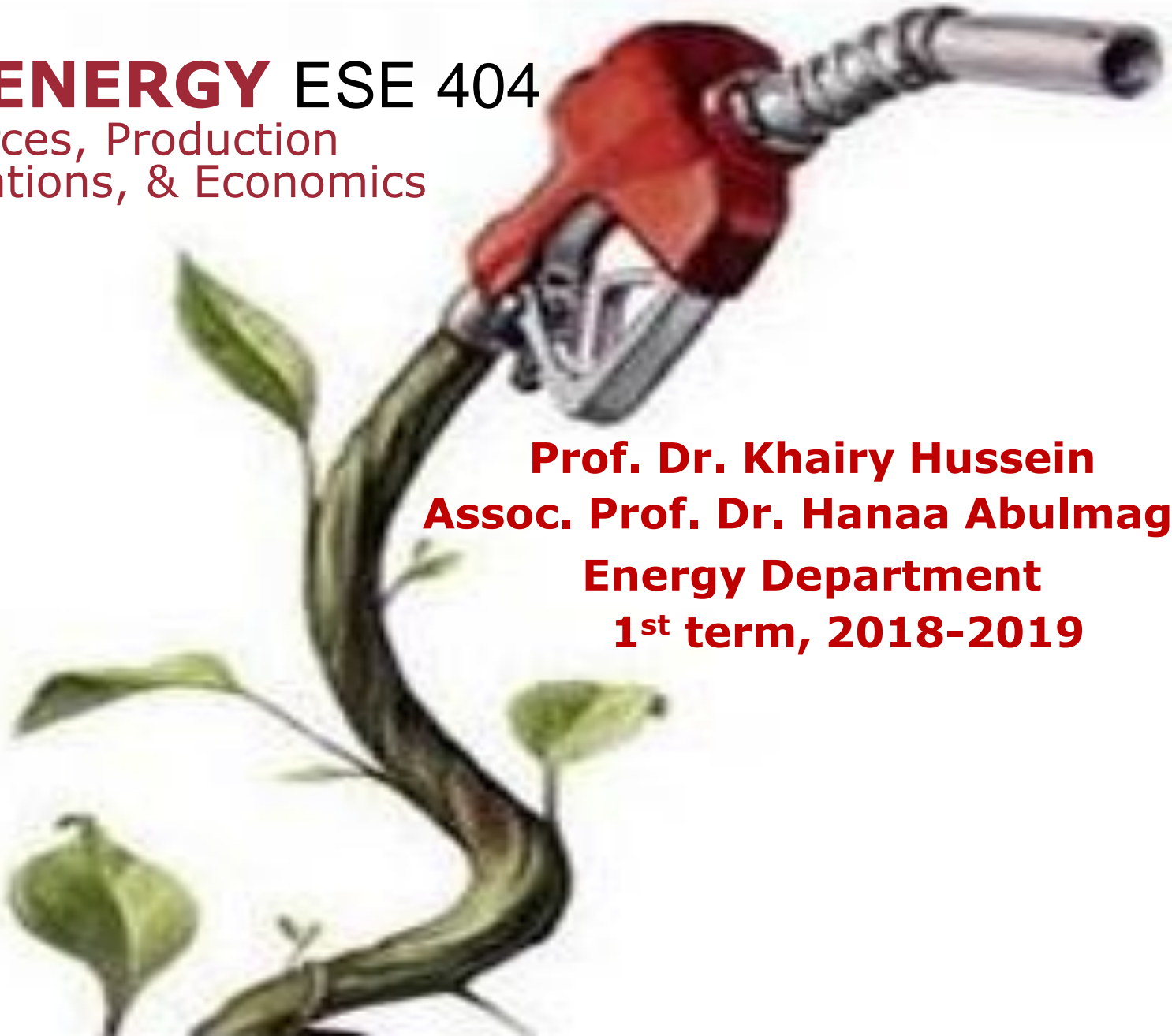


BIOENERGY ESE 404

Resources, Production
Applications, & Economics

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Energy Department
1st term, 2018-2019



Types of Biofuels

3) Biogas

Gas Biofuels

Biogas is a clean and efficient alternative fuel. It is a mixture of: CH_4 (major constituent 65%)– CO_2 – H_2 – H_2S – NH_3 .

- ❑ **Synthesis:** it is produced by a process called (**digestion**) which is an anaerobic breakdown of biodegradable materials such as manure, sewage, green waste, plants with bacteria (**methanogens**) in the absence of oxygen.
- ❑ It is produced in a closed system called digester.
- ❑ The heating value of biogas is about 60% of natural gas and about 25% of propane.





Production steps of biogas

➤ The anaerobic decomposition of organic matter occurs in a four-step process:-

1- **Hydrolysis**: the slowest step in which the hydraulic bacteria convert complex organic materials into simple liquid materials.

2- **Acidogenesis**: acidogenic bacteria convert the sugars and amino acids to alcohol and fatty acids.

3- **Acetogenesis**: acetogenic bacteria convert fatty acids and alcohols into H_2 , CO_2 and acetic acid.

4- **Methanogenesis**: methanogenic bacteria convert the H_2 and acetic acid to methane gas and CO_2 .

Types of digesters:

➤ **Mesophilic digester:** is a kind of bio-digester that operates in temperatures between 20°C – 40°C, typically 37 °C. It is the most used kind of bio-digesters in the world (90%).

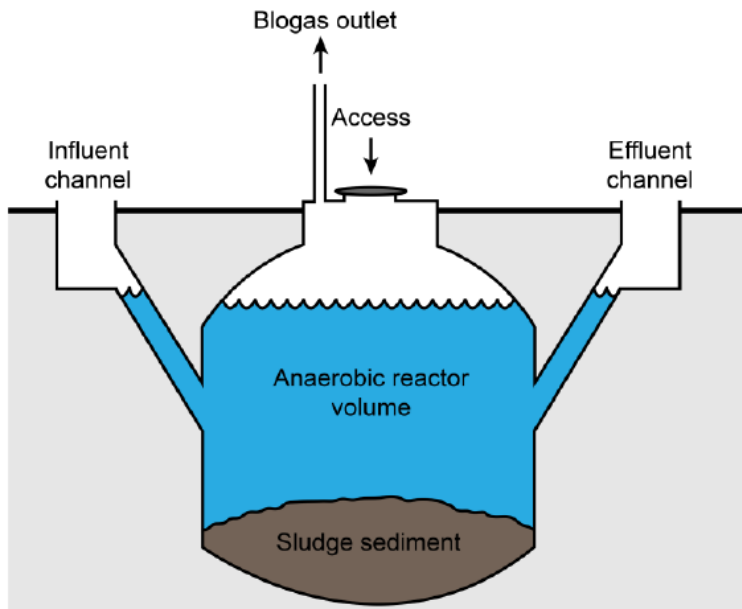


➤ **Thermophilic digester:** is a kind of bio-digester that operates in temperatures above 50 °C. It does not need agitation- faster in fermentation than a mesophilic digester.

Factors affecting the biogas production:

- Composition of the raw materials – load - digester type - mixing way - quality of methanogens – temperature.

Design of Biogas digesters



To know how to design digester for biogas synthesis, visit this link:

<http://www.instructables.com/id/Biogas-Digester/>

Advantages of Biogas

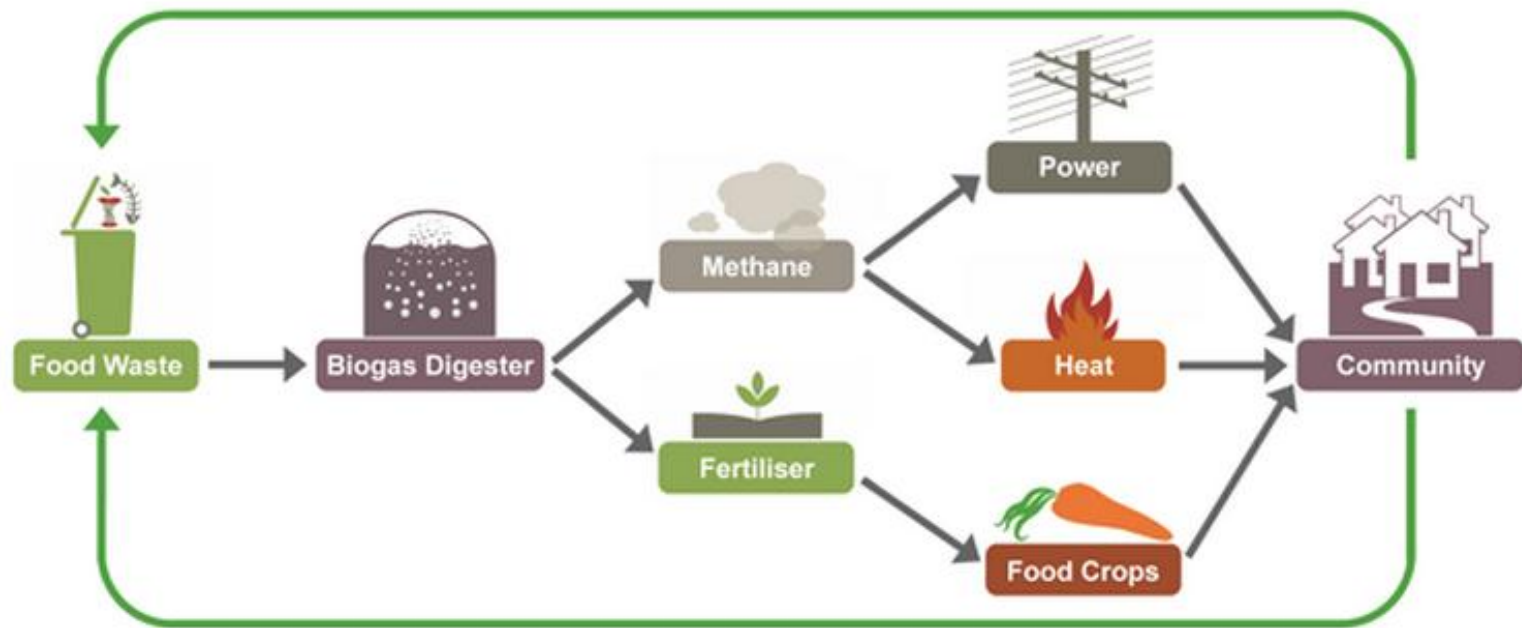
- The technology of biogas production is widely used in farm area, thus:
- It reduces the bad smell and protects water resources.
- It improves fertilizer value of manure.
- It reduces global climate change because if the manure is left to decompose it releases two main gases that changes the climate:

NO₂ (warms the atmosphere 310 times more than CO₂),

CH₄ (warms atmosphere 21 times more than carbon dioxide).

- **Disadvantages:** Biogas has corrosive nature and its storage is not practical

Applications of Biogas



1- To produce Electricity

2- Heating purposes

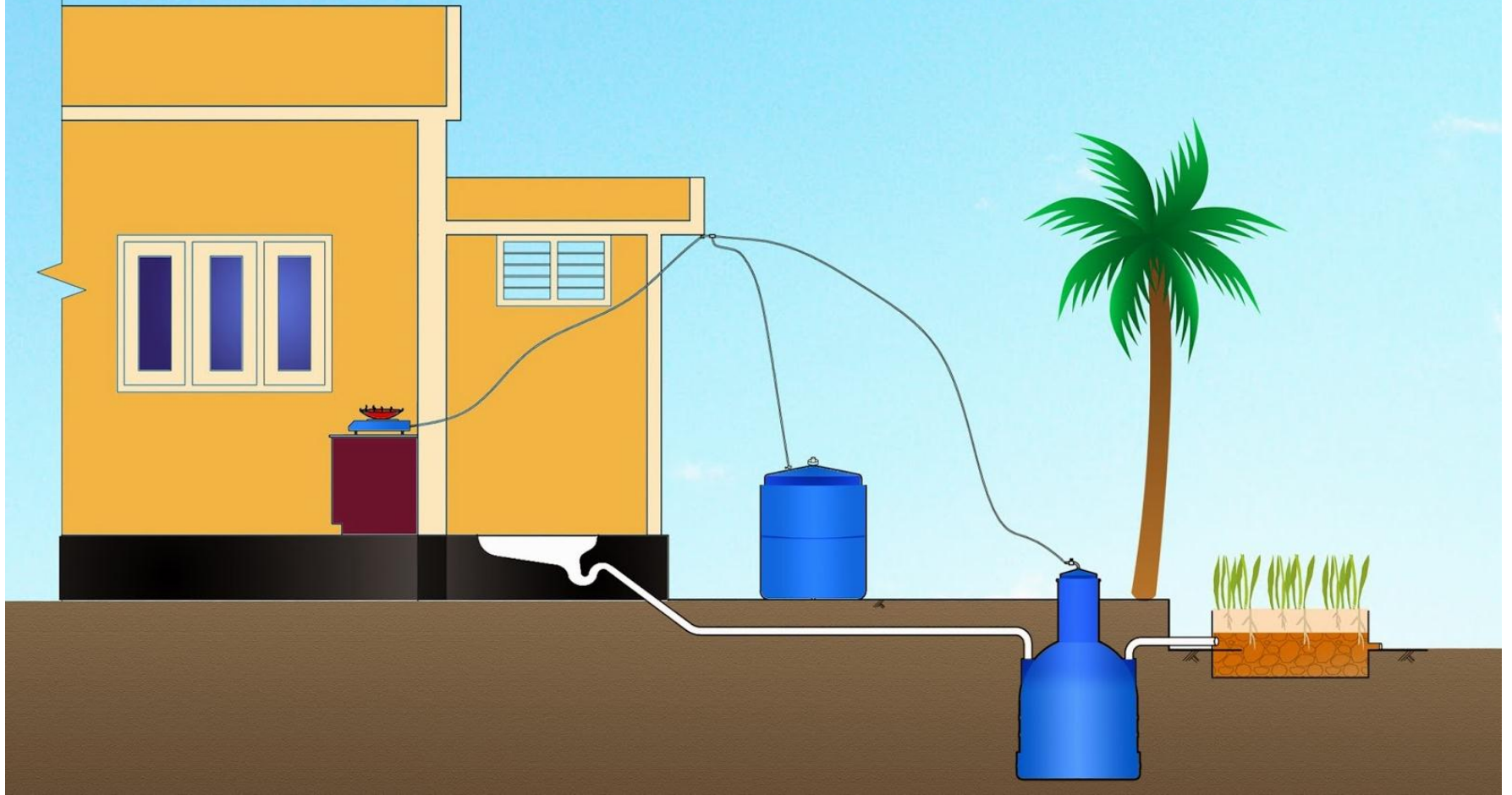
3- Methane can be combusted directly or converted to bioalcohols.

4- Millions of cows able to produce one hundred billion kilowatt hours of electricity, enough to power millions of homes.

Biogas for better life



Diagram showing Anaerobic Septic Tank linked with toilet and biogas plant



MAKING BIOGAS

"HEY GUYS,
CHECK OUT
HOW BIOGAS
IS CREATED!"



3

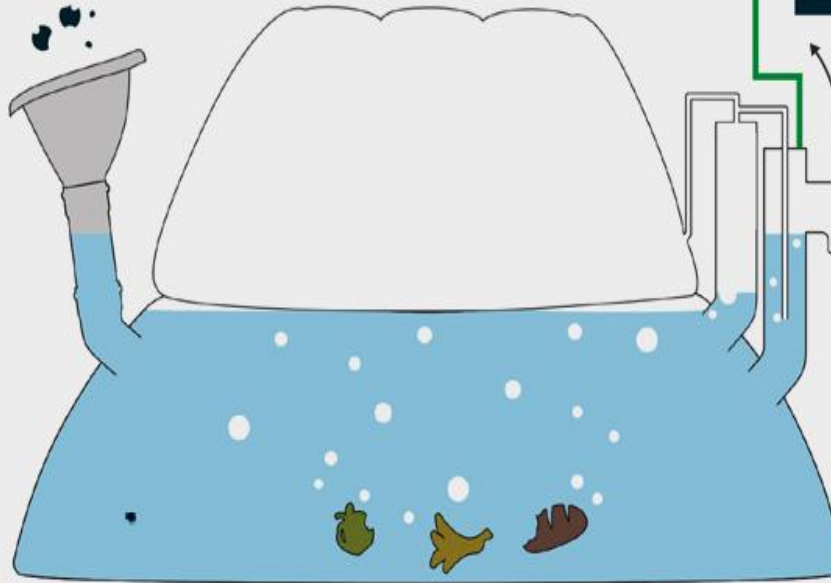
BIOGAS IS AGGREGATED
IN THE TANK AND STORED
AT LOW PRESSURE.



4

GAS FLOWS FROM THE
SYSTEM TO THE KITCHEN
STOVE VIA A PIPE

WASTE FED INTO
SYSTEM SINK.
UP TO 6 LITERS PER DAY.



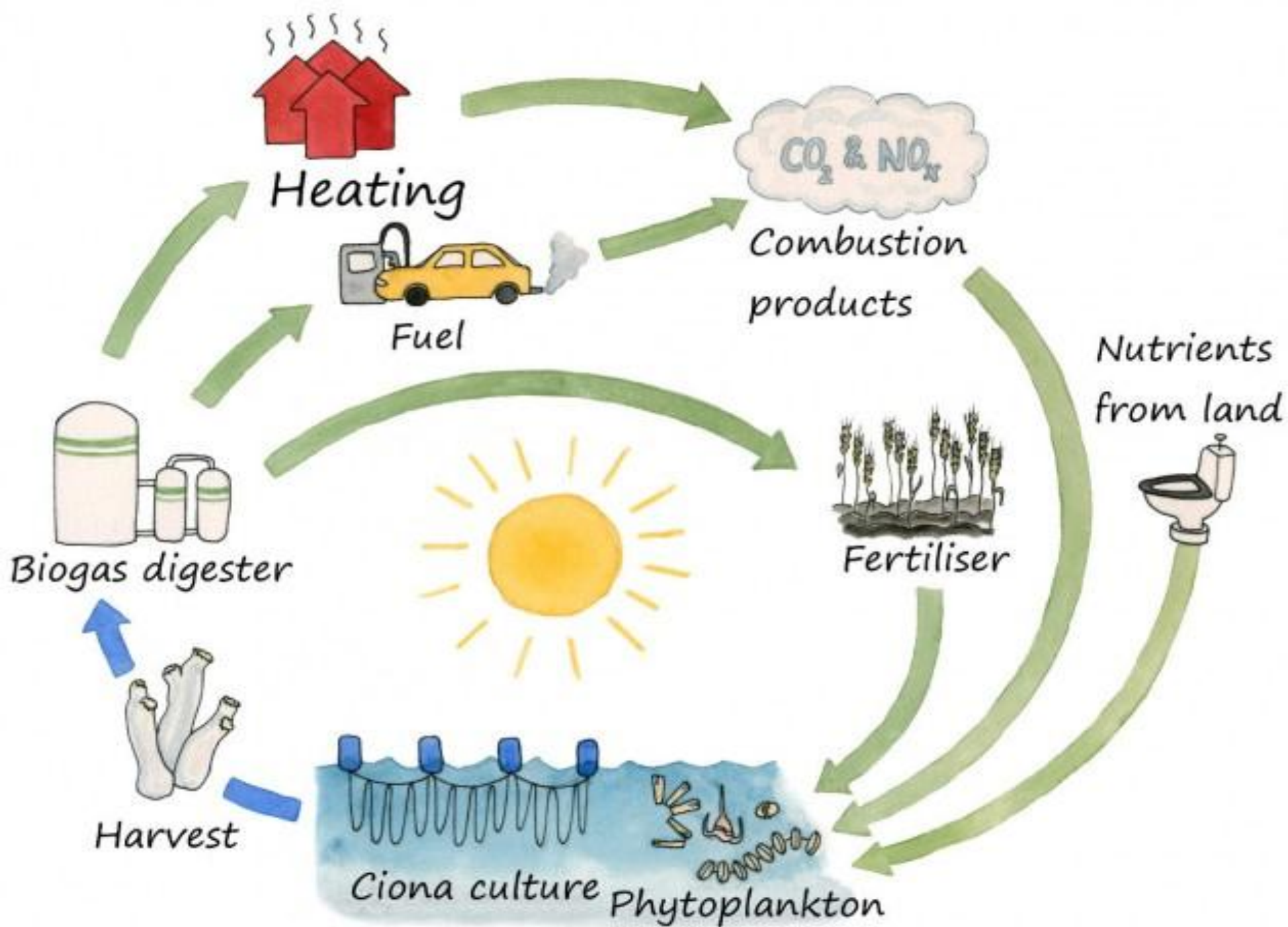
1

2

BACTERIA DIGEST THE ORGANIC
WASTE IN THE TANK AND TURN
IT INTO BIOGAS.

5

LIQUID FERTILIZER IS CREATED AS
THE BY-PRODUCT OF THE WASTE
DIGESTION PROCESS



Types of Biofuels

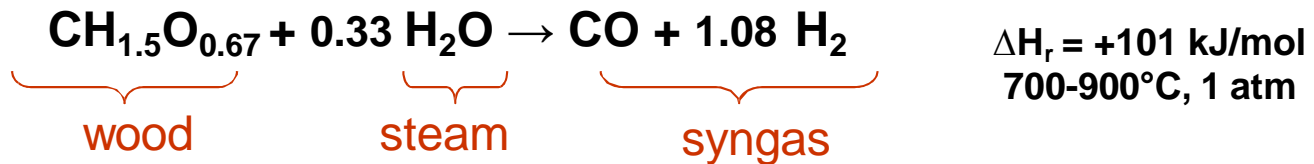
4) Syngas

Gas
Biofuels

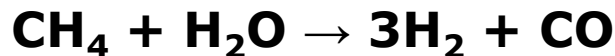
❑ Short name for synthetic gas that made up mainly of H₂ and CO. It contains also small quantity of CO₂ and other gases.

❑ **Synthesis:** produced by partial combustion of natural gas or biomass, and its production is a combination of two main processes:
A) pyrolysis, B) gasification

❖ **Pyrolysis:** decomposition of organic material by burning in absence of oxygen. It is used when the feedstock is solid biomass.



❖ **Gasification:** partial combustion of the biomass in a low oxygen environment, then passing of hot steam:



❑ **Benefits of syngas:**

- ✓ Generation of renewable power
- ✓ Conversion of problematic wastes to useful fuels
- ✓ Reduction in carbon emissions

❑ **Applications :**

Syngas is an intermediate compound that holds many valuable uses:

1- to produce methanol.

2- hydrogen can be used in fuel cells for generating electricity.

3- provided efficient production of other chemicals



Thermal Gas Generation in Dakahlia Plant



General Conversion Processes in Biofuel Production

To obtain biofuel from biomass, there are three types of conversion:

1) **Biological conversion**

- ❖ Fermentation: (production of bioalcohol)
- ❖ Anaerobic digestion (biogas such as methane)
- ❖ Anaerobic respiration (bio-battery)

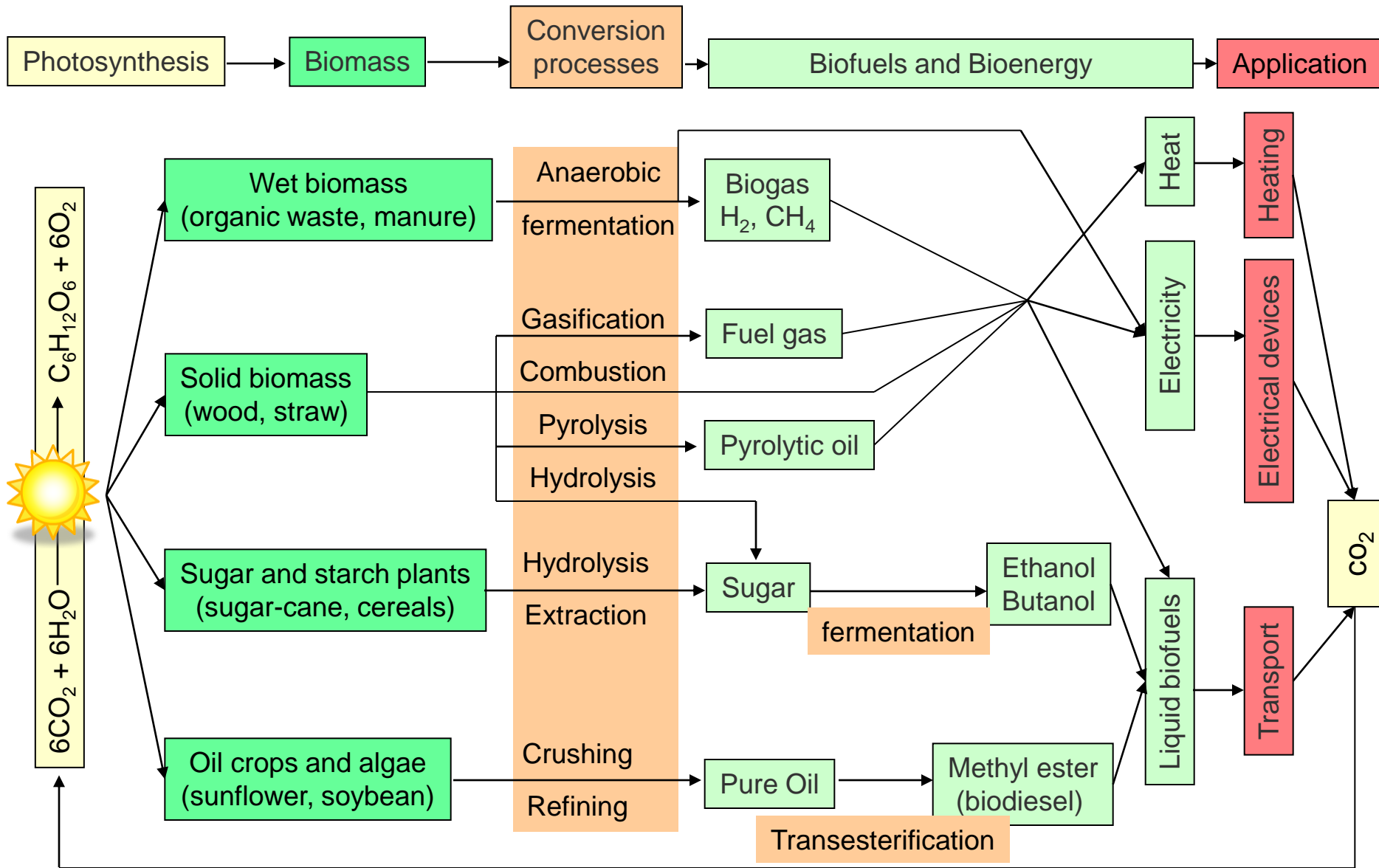
2) **Chemical conversion**

- ❖ Trans-esterification (biodiesel)

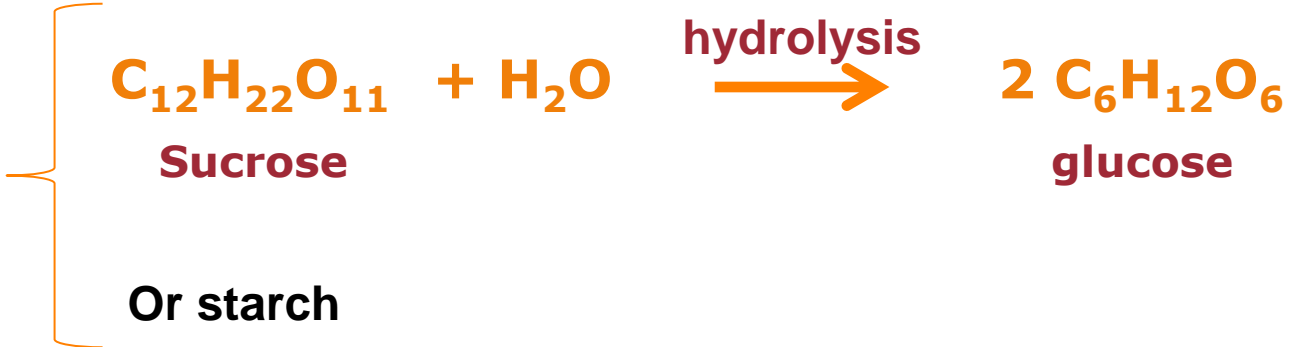
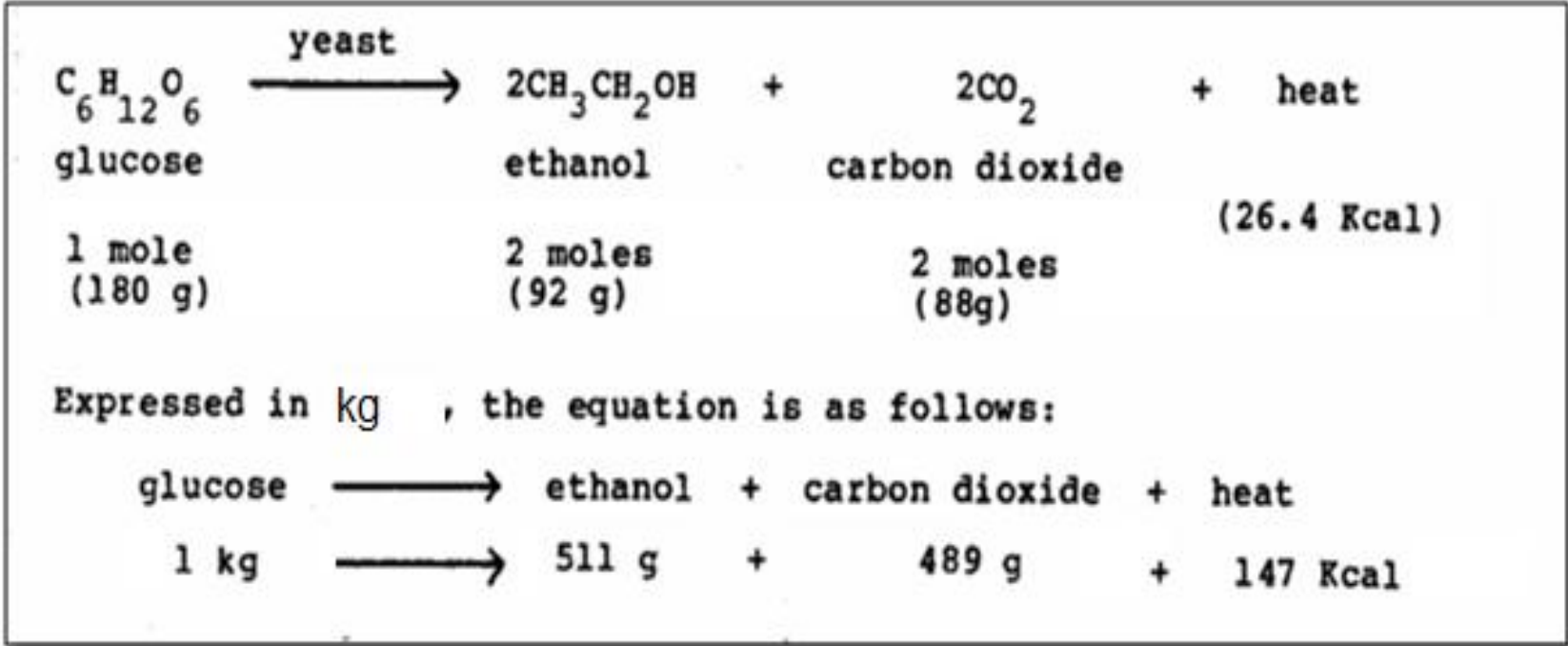
3) **Thermal conversion** (syngas)

- ❖ Combustion
- ❖ Gasification
- ❖ Pyrolysis

Biomass-to-Bioenergy Routes



Practice exercises on bio-alcohols production



End of 1st part

Dr. Hanaa Abulmagd