

Biomass Gasification Techniques

Introduction to Biomass

India is a land of village where the energy required for domestic purpose such as cooking is met from dried woods, twigs and leaves of plants and other dried organic matter such as cow dung.

This organic matter called as biomass is available freely as waste.

It contains stored energy from the sun.



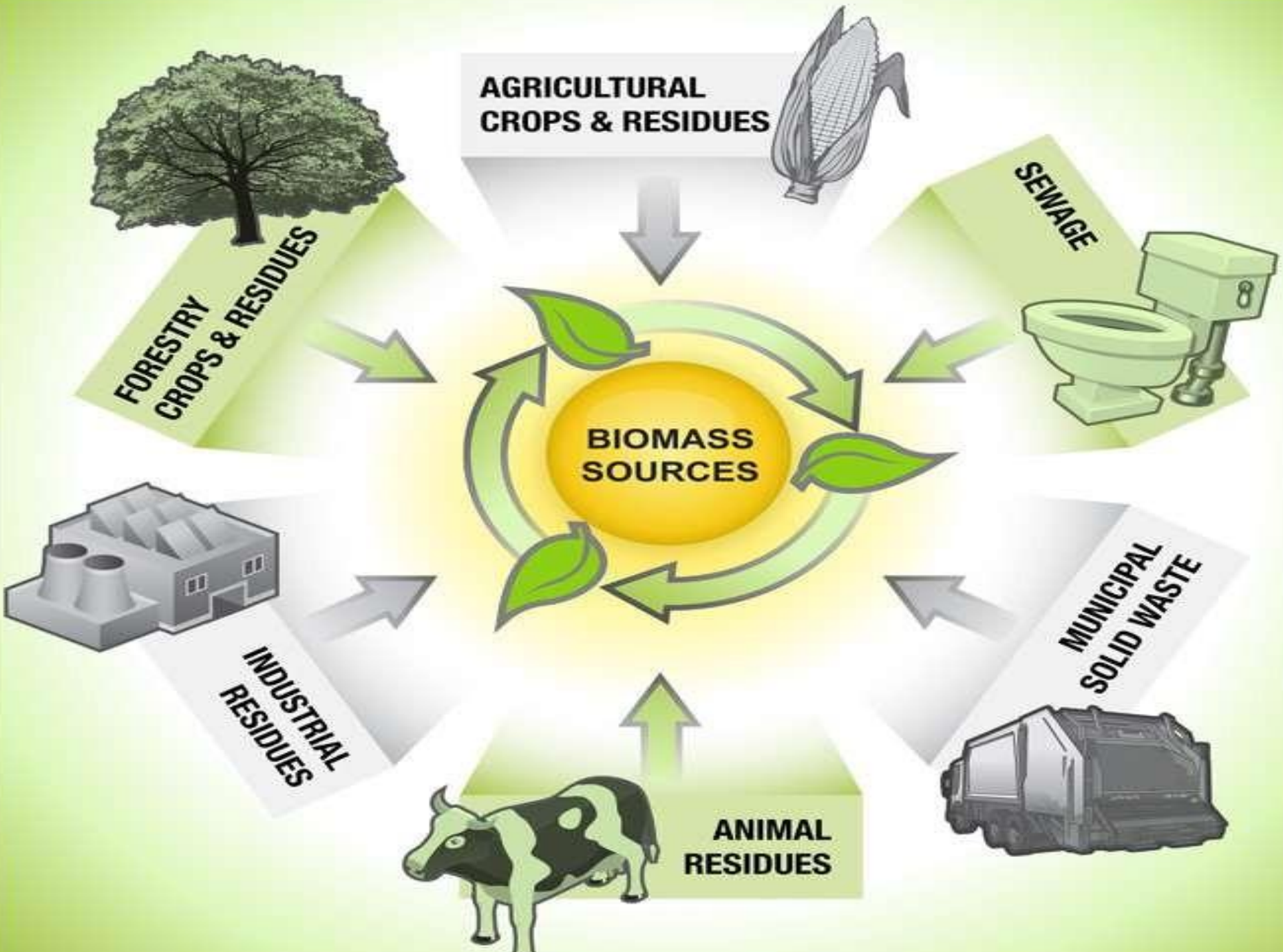
Introduction to Biomass

It is a renewable energy source because we can always grow more trees and crops, and waste will always exist.

The biomass is fast renewable forms of energy and available freely as waste and discarded matters.

UNDERSTANDING BIOMASS

What Is It?	What Can It Do?
A renewable low carbon fuel available throughout the UK	20% Average rate of return provided
A sustainable fuel that can deliver a significant reduction in net carbon emissions when compared with fossil fuels	30%-50% The amount you can save on fuel bills
Biomass includes organic matter like grass, leaves, wood, wood chips, rice husk, peanut shells, sugarcane fiber, sewage etc	Beat oil, gas and electricity prices
Fuels are sourced from wood, including pellets, chips and logs	Provide all your home or business' heating needs
	5-7 years Average payback time



**AGRICULTURAL
CROPS & RESIDUES**



**FORESTRY
CROPS & RESIDUES**

SEWAGE



**MUNICIPAL
SOLID WASTE**



**ANIMAL
RESIDUES**



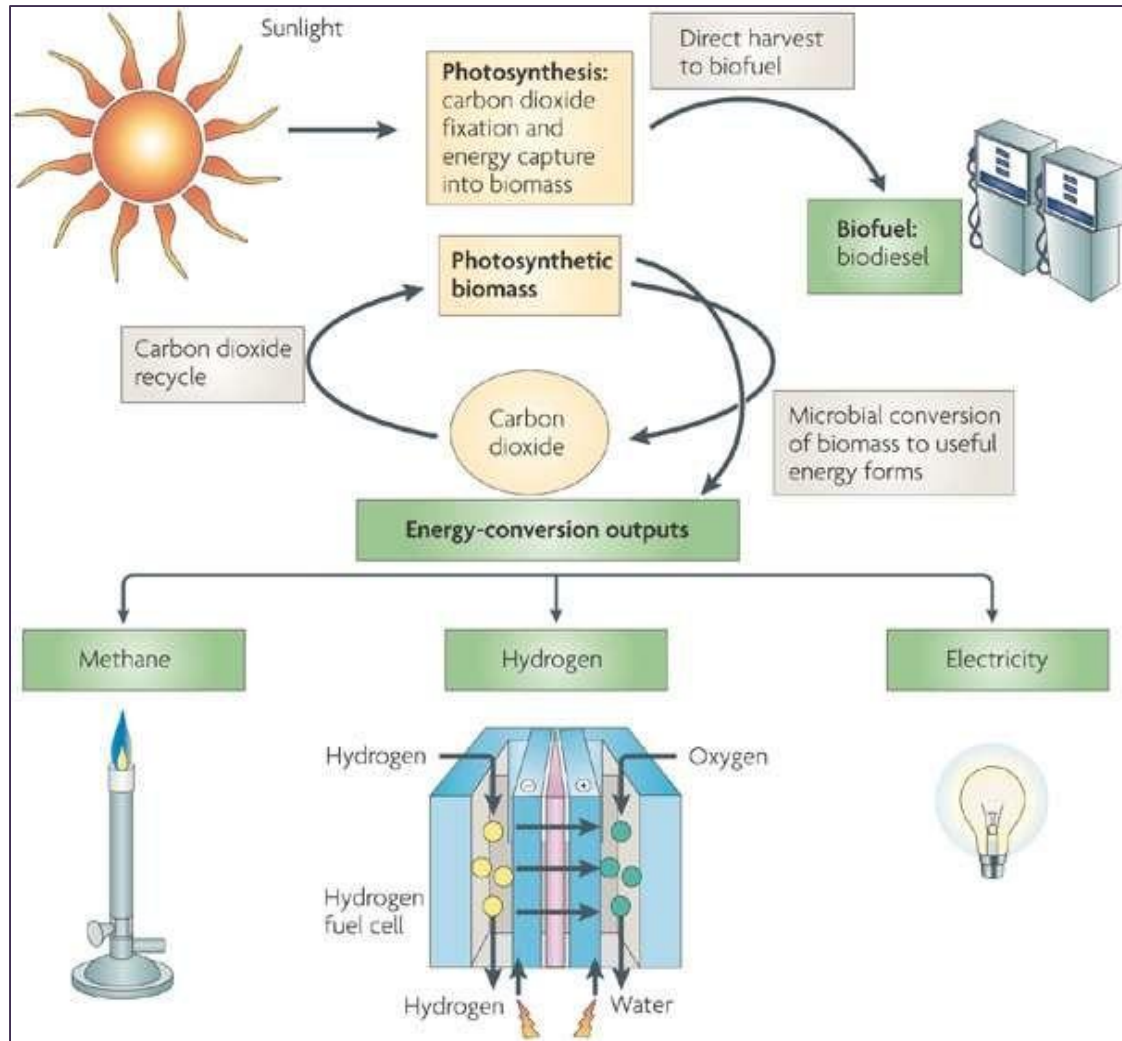
**INDUSTRIAL
RESIDUES**



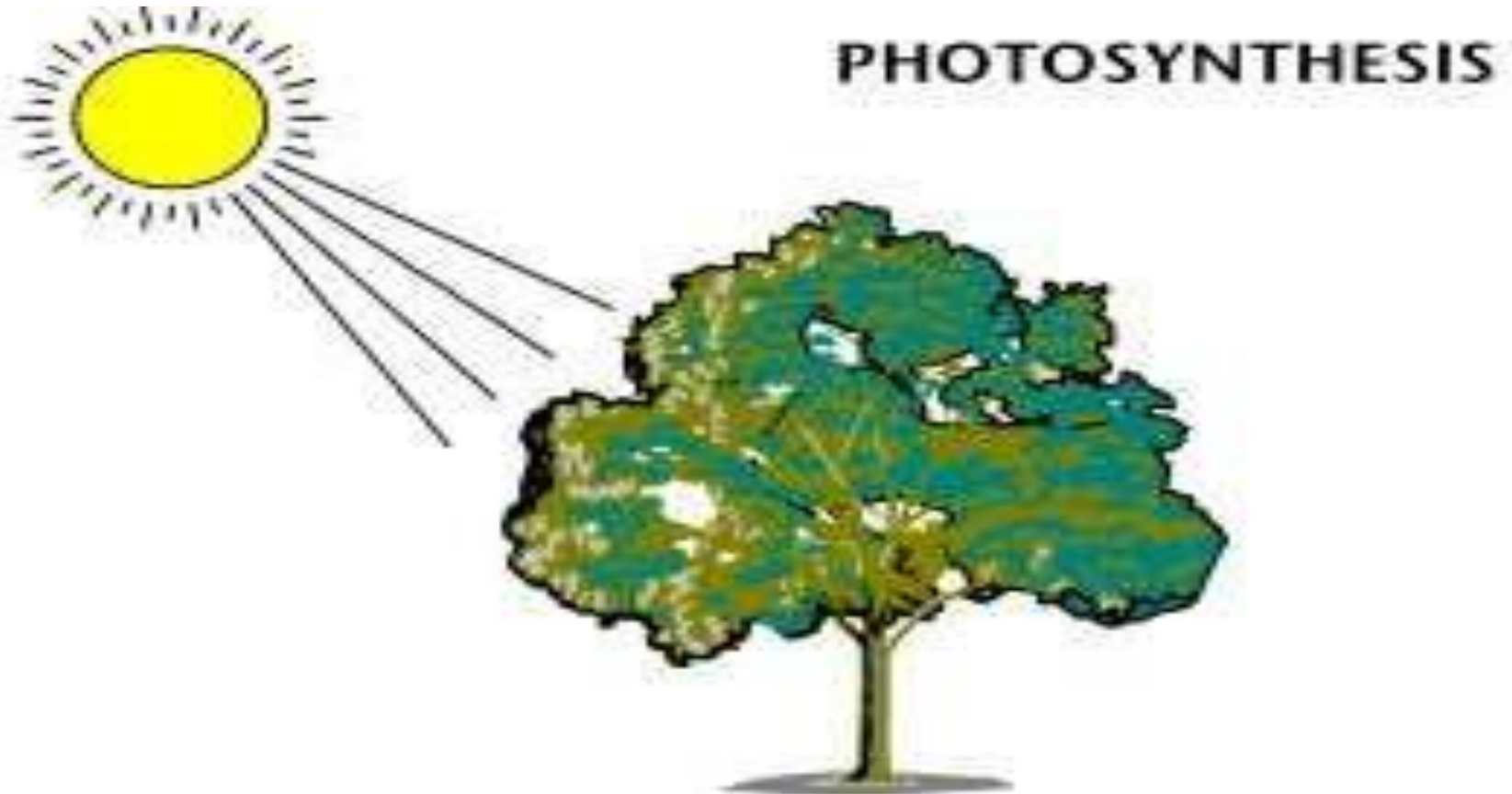
**BIOMASS
SOURCES**

Photosynthesis Process

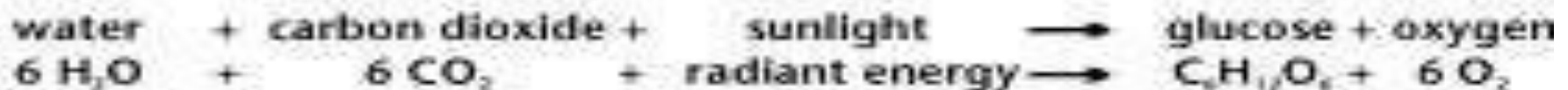
Photosynthesis is a chemical process that converts carbon dioxide into organic compounds, especially sugars, using the energy from sunlight.



Photosynthesis Process



In the process of photosynthesis, plants convert radiant energy from the sun into chemical energy in the form of glucose - or sugar.



Photosynthesis Process

Biomass is produced in the photosynthesis process which converts the solar energy into biomass energy.

Photosynthesis process only occurs in green plants. It is the process of combining the carbon dioxide from the atmosphere with water plus light energy to produce (sugars, starches, celluloses etc.) and oxygen.



Steps in Photosynthesis

Splitting of water molecule into H_2 & O_2 under influence of chlorophyll.

“Light Reaction”

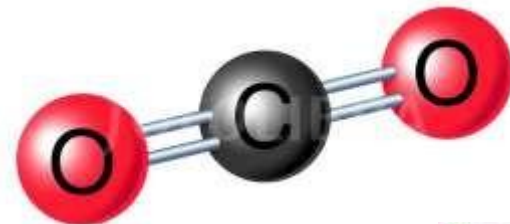
Hydrogen is transferred to CO_2 to form Starch or Sugar.

Necessary Conditions

Light



CO_2 Concentration



Temperature



Technology

Biomass technology today serves many markets that were developed with fossil fuels and modestly reduces their use

Uses - Industrial process heat and steam, Electrical power generation, Transportation fuels (ethanol and biodiesel) and other products.

Primary focus of the Biomass Program – development of advanced technologies.

Current Focus

Platform technologies

Sugar Platform Technology

Thermochemical Platform Technology

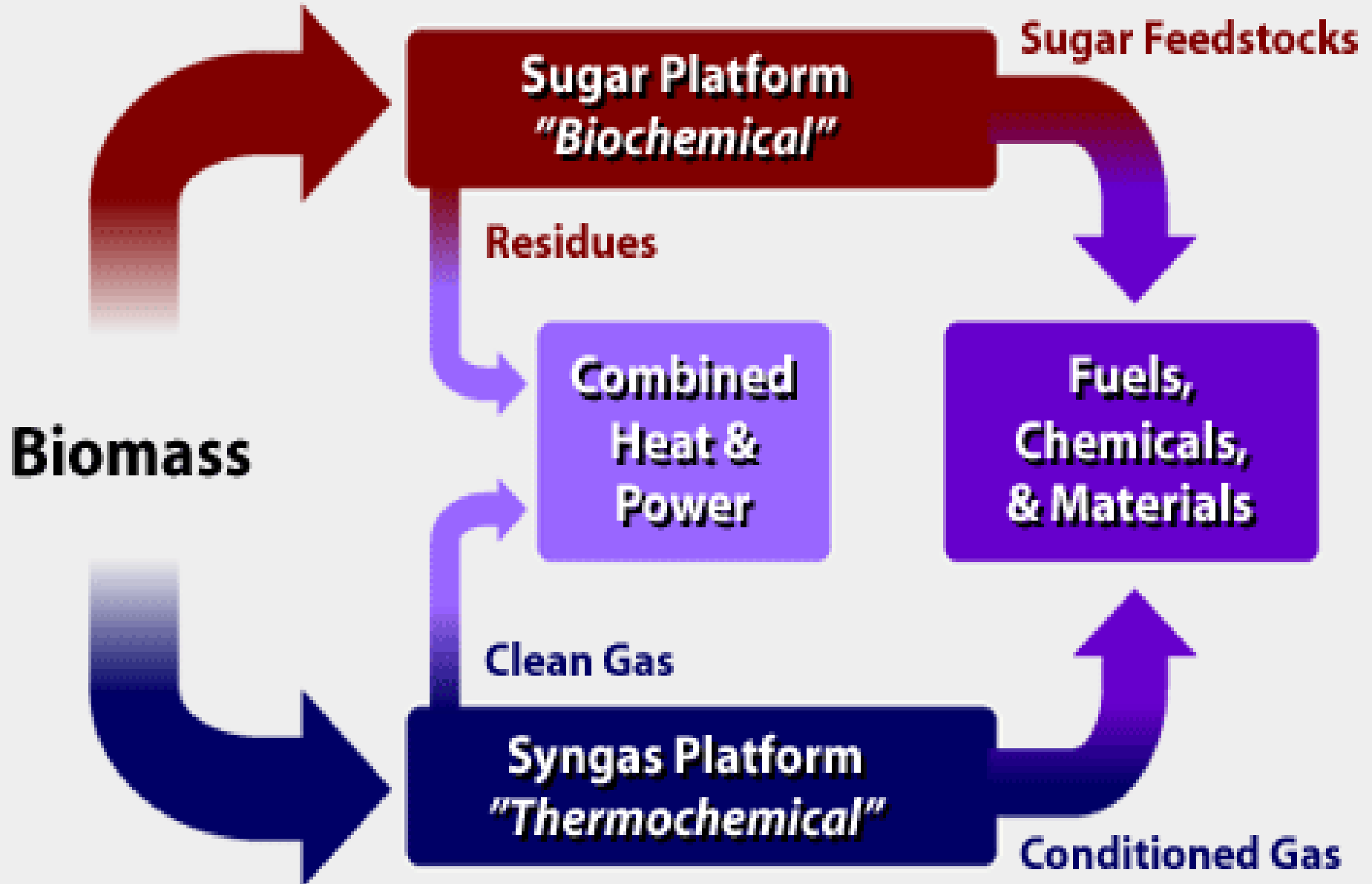
Bio-refinery

A facility that integrates biomass conversion processes and equipment to produce fuels, power, and chemicals from biomass.

Analogous to today's petroleum refineries

It is based on the “Sugar Platform” and the “Thermochemical Platform”

Biorefinery Concept



Modified Waste Vegetable Fat

Designed for general use in most compression ignition engines .

The production of MWVF can be achieved in a continuous flow additive process.

It can be modified in various ways to make a 'greener' form of fuel

E-Diesel

Uses additives in order to allow blending of ethanol with diesel.

Ethanol blends of 7.7% to 15% and up to 5%

Additives that prevent the ethanol and diesel from separating at very low temperatures or if water contamination occurs.

Jatropha

Biodiesel from Jatropha

Seeds of the Jatropha nut is crushed and oil is extracted

The oil is processed and refined to form bio-diesel.

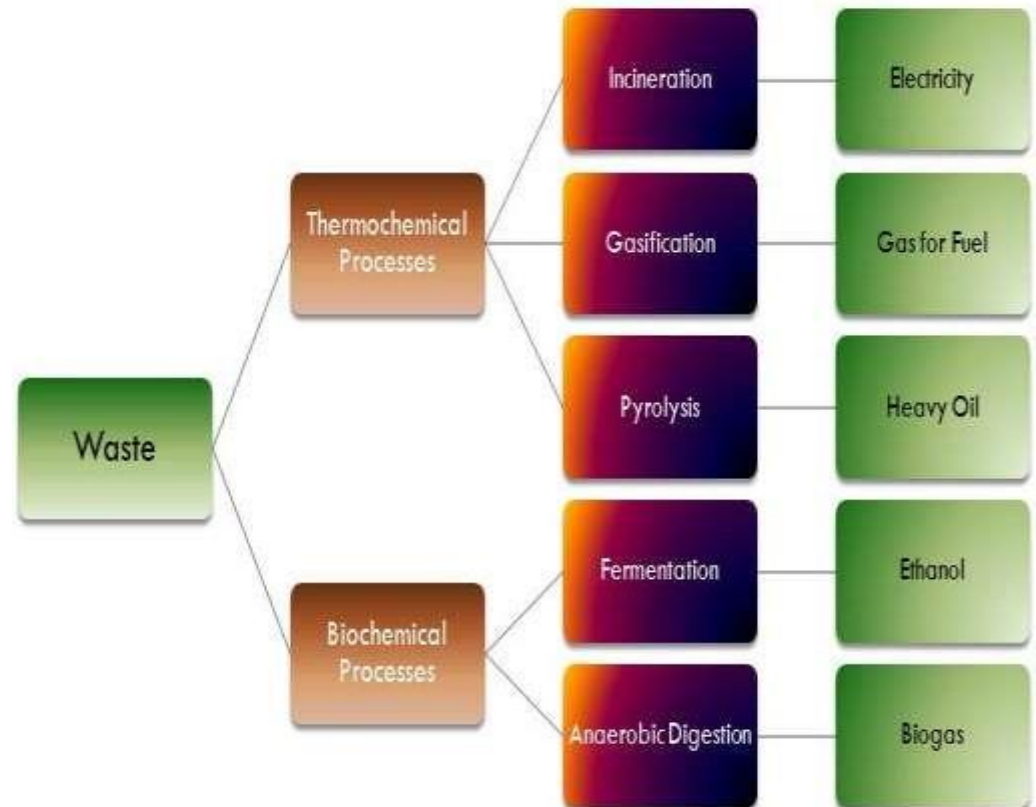




Biomass energy conversion

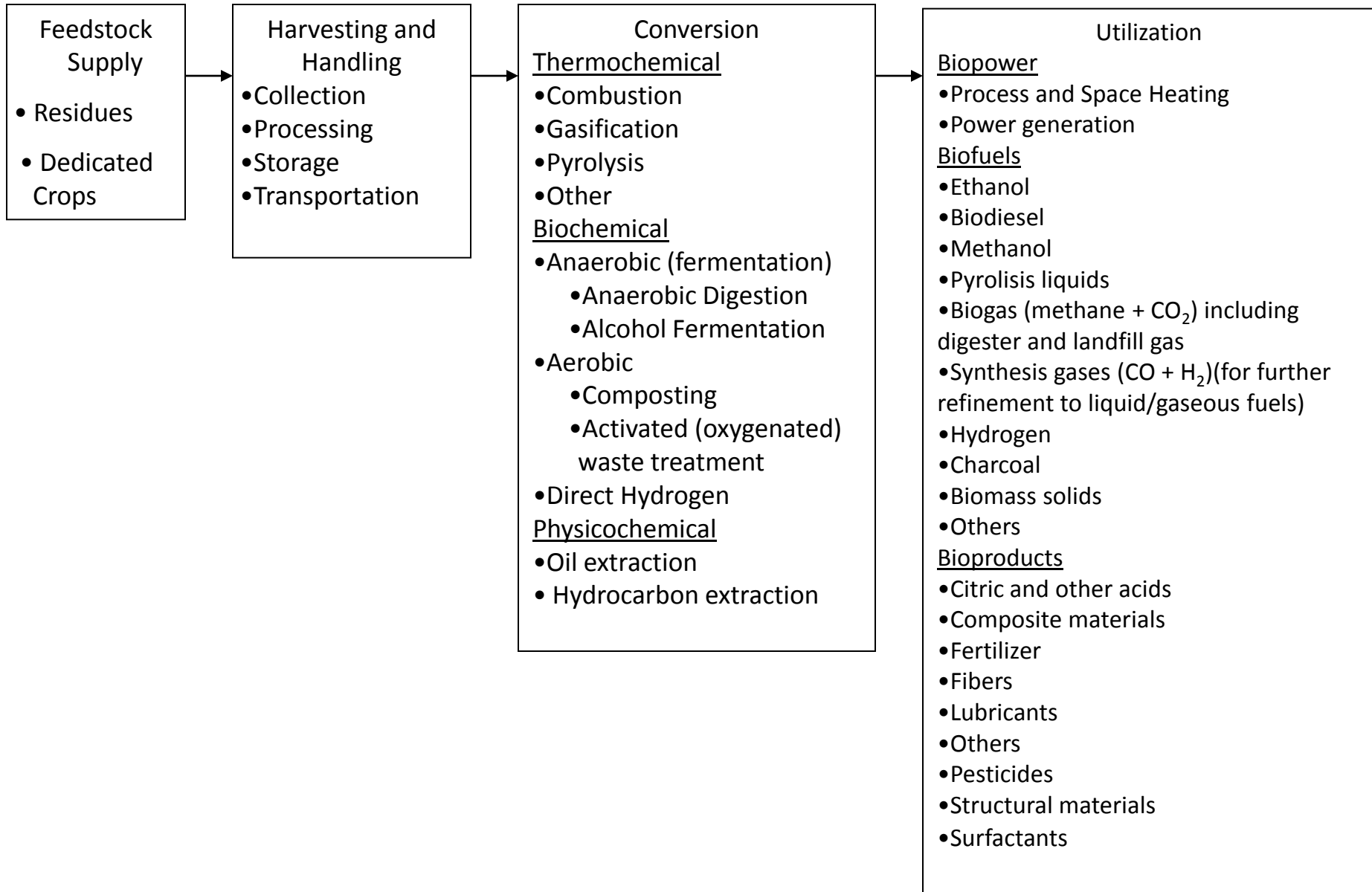
The various process used for conversion of biomass into energy or bio fuels can be classified as follows:

- 1) Direct combustion
- 2) Thermo chemical conversion
- 3) Biochemical conversion



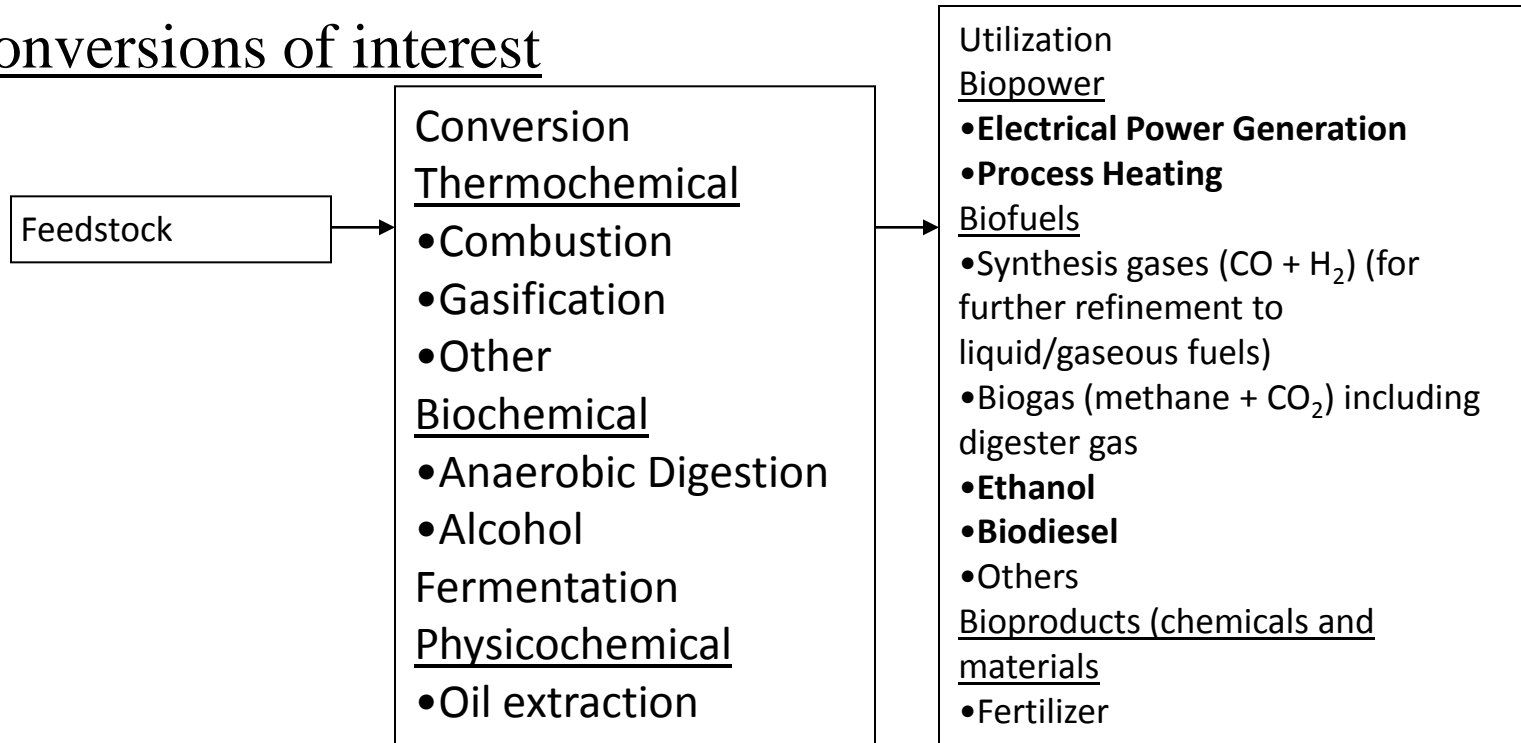
Biomass

Conversion



Biomass

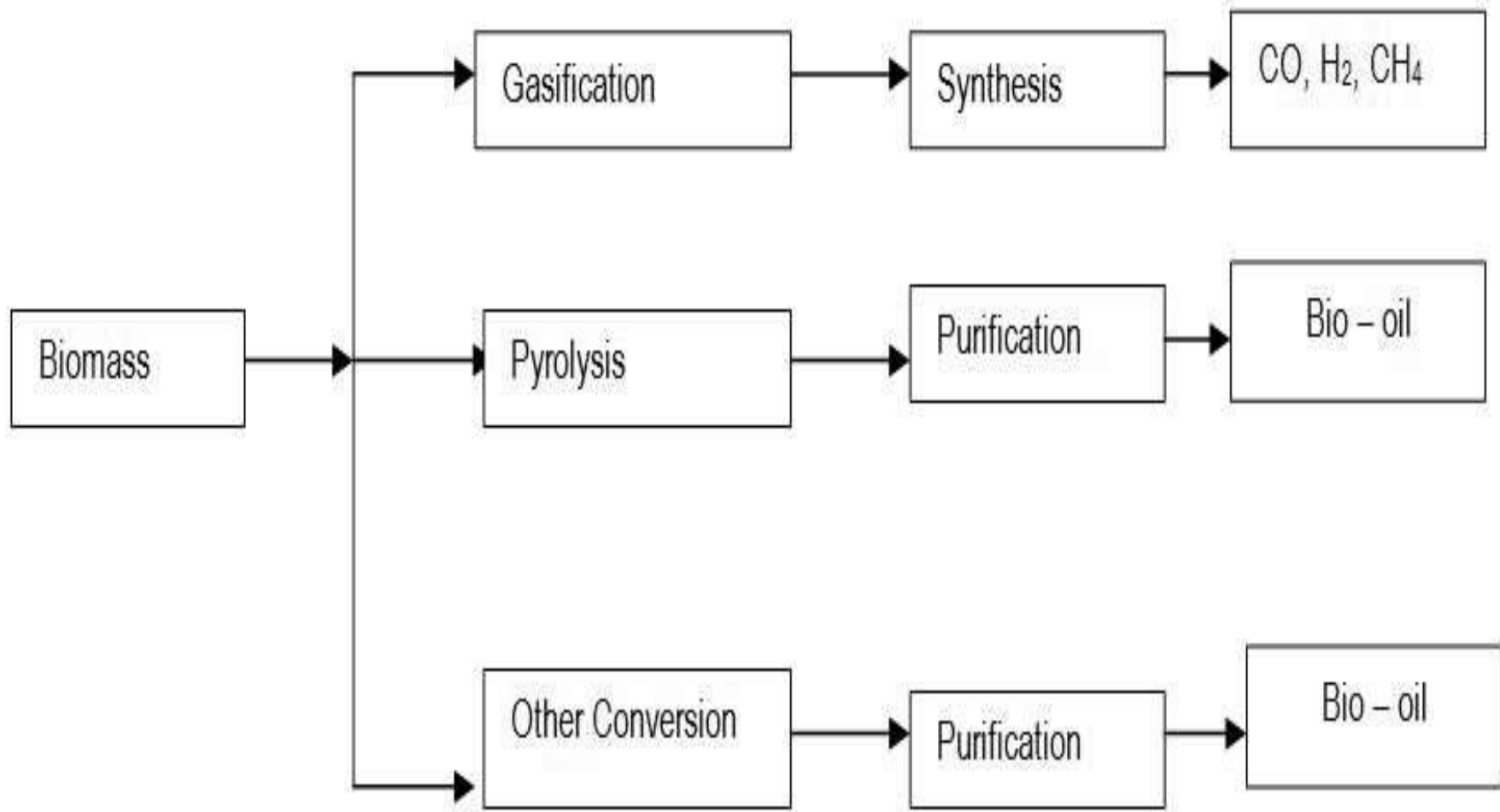
Conversions of interest



Combustion: direct-fired systems. They burn bio-energy feedstocks directly.

Gasification: biomass is heated with no oxygen or only about one-third the oxygen needed for efficient combustion. Biomass then gasifies to a mixture of carbon monoxide and hydrogen—synthesis gas or syngas.

Biochemical: relies on the abilities of specific microorganisms to convert biomass components to useful liquids and gases, as ethanol or methane.



Direct Combustion

The direct combustion of biomass in presence of oxygen/air to produce heat and by products is called direct combustion.

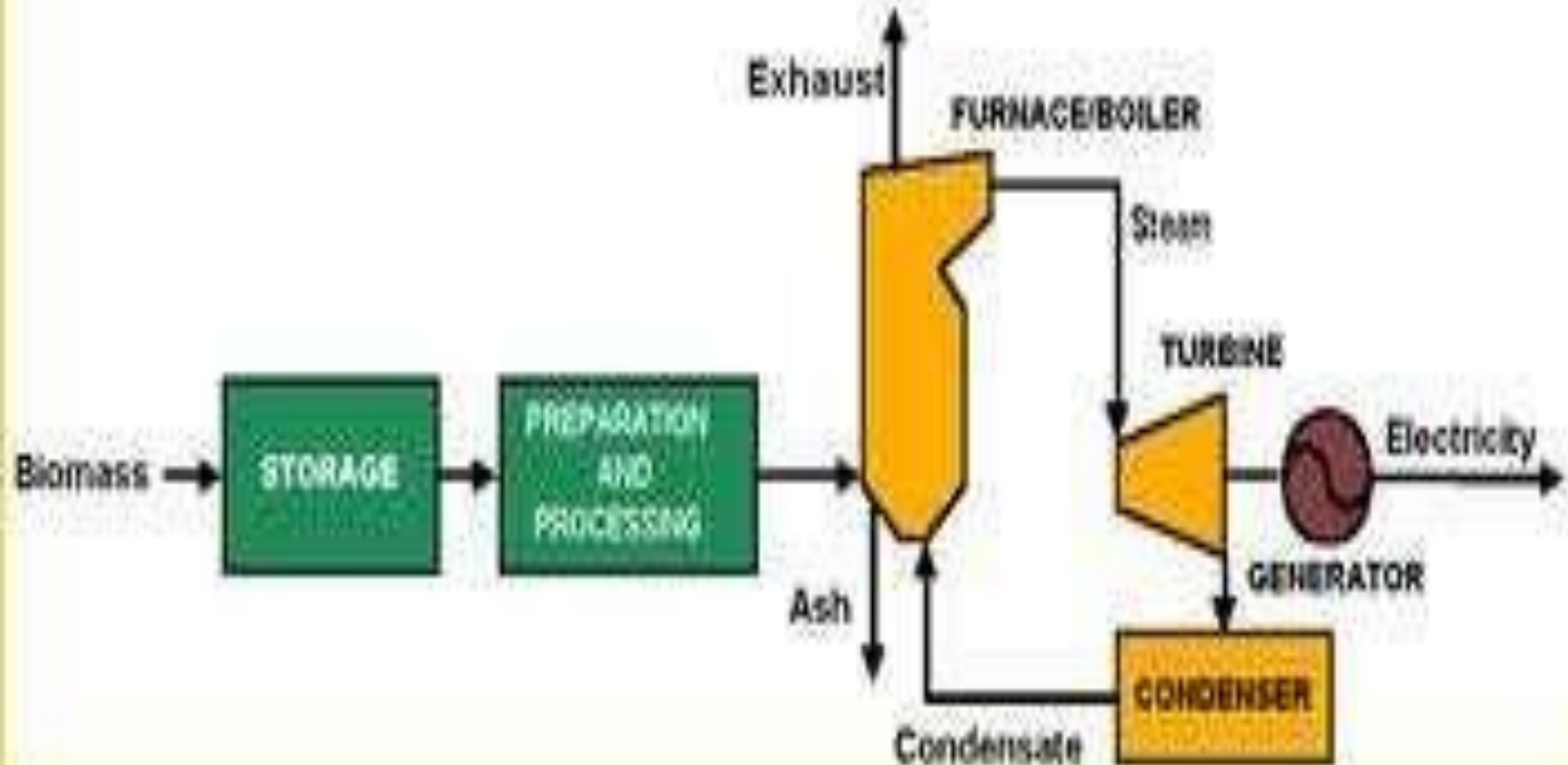
The complete combustion of biomass into ash is called incineration.

This heat energy in the product gases or in the form of steam can be used for various applications like space heating or cooling, power generation, process heating in industries or any other application.

However, if biomass energy by combustion is used as co generation with conventional fuels, the utilization of biomass energy makes it an attractive proposition.

Direct Combustion

Direct Combustion / Steam Turbine System



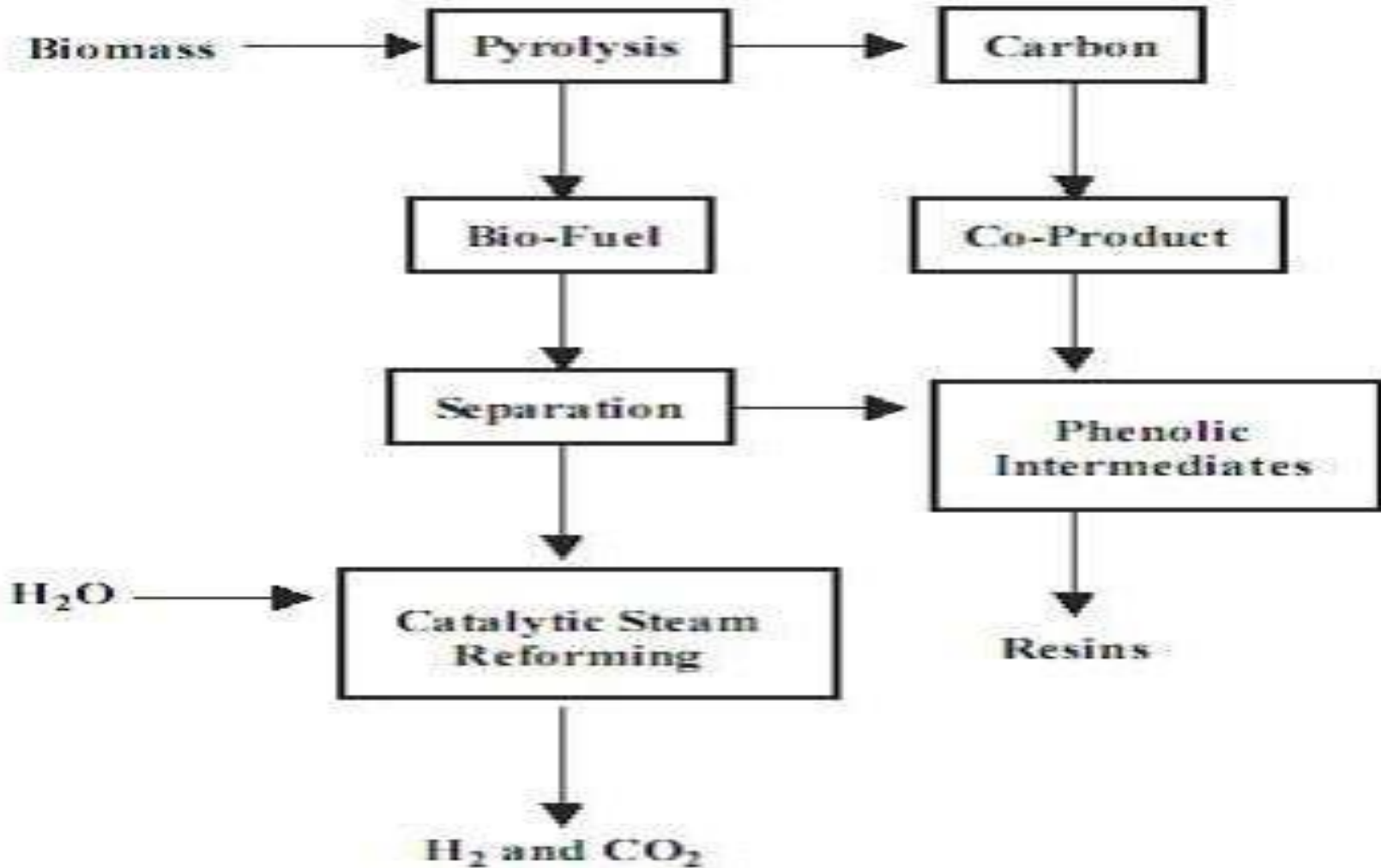
THERMO CHEMICAL CONVERSION

The thermo chemical reaction can convert the organic biomass into more valuable and convenient form of products as gaseous and liquid fuels, residue and by-products etc.

These processes can be carried out in following ways:

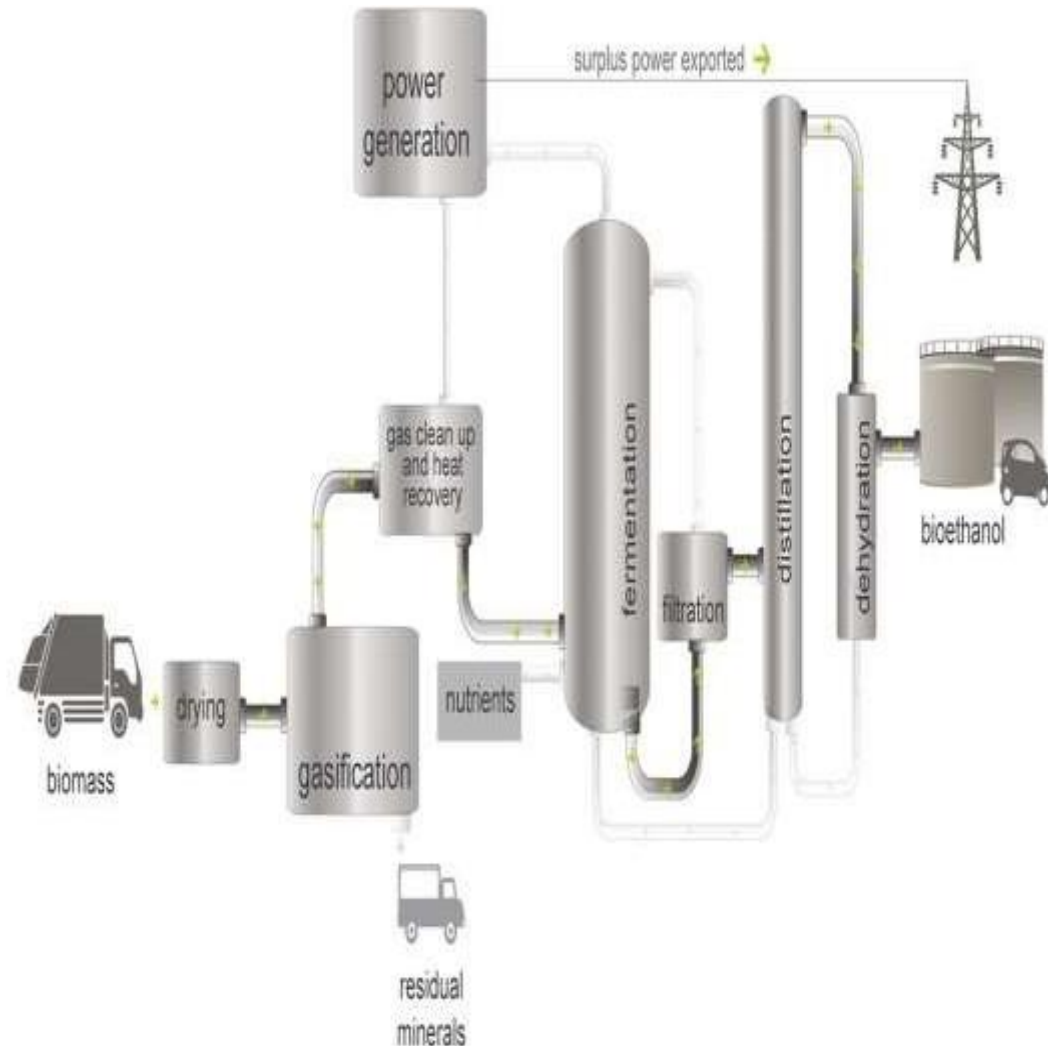
- 1) Gasification
- 2) Pyrolysis

THERMO CHEMICAL CONVERSION



Gasification

Heating of biomass in presence of limited oxygen and air (deficient O_2 /air) is called gasification. it produces gaseous fuels like H_2, CO, CH_4, N_2 of low calorific value.



Pyrolysis

It is the heating of biomass in a closed vessel at temperatures in the range 500°C-900°C in absence of O₂/air or with steam. It produces solid, liquid and gases.

The pyrolysis process can use all type of organic materials including plastic and rubbers.

Biochemical Conversion

In biochemical processes the bacteria and micro organisms are used to transform the raw biomass into useful energy like methane and ethane gas. Following organic treatments are given to the biomass:

- 1) Fermentation of biomass (Aerobic digestion)
- 2) Anaerobic digestion of biomass

Fermentation

Fermentation is a process of decomposition of complex molecules of organic compound under the influence of micro-organism(ferment) such as yeast, bacteria, enzymes etc.

The example of fermentation process is the conversion of grains and sugar crops into ethanol and CO_2 in presence of yeast.

Anaerobic digestion

The anaerobic digestion or anaerobic fermentation process involves the conversion of decaying wet biomass and animal waste into biogas through decomposition process by the action of anaerobic bacteria.

The most useful biomass for production of biogas are animal and human waste, plant residue and other organic waste material with high moisture content.



Reference

- Huang J, Schmidt KG, Bian Z. Removal and conversion of tar in syngas from woody biomass gasification for power utilization using catalytic hydrocracking, *Energies*, 2011, vol. 4 (pg. 1163-77)
- [National Non-Food Crops Centre. "NNFCC Renewable Fuels and Energy Factsheet: Anaerobic Digestion"](#), Retrieved on 2011-11-22
- [Agricultural Biogas](#), www.clarke-energy.com, accessed 08.11.11
- Neubauer Y. Strategies for tar reduction in fuel-gases and synthesis-gases from biomass gasification, *J Sustain Energy Environ*, 2011(pg. 67-71) special issue
- Li Qingyuan, Ji Shengfu, Hu Jinyong, Jiang Sai, 2013. Catalytic steam reforming of rice straw biomass to hydrogen-rich syngas over Ni-based catalysts, *Chinese Journal of Catalysis*, 34: 1462- 1468
- Mohammad Asadullah, 2014. Barriers of commercial power generation using biomass gasification gas: A review, *Renewable and Sustainable Energy Reviews*, 29: 201-215.
- Emanuele Graciosa Pereira, Jadir Nogueira da Silva, Jofran L. de Oliveira, Cassio S. Machado, 2012. Sustainable energy: A review of gasification technologies, *Renewable and Sustainable Energy Reviews*, 16: 4753-4762.



Thank You

Any Questions...?