Introduction to

Biomass Utilization Technology for Rural Development

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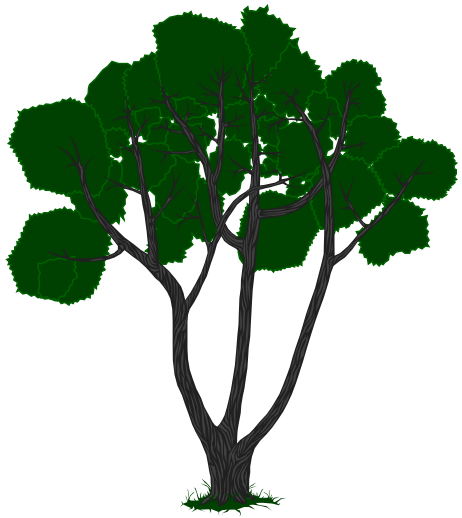
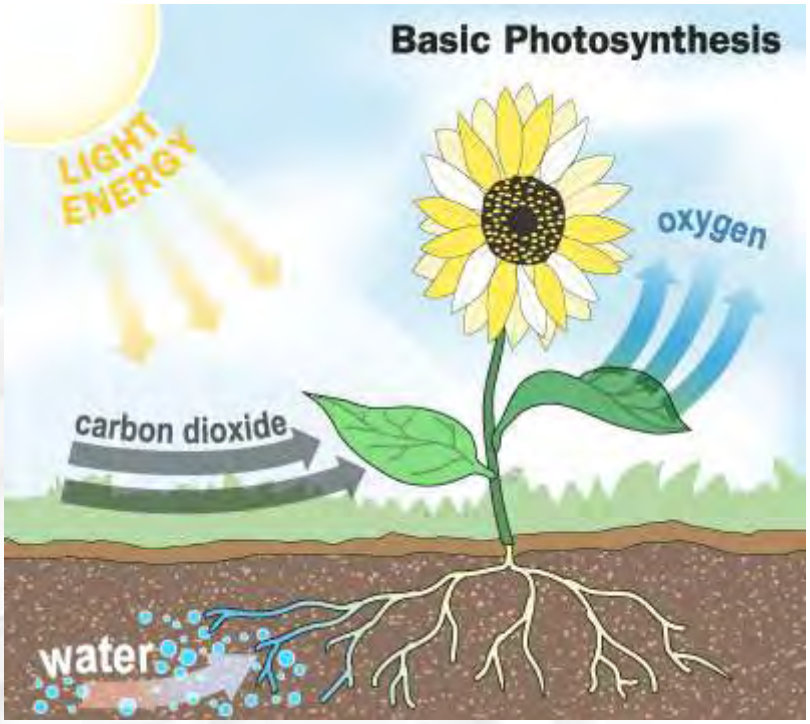
Overview of Presentation



- Introduction
- Biomass energy
- Conversion processes
  - * Physical
  - * Thermochemical
- Technology demonstration

INTRODUCTION

Transitions



Source of energy, chemicals, and materials
for **Humankind** from the past to the future

Biomass → Fossil fuels . . . . . → Biomass !

Definitions

Biomass

A stored source of solar energy collected by plants via photosynthesis. Organic materials of recent biological origin, renewable, natural resources

Bioenergy

Conversion of the chemical energy of the biorenewable resource into heat and power

Biobased products

Fuels, chemicals, and natural fibers derived from biorenewable resources

Return to Bioenergy & Biobased Products

Improved Environmental Quality

(Local, regional, global impacts)

Concerns over National Security

(Energy crisis, scarcity, high petroleum price)

Excess Agricultural Production

(self-sufficiency, stability of agricuture)

Importance of Rural Development

(repopulation, employment, social cohesion, improved economic development, transportation, quality of life)

Biomass sources

from (1) Nature, (2) Community, (3) Industry

Woods
- Wood chips, sawdust
- Wood waste

Weeds

Algae

Municipal sold waste

Agricultural residues
- Corn stover
- Rice husks, straw
- Sugarcane bagasse
- Cassava rhizome
- Palm shells
- Animal waste

Energy crops
- Hybrid poplar
- Switchgrass
- Willow
- Bamboo
- Eucalyptus

Oil bearing biomass

Biomass for Energy

Refuse Derived Fuel (RDF)

Sugar cane

Cassava

Palm

Wood chip

Rice husk

Corn cob

Composition of Biomass

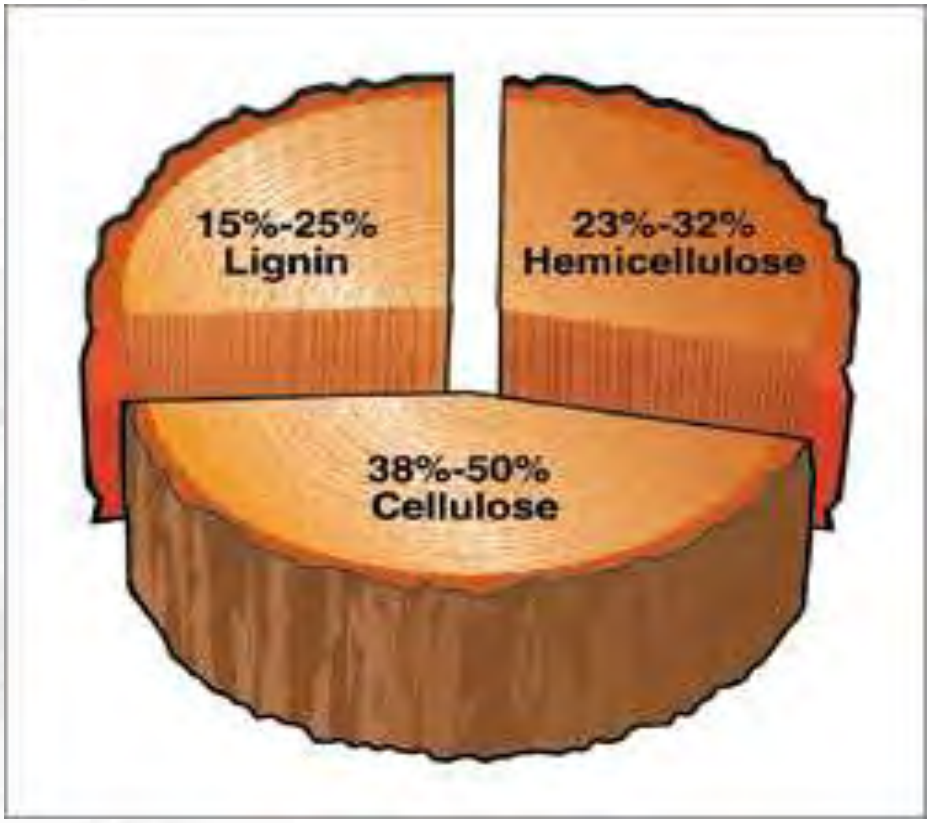
Elemental composition

Oxygen	30 – 40%
Carbon	30 – 60%
Hydrogen	5 – 6%

Proximate analysis

- Fixed carbon
- Ash
- Volatile matter
- Moisture

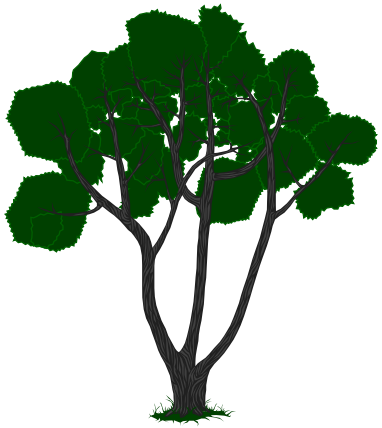
Lignocellulosic material



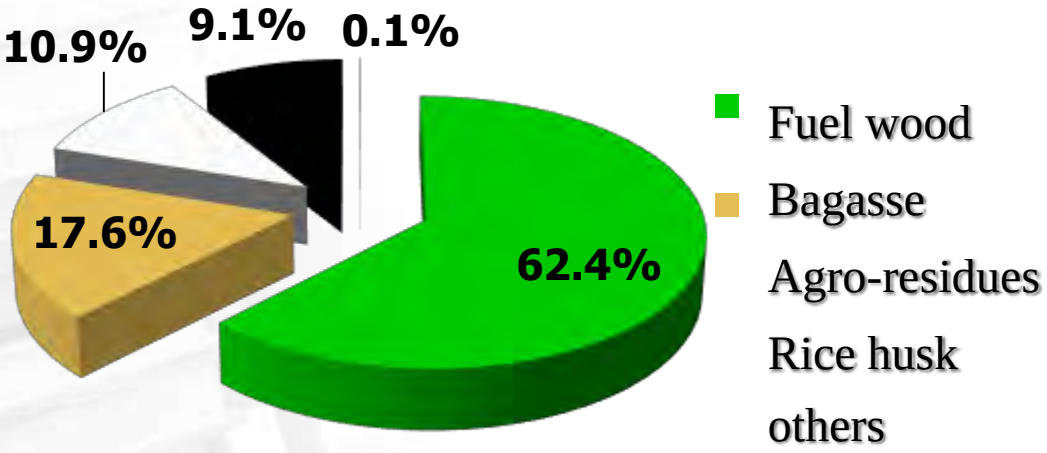
Challenges in using Biomass

Most biorenewable resources are solid materials of low bulk density, high moisture content, low heating value

- difficulty in handling, and transport
- reduced performance



Pattern of Biomass Use in Thailand – year 2007



Accounted for only 18% of total commercial energy use !

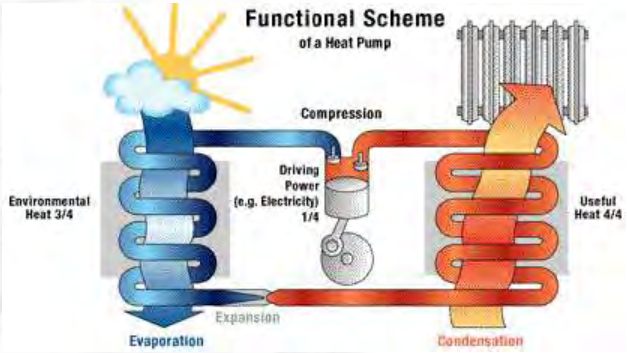
Pathways for Biomass Energy Use

PRIMARY BIOMASS FUELS

COMBUSTION

THERMAL ENERGY

CONVERSION PROCESS: BIOLOGICAL OR THERMO-CHEMICAL

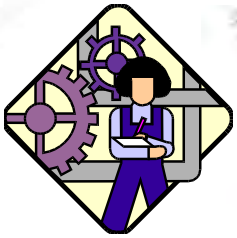


HEAT PUMP

EXTERNAL COMBUSION ENGINES

SECONDARY BIOMASS FUELS

USE IN INTERNAL COMBUSION ENGINES



MECHANICAL AND/OR ELECTRICAL ENERGY

CONVERSION PROCESS

Biomass Conversion

Physical conversion

Sorting, Drying, Size reduction	**- RDF**
Densification	**- Briquette**

Thermochemical conversion

Combustion	**- Heat, Work, Electricity**
Pyrolysis & Carbonization	**- Bio-oil, Charcoal**
Gasification	**- Producer gas**
F-T synthesis	**- Synthetic oils**

PHYSICAL CONVERSION

- RDF
- Densified Fuels

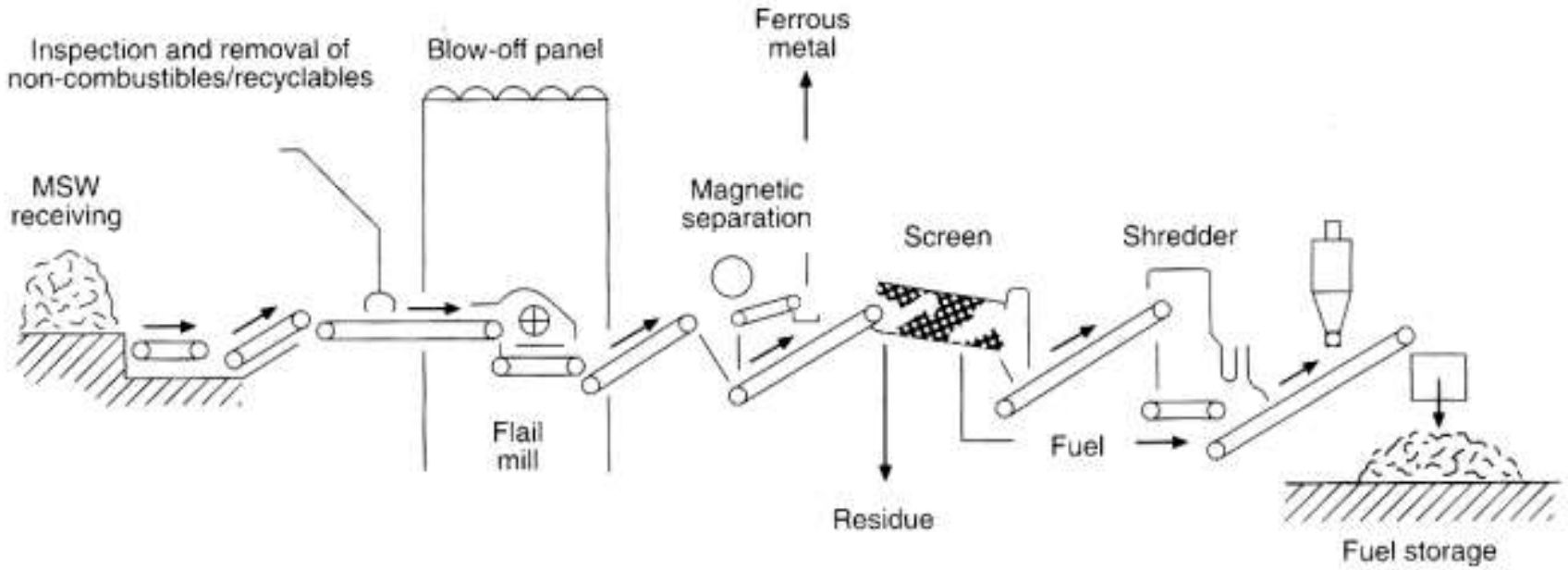
Municipal Solid Wastes

Solid wastes contain various materials, combustible and non-combustible

Table 1
Contents of municipal solid waste (wt% of total) collected in Chiang Mai in the year 2002

Component	Lower limit	Upper limit
Food waste	20.0	50.0
Paper waste	5.1	17.8
Plastic waste	6.2	13.8
Glass	2.0	15.0
Metals	0.9	2.5
Leather and rubber	1.0	13.0
Textile	1.0	3.0
Wood	1.2	11.9
Ceramic and stones	0.5	6.7
Other	1.0	6.6

Refuse Derived Fuels

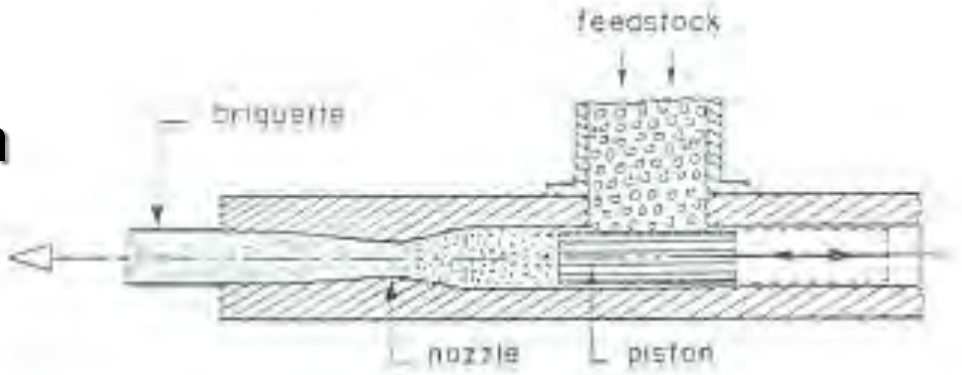


Densification

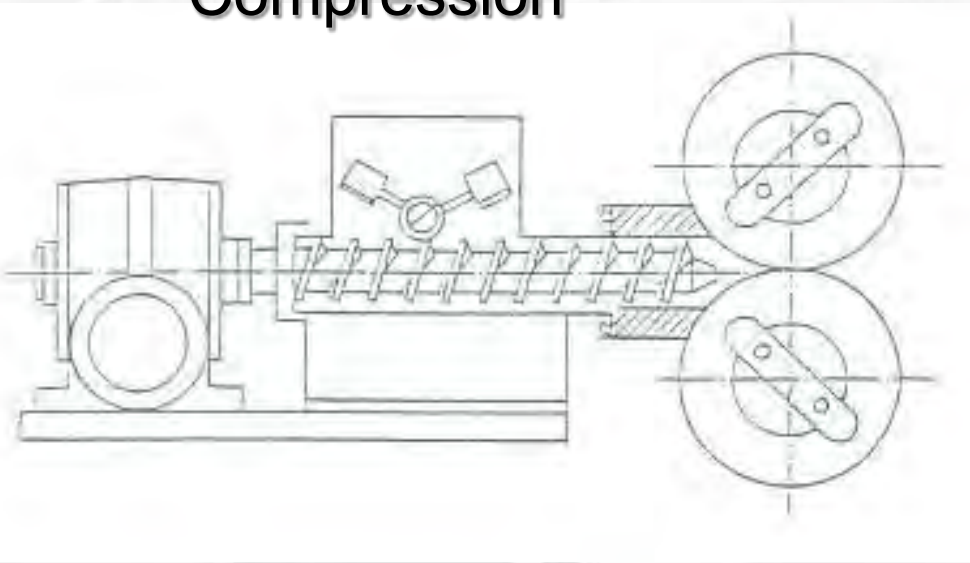
- ✓ Improved effective bulk density
- ✓ Regular shape
- ✓ Ease of handling and loading
- ✓ Homogeneous composition
- ✓ Higher energy per volume
- ✓ Dust and odours are minimized

Densifier

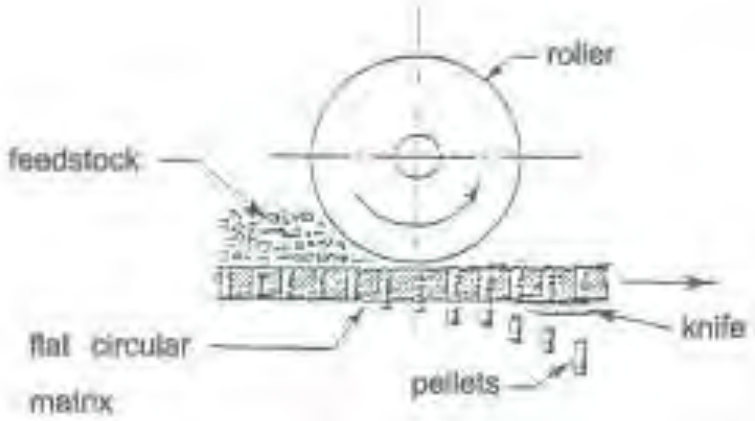
Extrusion



Compression



Pelletisation

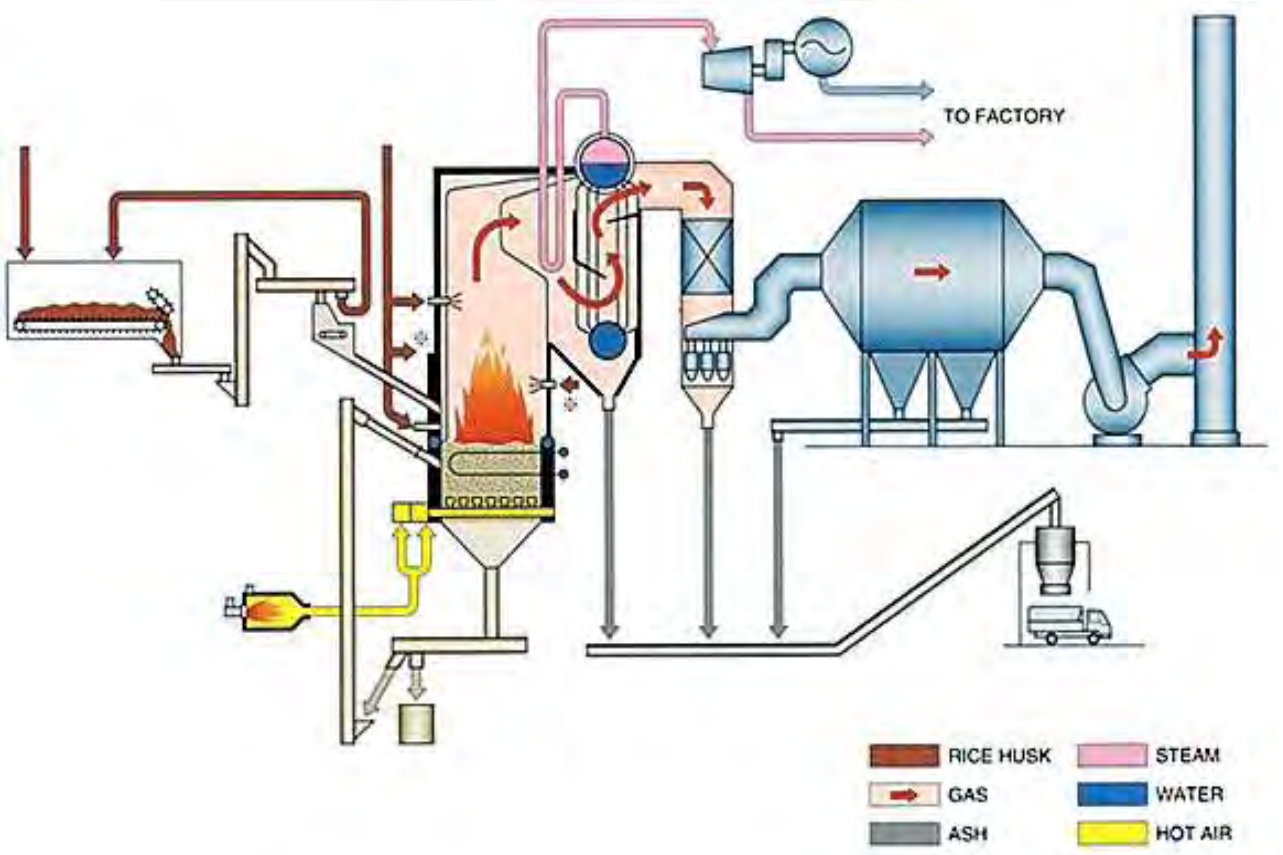


THERMOCHEMICAL CONVERSION

- Combustion
- Pyrolysis, Carbonization
- Gasification

Combustion

- Biomass combustion provides basic energy for cooking and heating in rural households, and for production processes in a variety of traditional industries



- Direct combustion using biomass to produce steam and electricity in agro-industrial process

Pyrolysis

Thermal decomposition of organic compounds in the absence of oxygen to produce liquids, gases and solids.

Liquids → Bio-oils, Bio-crude oils, Pyrolysis liquids

Gases → Synthetic gases (CO, CO_2, HCs, H_2)

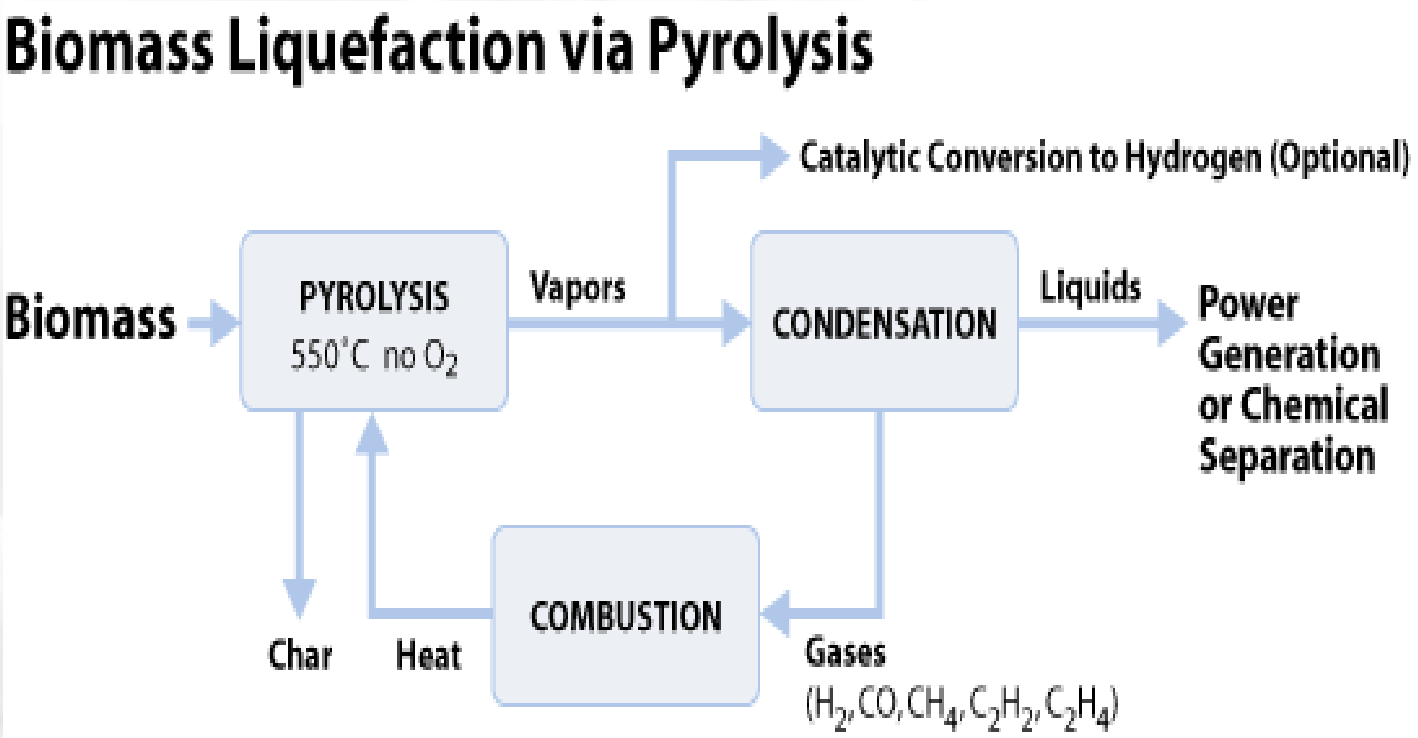
Solids → Char

Factors Affecting Pyrolysis Process

- Heating rate, heat source
- Reaction temperature
- Residence time
- Pretreatment (drying, size reduction)
- Seconady cracking
- Vapor cooling, liquid collection
- Char and ash separation

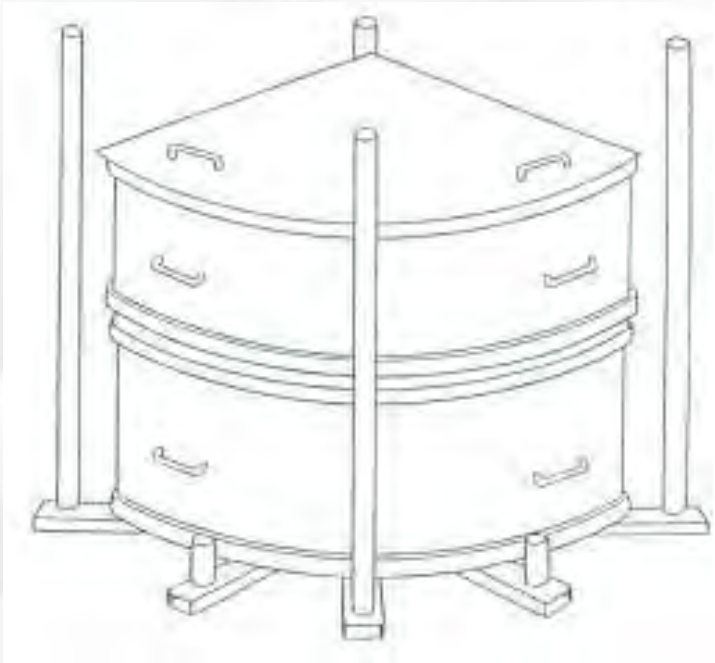
Pyrolysis oils, Bio-oils

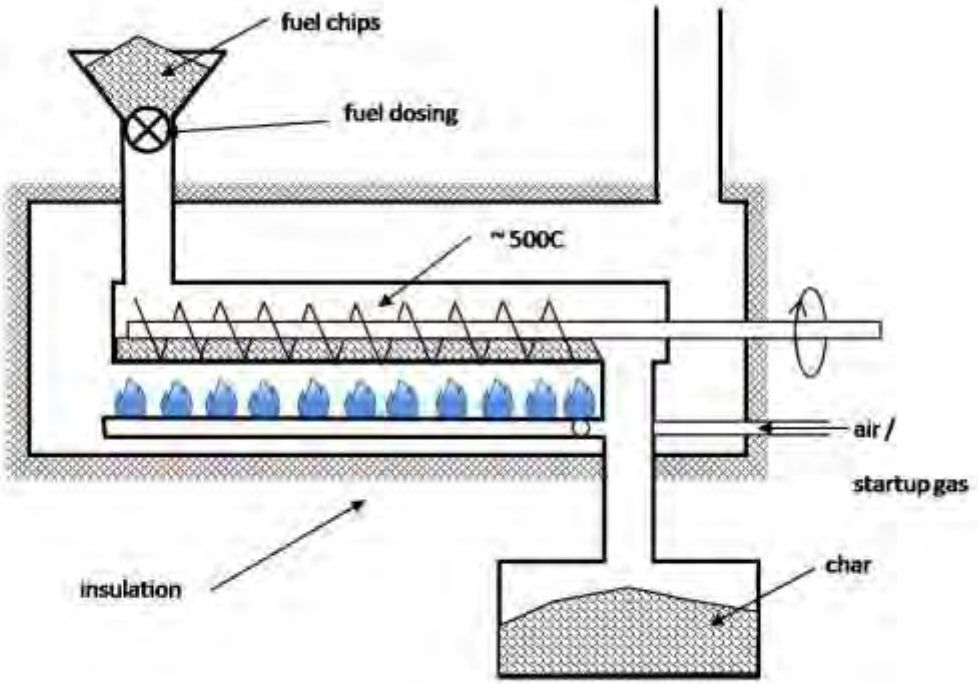
High liquid yield is possible at short residence time (0.5-2 s) and moderate temperatures (400-600°C)



Carbonization

Slow thermal treatment of biomass in the absence of oxygen, converted into low volatile, charcoal



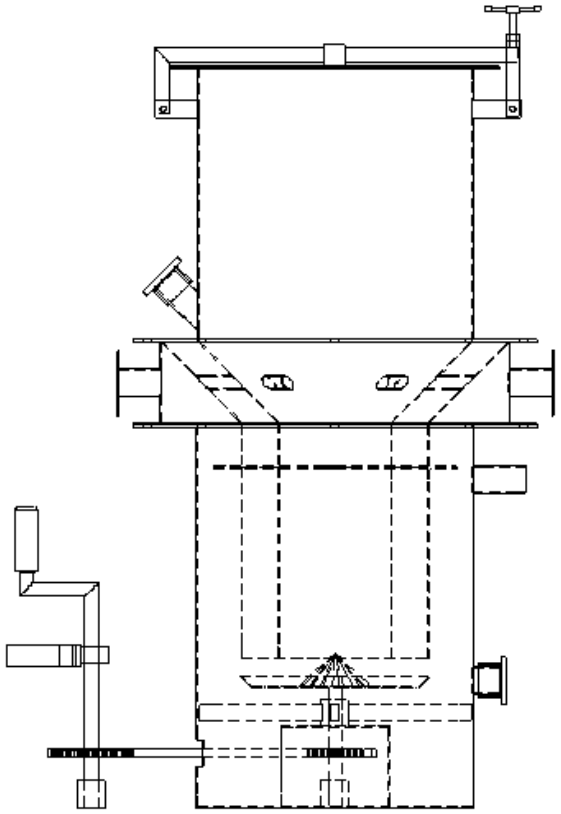


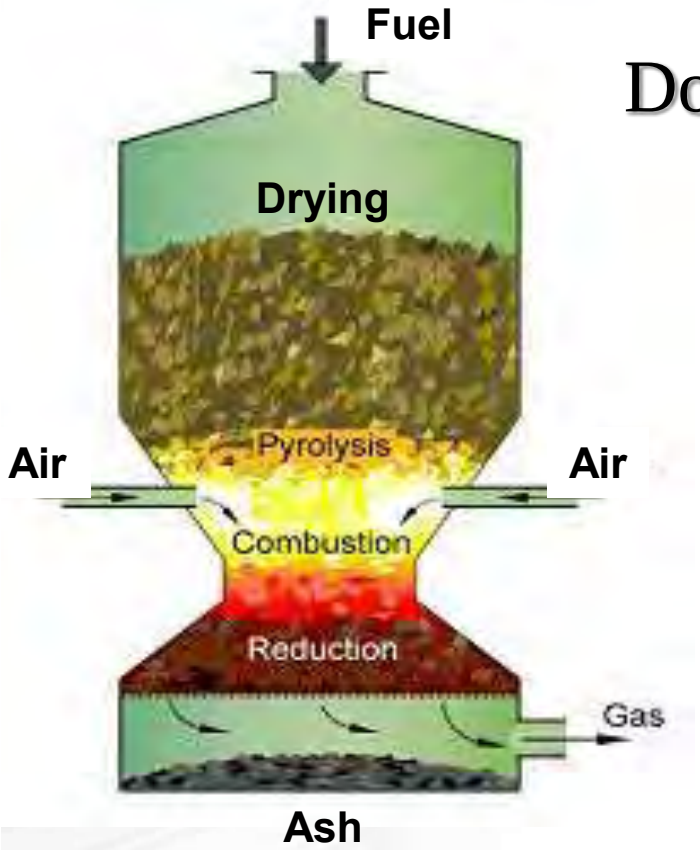
Gasification

A high temperature (750-900°C) conversion of solid, carbonacerous fuels into flammable gas mixtures. This gas is known as producer gas or synthetic gases, consisting of CO, H_2, CH_4, CO_2, and N_2

Combustion	$C + H_2O$	⟶	CO_2 + 393 KJ/mol
Water gas reaction	$C + H_2O$	⟶	$CO + H_2O$ – 131.4 KJ/mol
Water shift reaction	$CO + H_2O$	⟶	$CO_2 + H_2$ + 41.2 KJ/mol
Boudouard reaction	$C + CO_2$	⟶	2CO – 172.6 KJ/mol
Methane reaction	$C + 2H_2$	⟶	CH_4 + 74.9 KJ/mol

Gasifier

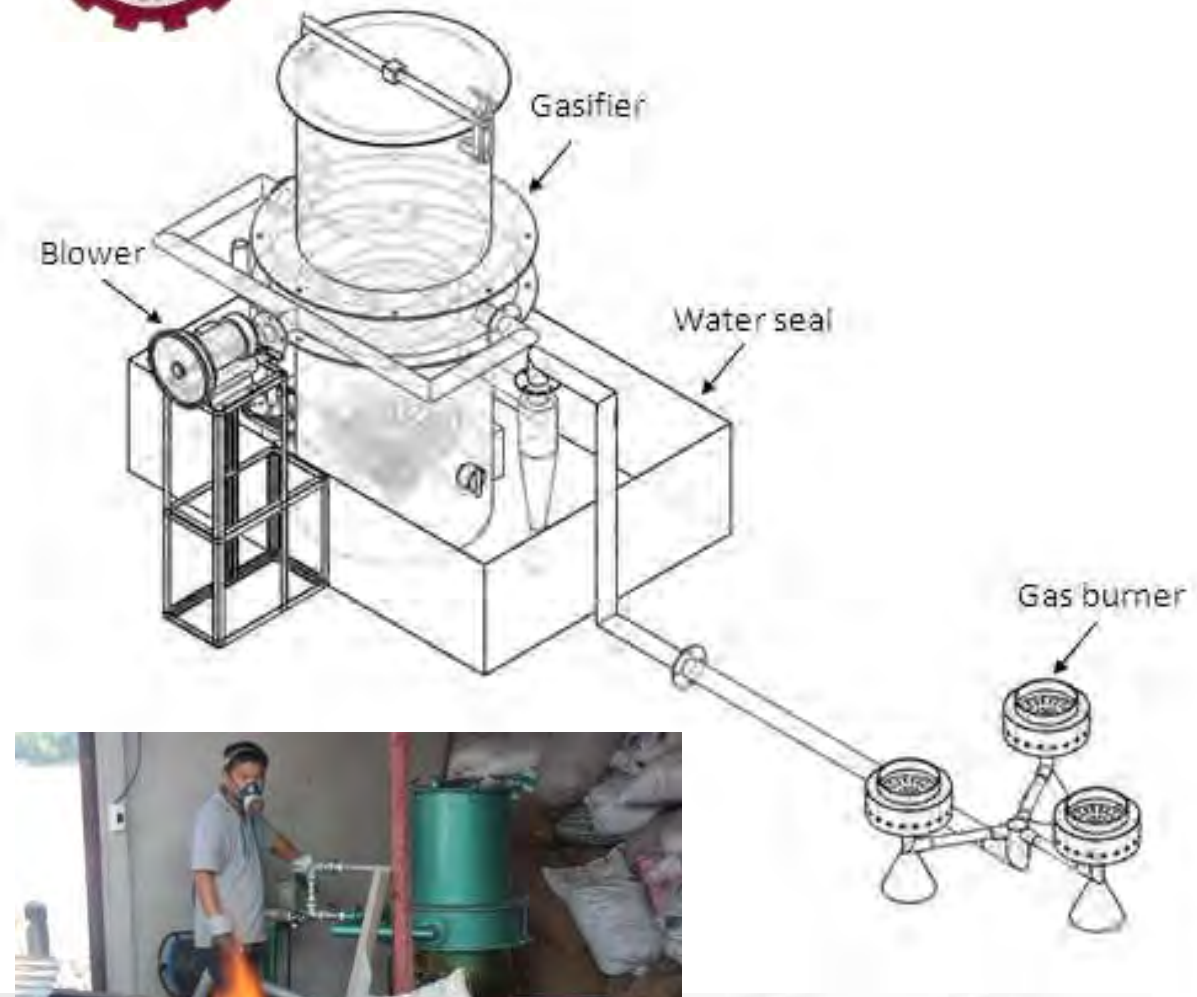


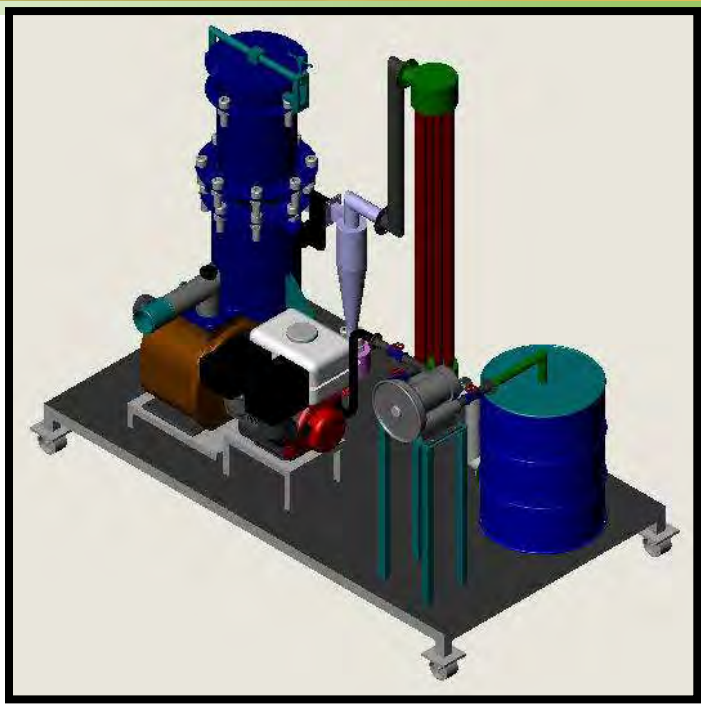


Downdraft Gasifier

1. Drying zone
2. Pyrolysis zone
3. Combustion zone
4. Reduction zone

Application of Producer Gas





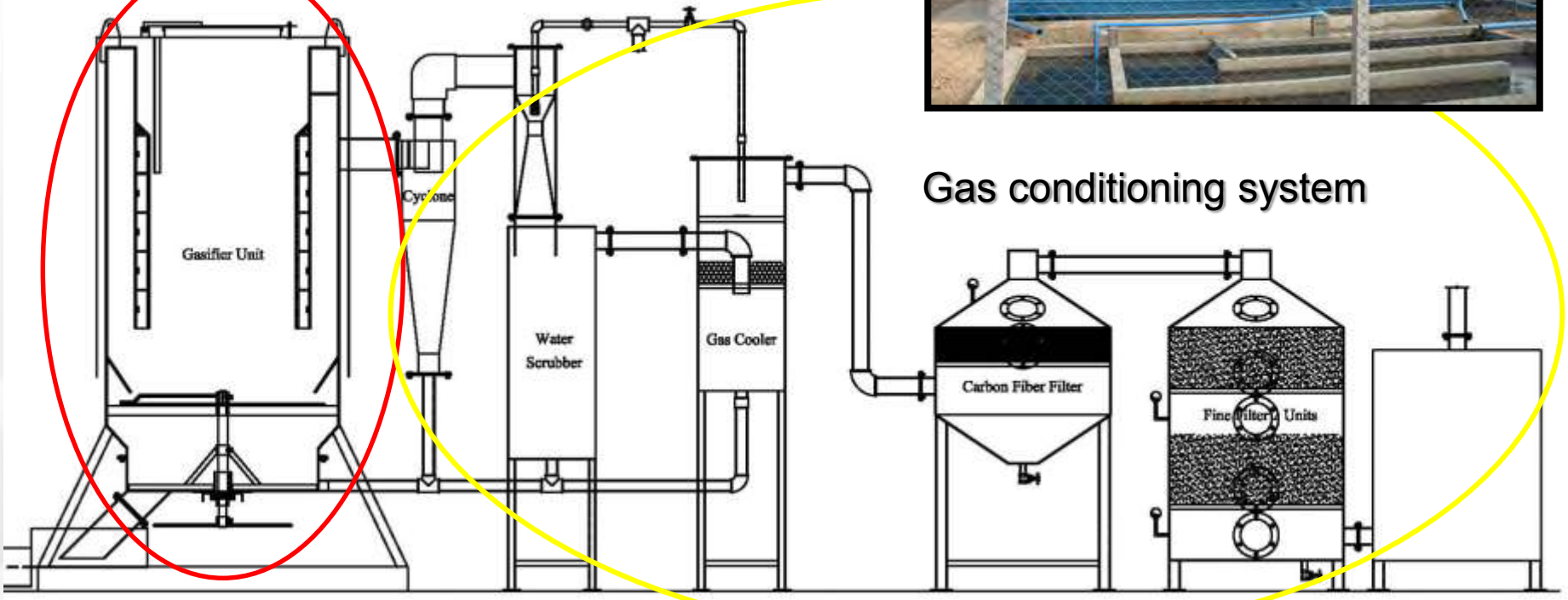
Gasifier – engine system

Heat

Small Power Plant

Reactor

Gas conditioning system



Further Readings

เทคโนโลยีการแปลงสภาพ
ชีวมวล

รศ.ดร. นคร ทิพยาวงศ์

Further Readings

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IMΦ
Thank you
for your attention !
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