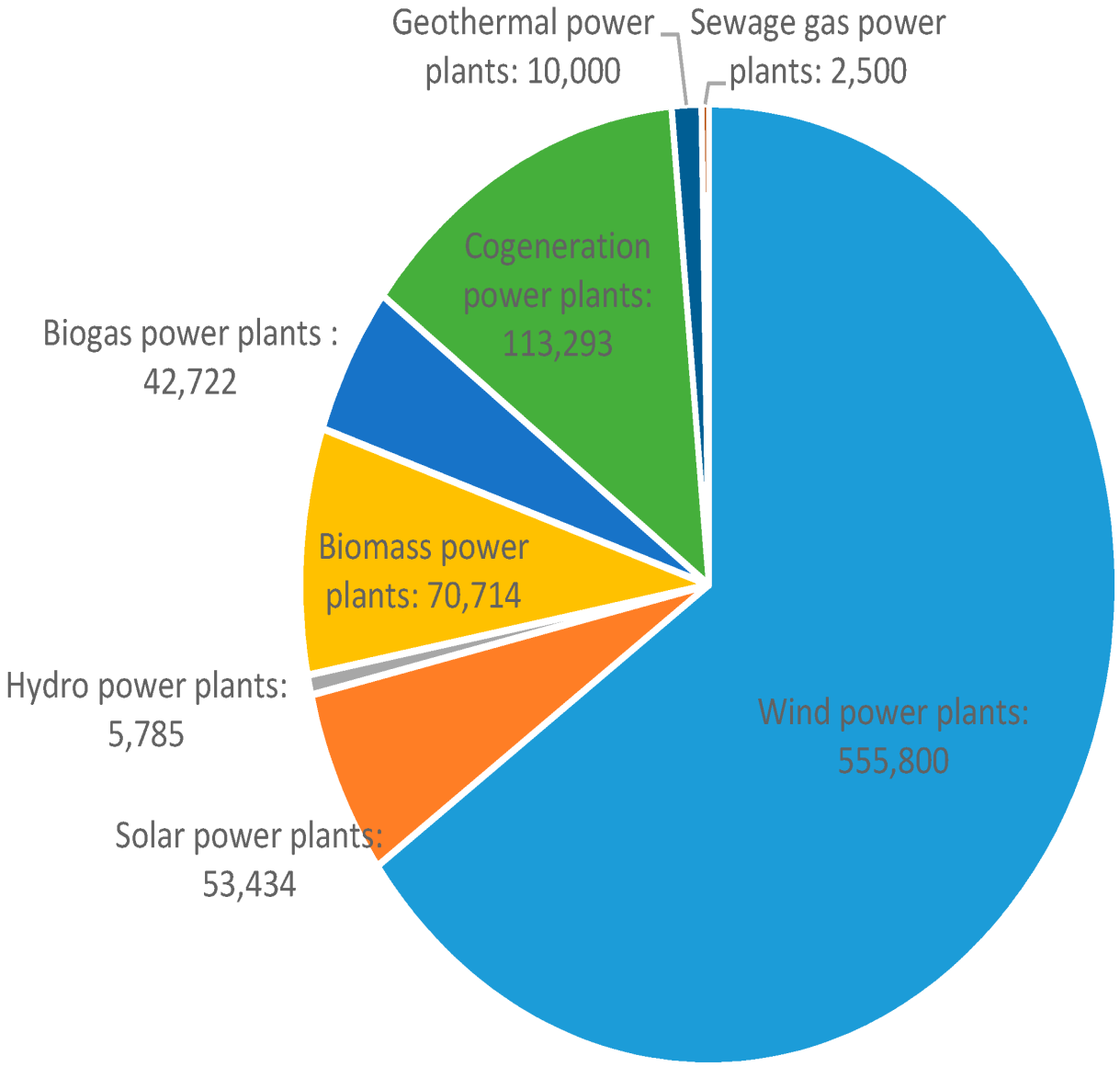
Biogas Production Using Small Scale Biodigester

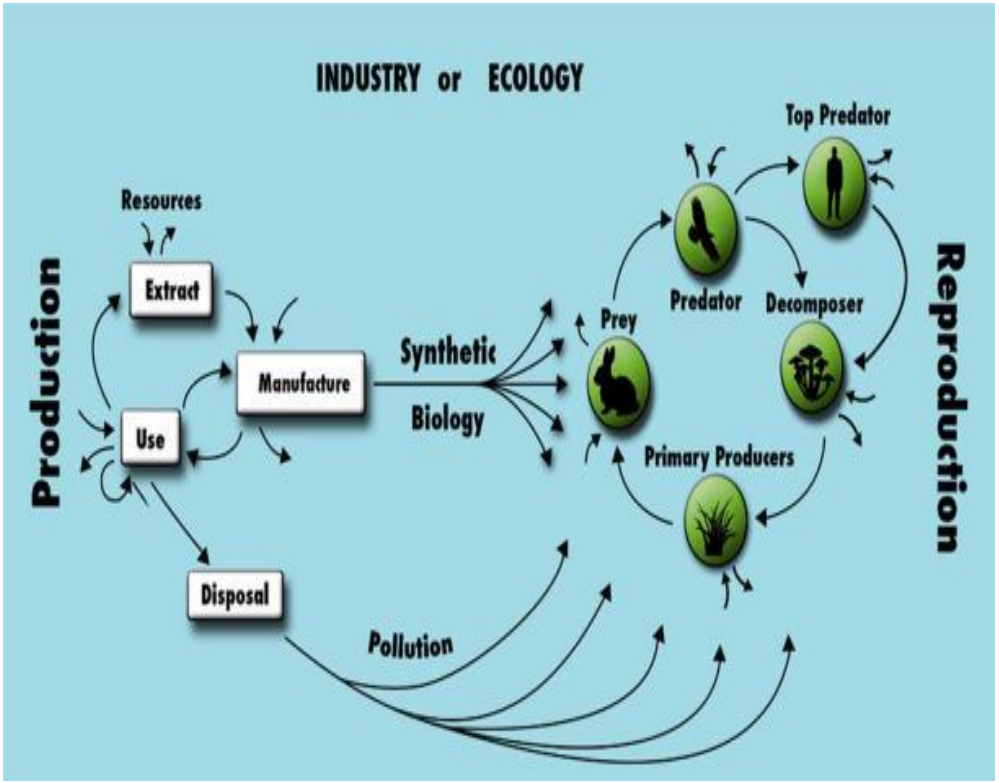
BIOGAS PLANT


Agricultural residues
Forestry residues
OFMSW
Organic industrial waste
Aquatic biomass
Animal manure
BIOGAS


Geothermal power plants: 10,000
Sewage gas power plants: 2,500
Cogeneration power plants: 113,293
Biogas power plants : 42,722
Biomass power plants: 70,714
Hydro power plants: 5,785
Solar power plants: 53,434
Wind power plants: 555,800

Introductio n

- Are biofuel “carbon neutral”?
- that CO_2 emissions produced during combustion of the fuels **are completely offset** by the biogenic CO_2 uptake during plant growth.
- The boundaries between industry and the environment are blurred.
- Information exchange is not designed in the industrial/ecological systems boundary (i.e., genetically modified



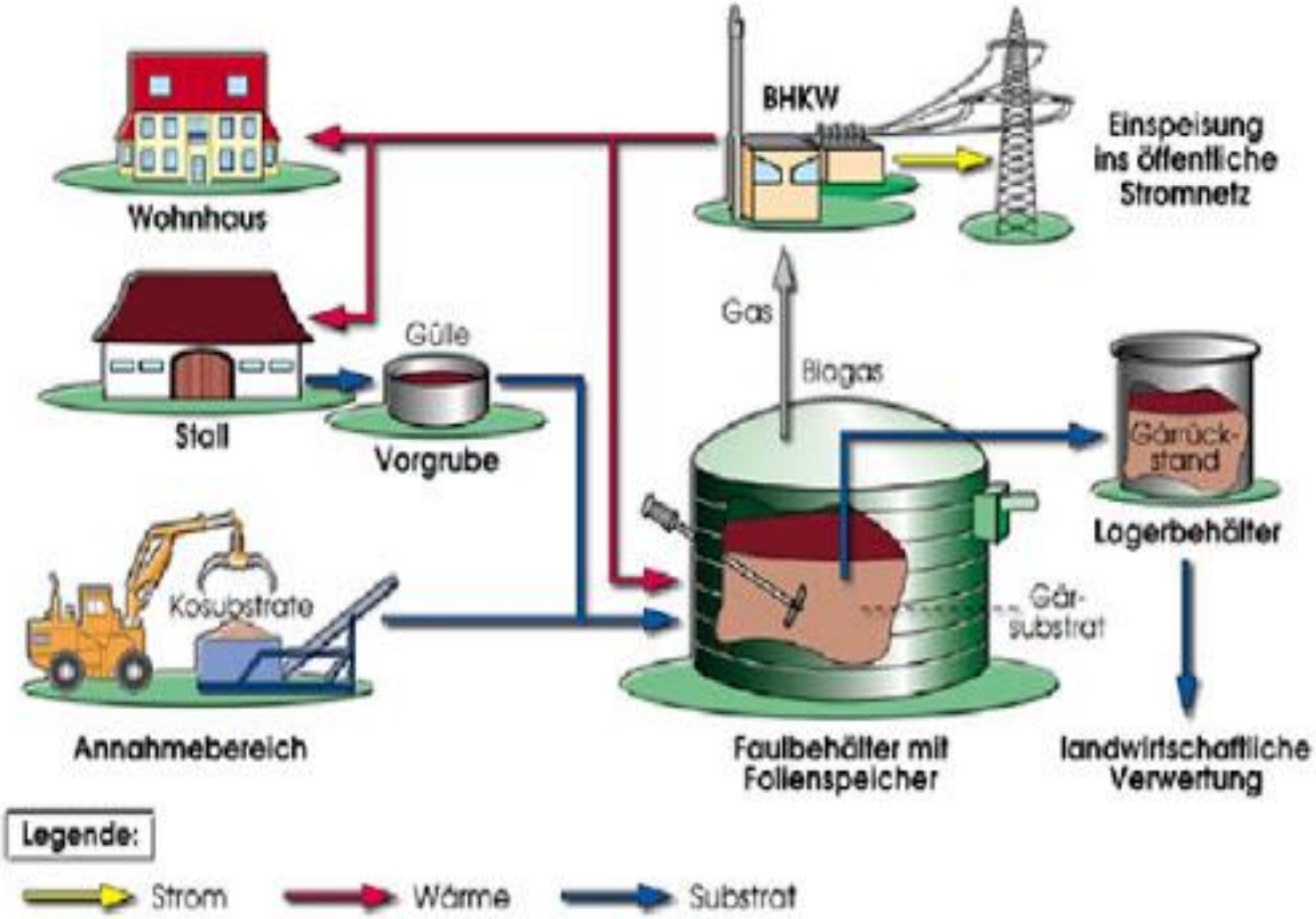
Source: Seager et al., 2

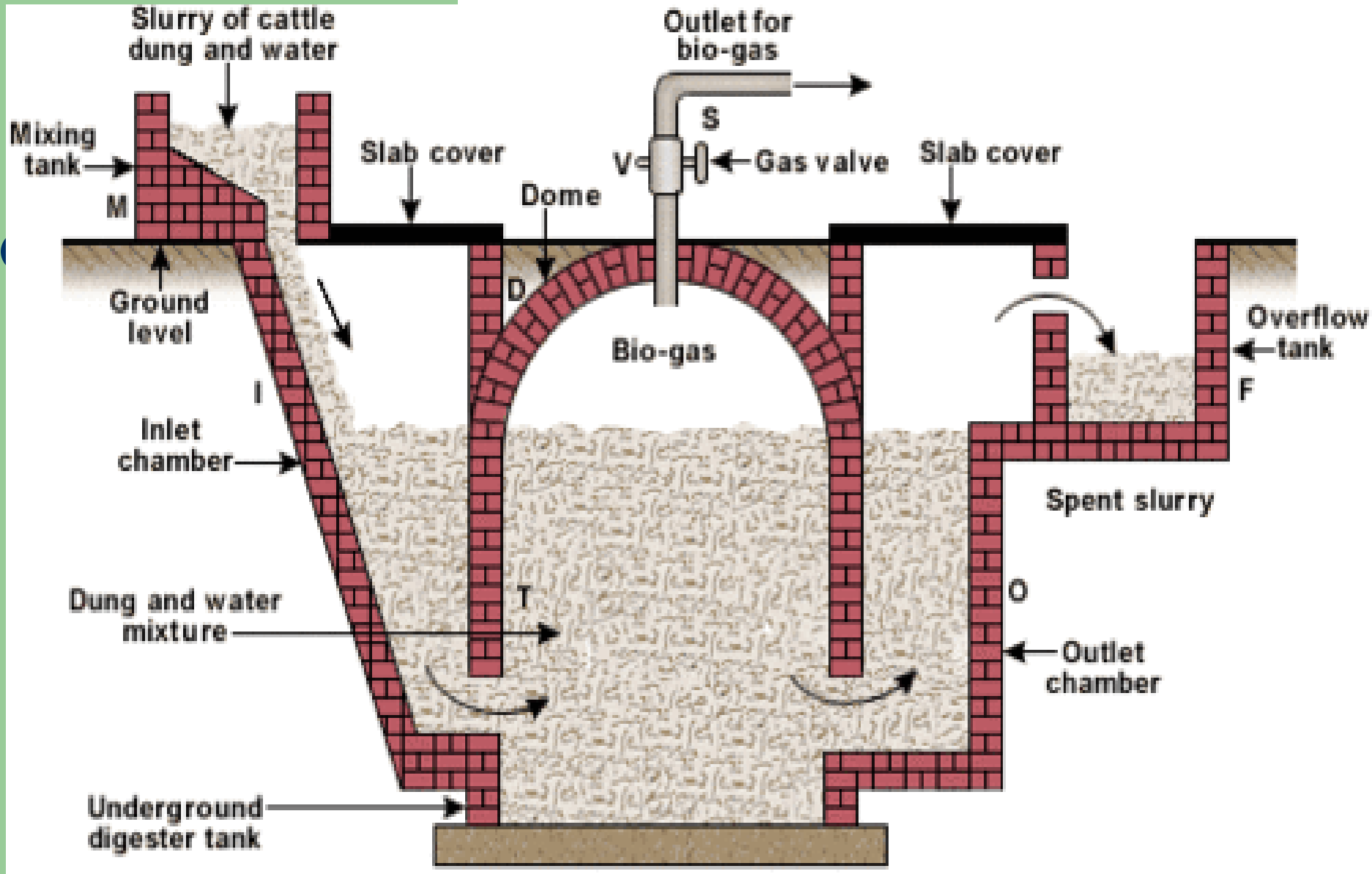
What is Biodigester?

- Biodigester is a system that promotes decomposition of organic matter.
- It produces biogas, generated through the process of anaerobic digestion.
- Biogas generated can be used for cooking, heating, electricity generation, and running a vehicle.

Anaerobic Digestion

- Reduce
  - Smell
  - Greenhouse gas
  - Pathogen level
- Produce biogas
- Improve fertilizer value of manure
- Protect water resources


BHKW
Einspeisung ins öffentliche Stromnetz
Wohnhaus
Gas
Biogas
Güle
Stall
Vorgrube
Gärrück-stand
Lagerbehälter
Kosubstrate
Gär-substrat
Annahmebereich
Faulbehälter mit Folienspeicher
landwirtschaftliche Verwertung
Legende:
Strom
Wärme
Substrat



Fixed-dome type bio-gas plant.

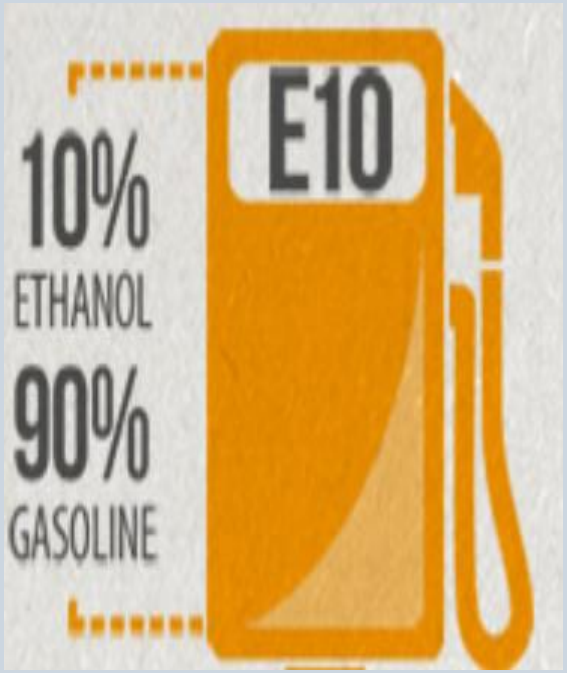
The Process of Biodigestion

- Liquefaction
- Acid Production
- Acetate Production
- Methane Production

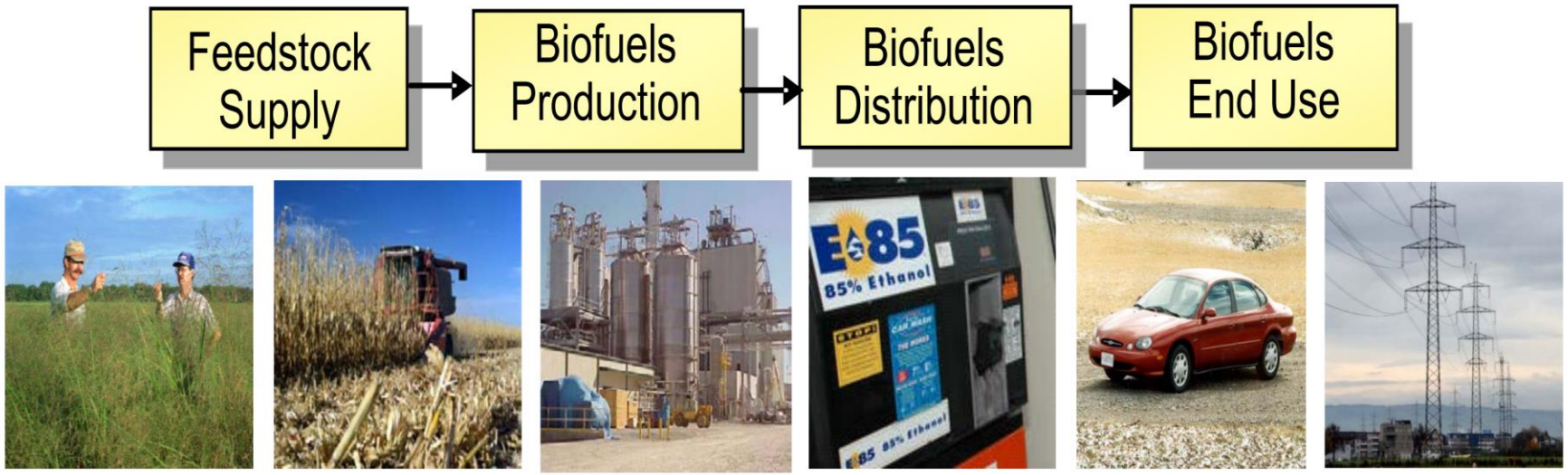
Motivation

Three birds with one stone

- Use up damaged stocks
- Less air pollutants from vehicles
- Less open biomass burning



Motivation



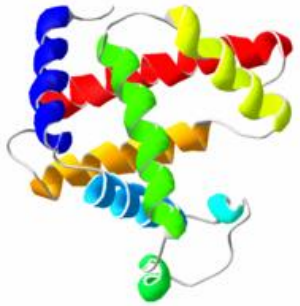
Source: Male, 201

The processes used to grow and collect biomass, including any associated land-use change, can incur additional GHG and PM2.5 emissions.

Liquefaction

- Complex organic matter is degraded to basic structure by hydraulic bacteria.

- Protein -> Polypeptide and Amino Acid
- Fat -> Glycerin and Fatty Acid
- Amylose -> Monosacride and Polysacride



Acid Production

- Also called the acidogenesis
- Simple organic matters are converted into H^2 and CO_2
- Acting bacteria in this process are called hydrogen-producing bacteria and acid-producing bacteria.

Acetate Production

- Acetogenesis.
- The short-chain fatty acids are metabolized by synthrophic acetogenic and homoacetogenic bacteria into acetate, carbon dioxide, and hydrogen.

Methane Production

- Methanogenesis
- In this process, acetic acid, H_2, CO_2, are converted into CH_4.
- Methane-producing bacteria have strict PH requirement and low adaptability to temperature.

Biogas

- Biogas is generated by the activity of anaerobic bacteria.
- Biogas is comprised of about 60% of methane, 40% of carbon dioxide, and small amount of hydrogen sulfide, nitrogen, and hydrogen.
- The heating value of biogas is about 60% of natural gas and about 25% of propane.
- Biogas has corrosive nature and storage of biogas is not practical.

Application of Biogas

- The technology of biodigester is widely used in developing country such as China, Vietnam, India, and Central and South America as well as in developed country.
- Anaerobic digester can be used in remote farm area to produce biogas from manure and protect water resources.

Basic Designs of Digester

- Continuous-fed
- Batch-fed

Continuous-fed System

- Suited for large-scale manure substrate bioreactor.
- Steady biogas production can be expected.
- May require auxiliary equipments.
- Requires high liquid content.
- Temperature, loading rate, and solid content need to be carefully monitored.

Batch-fed System

- The simplest design.
- Low cost.
- The feedstock is loaded one batch at time.
- Irregular biogas production.
- Can operate on high solid content.
- Less susceptible to fluctuation of factors.
- Requires manual labor.

Bag Biodigester

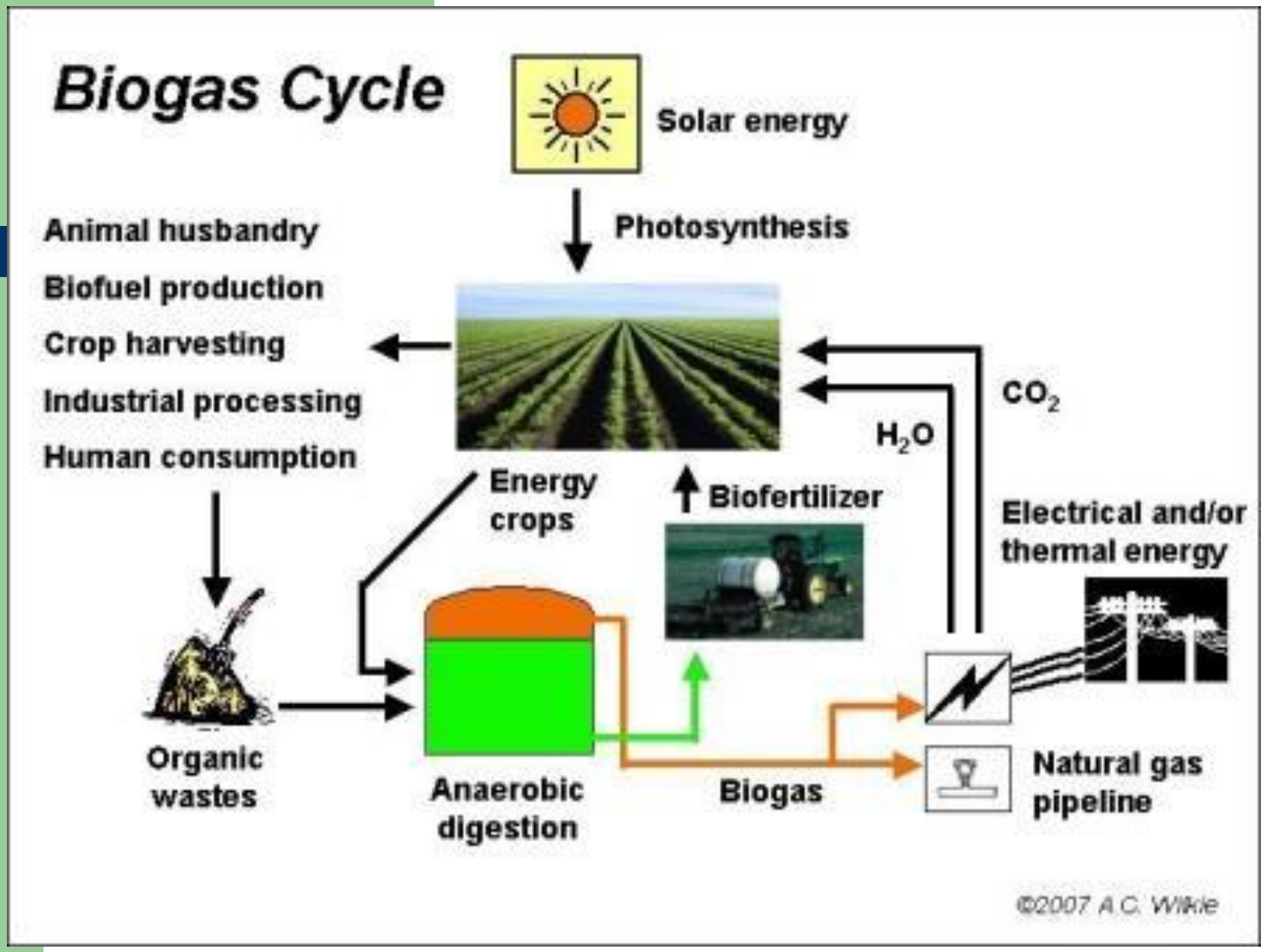
- The idea is to make a small-scale, low-cost biodigester plant so that anyone in the world can make it and produce biogas.

Preparation

- Feed the bag with the effluent.
- Cut the garden hose to an adequate length and pull the bag through the garden hose.
- Fold the bag against the surface of the garden hose.
- Attach the adapter to the garden hose over the bag.
- Connect the hose and the gas collector using adequate adapters.

Operation

- The generator requires little maintenance besides occasional stirring.
- When the batch is done, disconnect the garden adapter and unload the effluent.
- For the next batch, apply about 10% of the previous batch to activate the new batch.
- After loading the feedstock, connect the adapter again and repeat the process.


Biogas Cycle
Solar energy
Photosynthesis
Animal husbandry
Biofuel production
Crop harvesting
Industrial processing
Human consumption
CO_2
H_2O
Energy crops
Biofertilizer
Electrical and/or thermal energy
Organic wastes
Anaerobic digestion
Biogas
Natural gas pipeline
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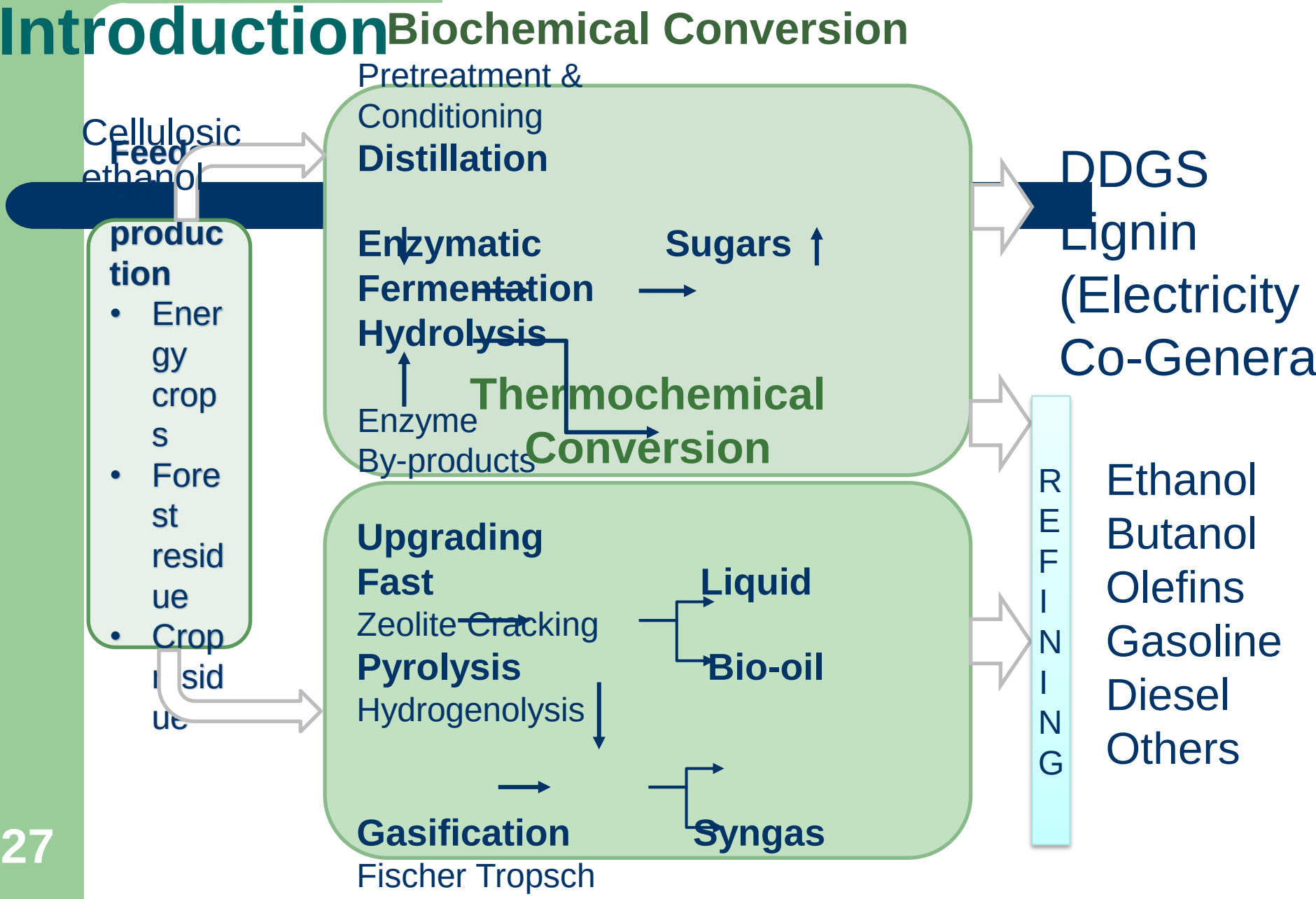
Introduction



Introduction

First Generation Biofuels

- Ethanol produced via fermentation of sugars (from corn, sugar cane, sorghum, etc.)
- Biodiesel produced via transesterification of triglycerides

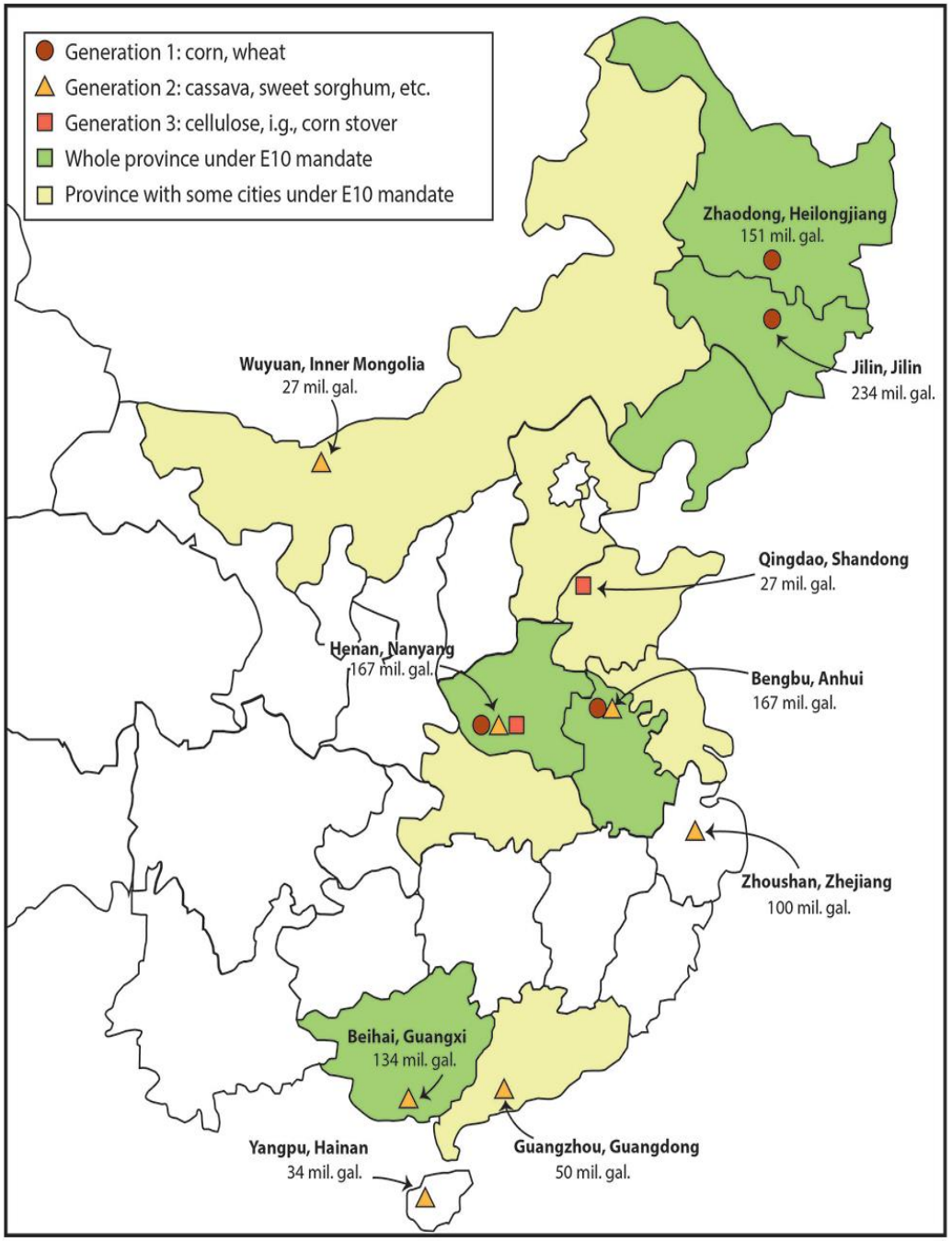
Second Generation Biofuels

- Non-food feedstocks
- Advanced processing technology
- Or both

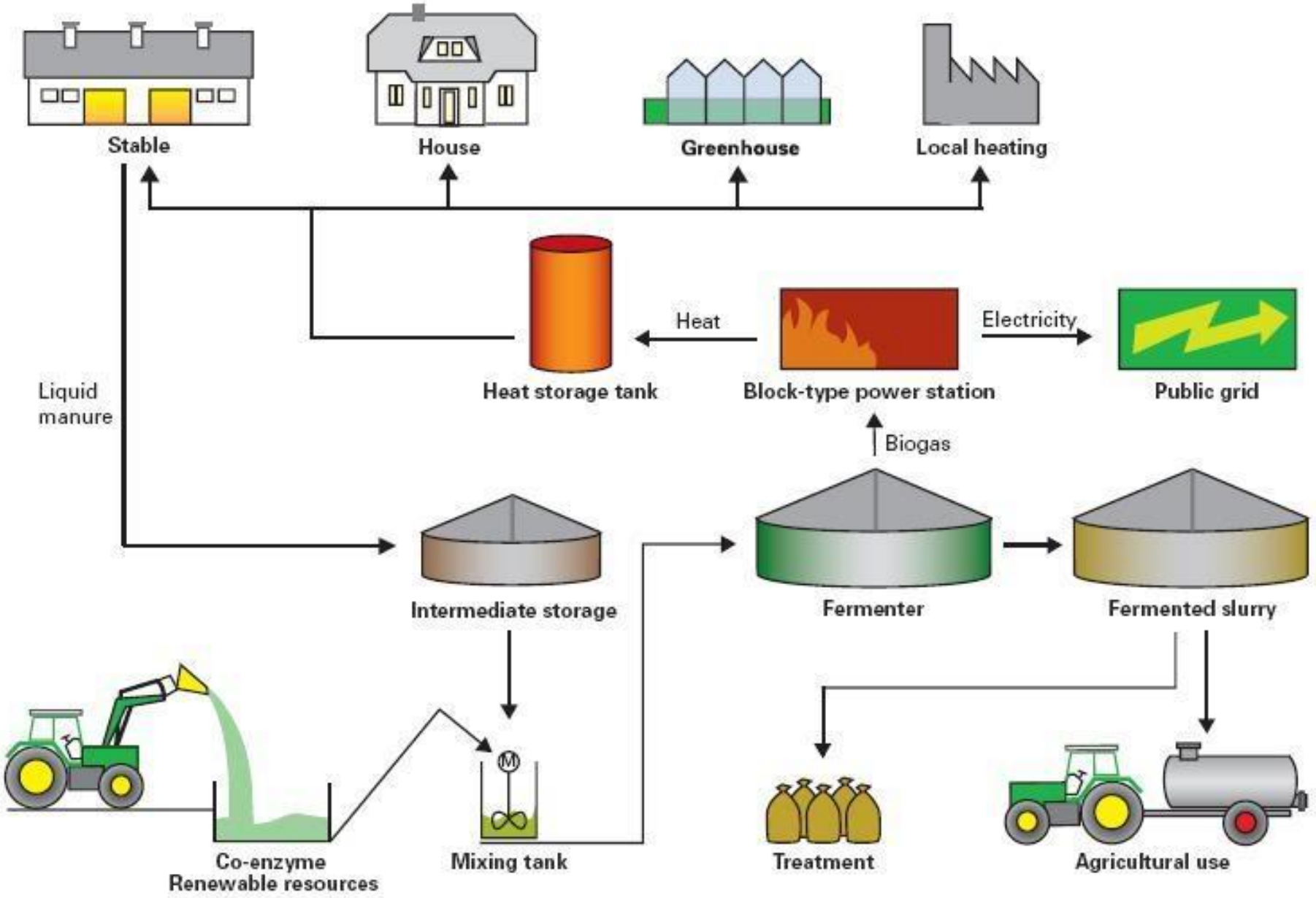
Discussion

corn ethanol producers currently accounts for 64% of total output.

- 70% of cassava are imported from Southeast Asia.
- Cellulosic ethanol production is not expected to reach



Source: Li et al,. 2017


Stable
House
Greenhouse
Local heating
Heat storage tank
Heat
Block-type power station
Electricity
Public grid
Liquid manure
Biogas
Intermediate storage
Fermenter
Fermented slurry
Co-enzyme
Renewable resources
Mixing tank
Treatment
Agricultural use

Typical composition of biogas

Compound	Formula	%
Methane	CH_4	50–75
Carbon dioxide	CO_2	25–50
Nitrogen	N_2	0–10
Hydrogen	H_2	0–1
Hydrogen sulphide	H_2S	0–3
Oxygen	O_2	0–0