Biochar: Introduction and Background

Background

The word "biochar" is a late 20th Century English neologism derived from the Greek word βίος *bios*, "life" and "char" (product of carbonisation of biomass, as charcoal

Background

It is simply charcoal, but used in certain applications

Pre-Columbian Amazonians produced biochar by smoldering agricultural waste (i.e., covering burning biomass with soil in pits or trenches

Background

A research team working in French Guiana hypothesized that the Amazonian earthworm *Pontoscolex corethrurus* was the main agent of fine powdering and incorporation of charcoal debris in the mineral soil

European settlers called it *terra preta de Indio*

Definitions

A solid material obtained from the thermo-chemical conversion of biomass in an oxygen limited environment

A carbon rich product when biomass such as wood manure or leaves is heated in a closed container with little or no air

Introduction

- Biochar is a fine grained charcoal high in organic carbon and largely resistant to decopmposition.
- It is produced from pyrolysis of plant and waste feedstock.
- Charcoal made from plant material or waste in high temperature oven with limited oxygen.

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- As a soil amendment, biochar creates a recalcitrant soil carbon pool that is carbon-negative, serving as a net withdrawal of atmospheric carbon dioxide

Introduction

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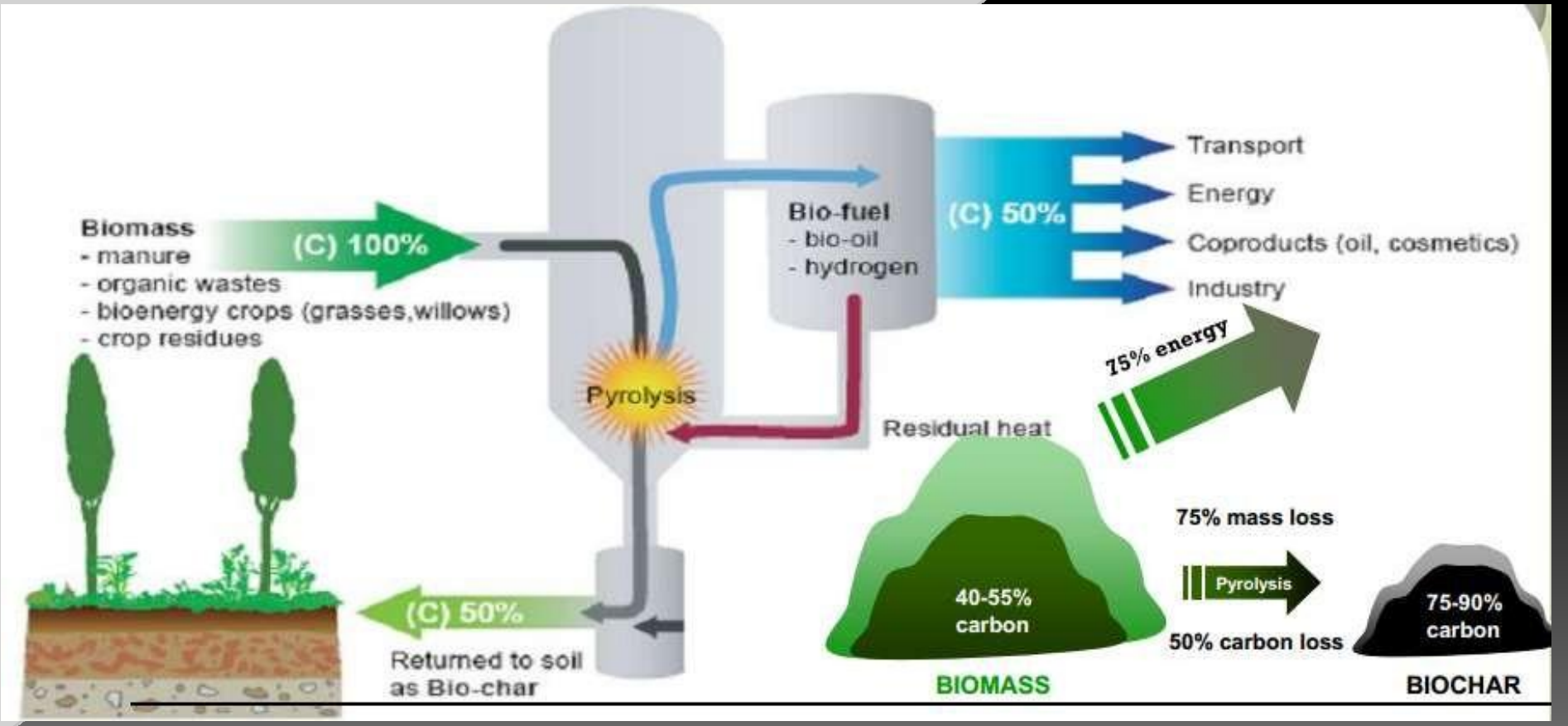
When put in soil, biochar sequesters carbon for 1000's of years.

It's carbon negative because it holds carbon from that would otherwise remain in the active carbon cycle.

Biochar=carbon-rich residue of heating biomass without oxygen

International Biochar Initiative



How to Made A Biochar ?

Not this way anymore!

Now pyrolysis ovens are used.

U.S. Biochar Initiative

Pyrolysis

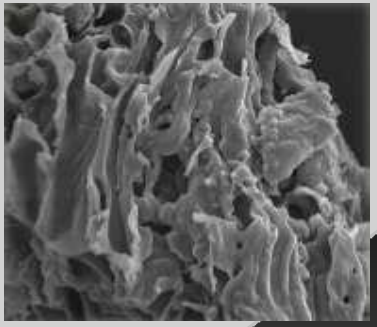
Transformation of a compound into smaller and simpler compounds, or compounds of higher molecular weight, under elevated temperatures usually in the range of 400°C to 800°C to as high as 1400°C. It differs from combustion in that it occurs in the absence of air and therefore no oxidation takes place.

Pyrolysis

PYROLYSIS: The thermal degradation of biomass in the absence of oxygen to produce condensable vapours, gases and charcoal. Emission captured.

COMBUSTION: The reaction of a material in the presence of heat and air/ O_2 leading to complete oxidization. Emission released.

PRODUCT OF PYROLYSIS



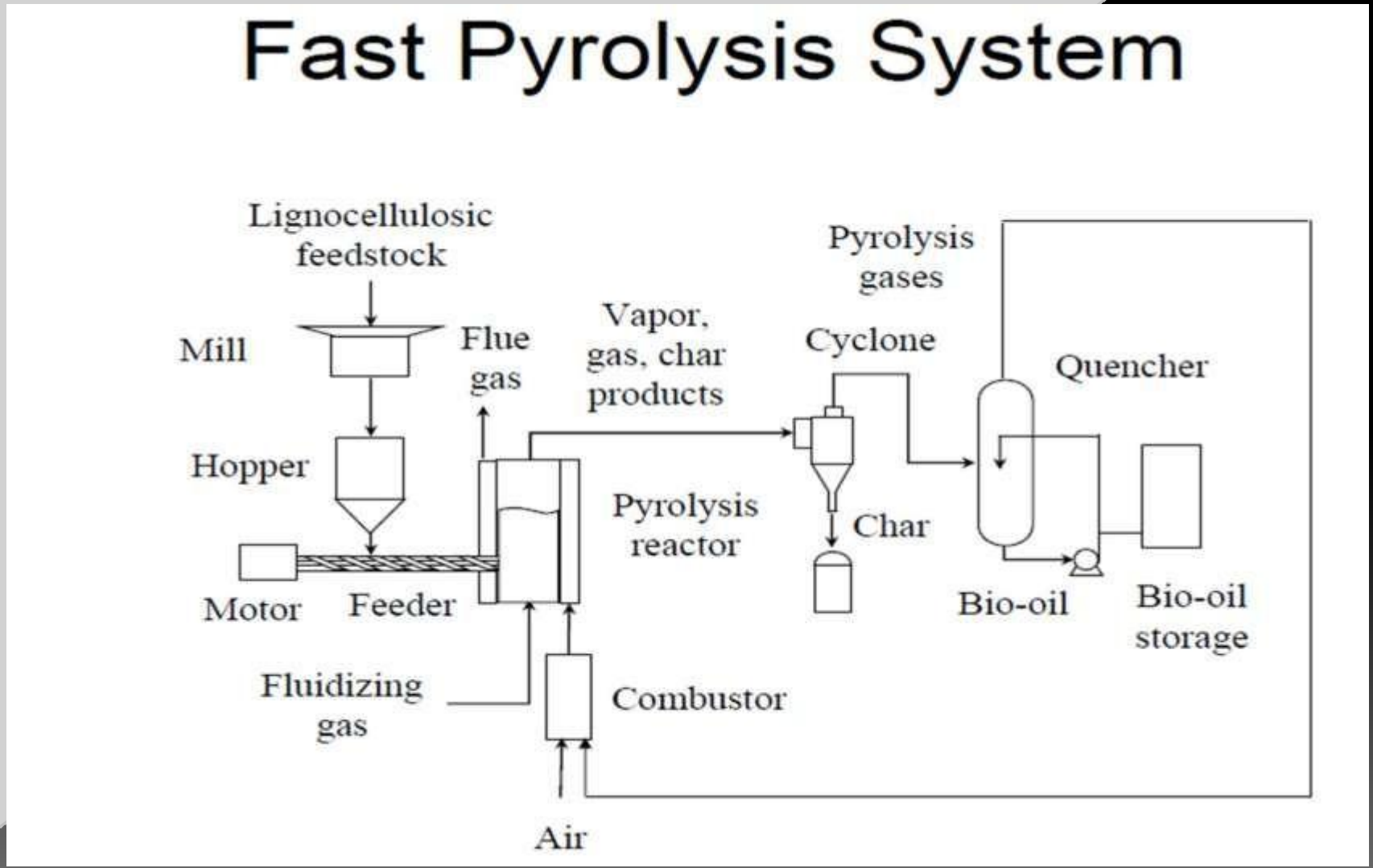
BIOCHAR

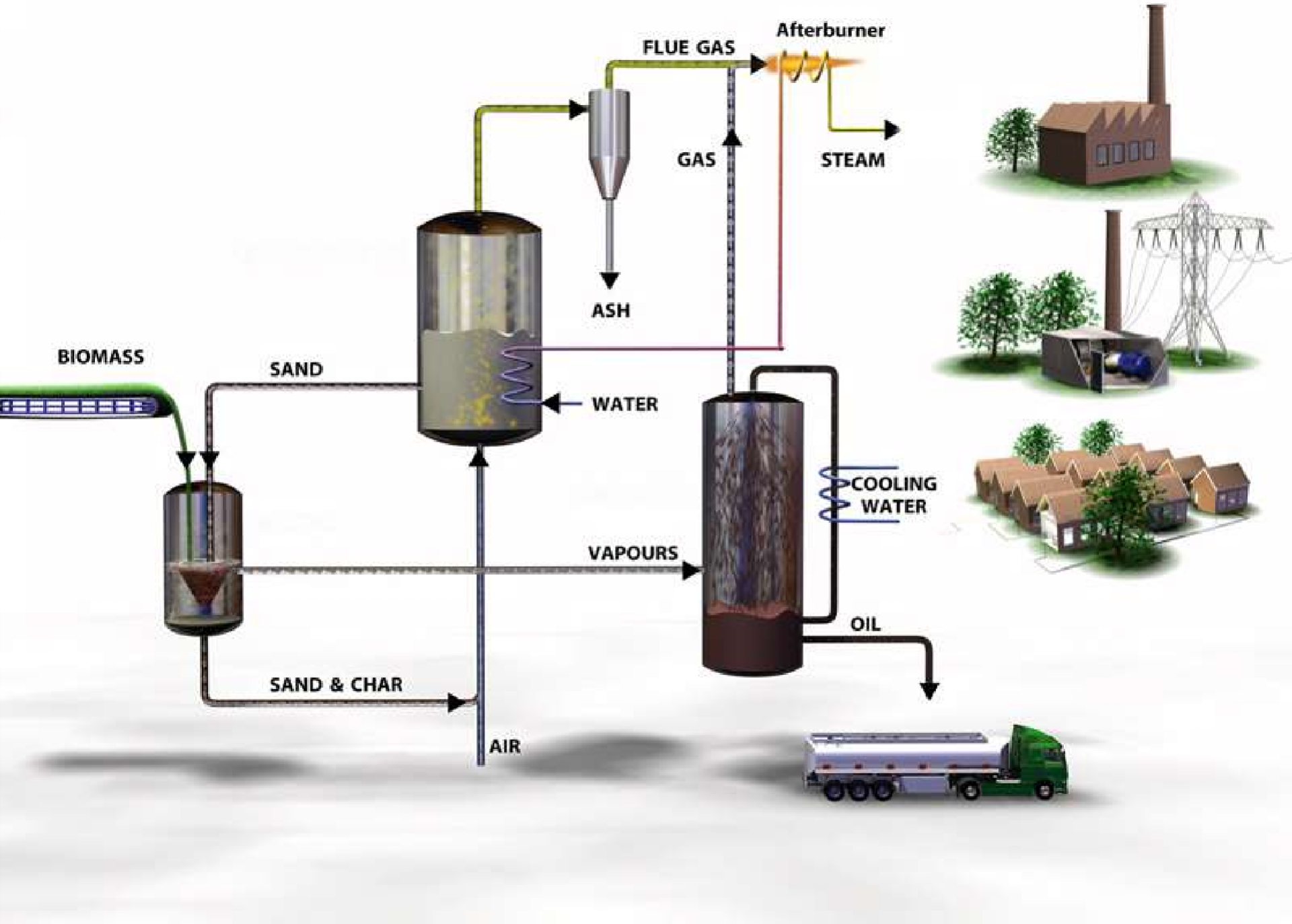
BIO-OIL

SYNGAS

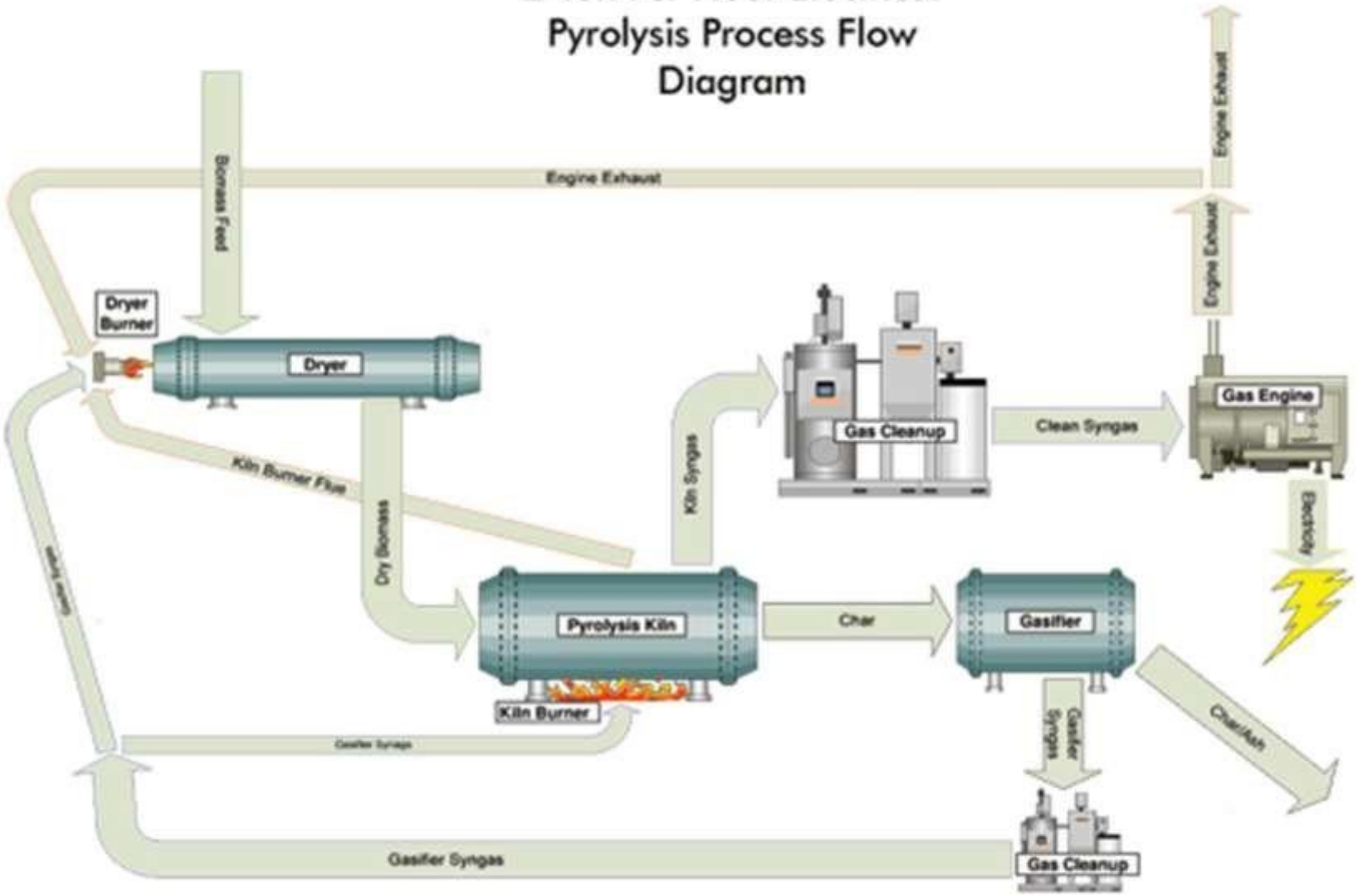
HEAT WITH MINIMAL EMISSIONS

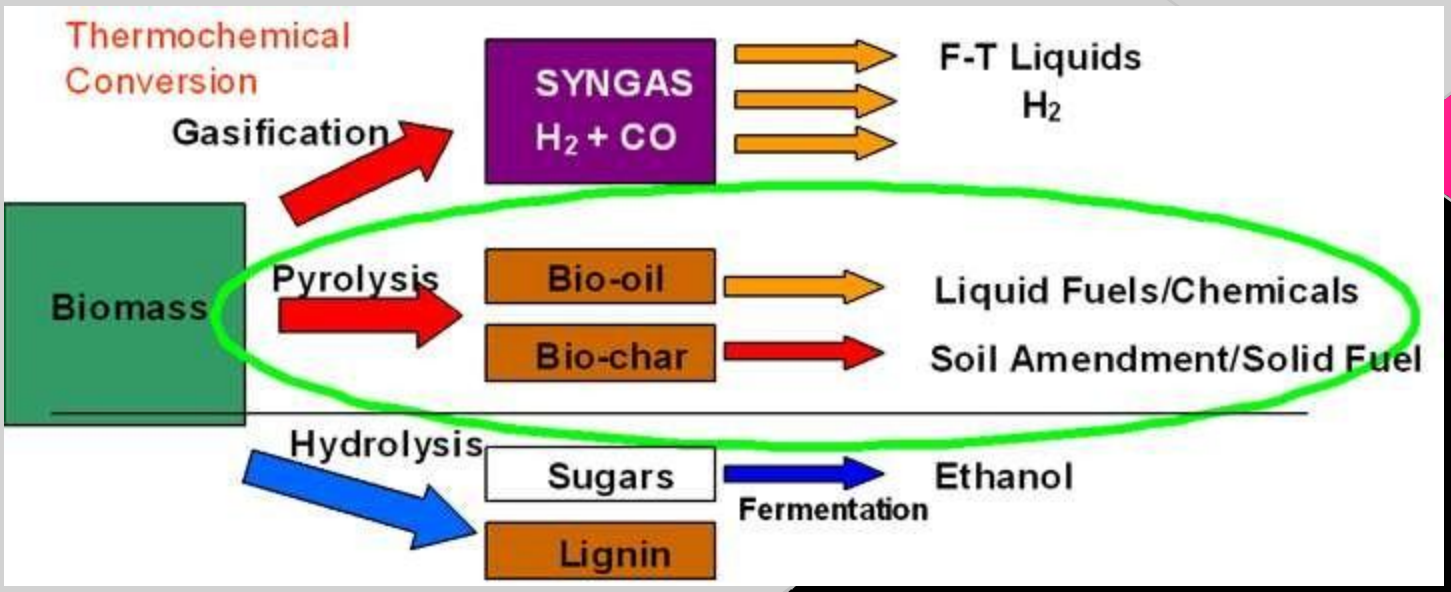
DESIGN OF PYROLYSIS CHAMBER




Afterburner
FLUE GAS
GAS
STEAM
ASH
BIOMASS
SAND
WATER
COOLING
WATER
VAPOURS
OIL
SAND & CHAR
AIR

2 Ton Per Hour Electrical Pyrolysis Process Flow Diagram




Thermochemical Conversion
Gasification
SYNGAS
H_2 + CO
F-T Liquids
H_2
Biomass
Pyrolysis
Bio-oil
Bio-char
Liquid Fuels/Chemicals
Soil Amendment/Solid Fuel
Hydrolysis
Sugars
Lignin
Fermentation
Ethanol


Bio-char
Bio-oil
Pyrolysis
Distillation
Distillate
Rice husk
Atmospheric distillation residue

SOIL AMENDMENT

- ✓ Ionic charge attracts water; high porosity holds water.
- ✓ Lowers bulk density of soil
- ✓ Biochar increases cation exchange capacity, and hence retention of ammonium (NH_4^+)
- ✓ Enhanced sorption of organics (nutrients, herbicides, pesticides, enzymes)

SOIL AMENDMENT

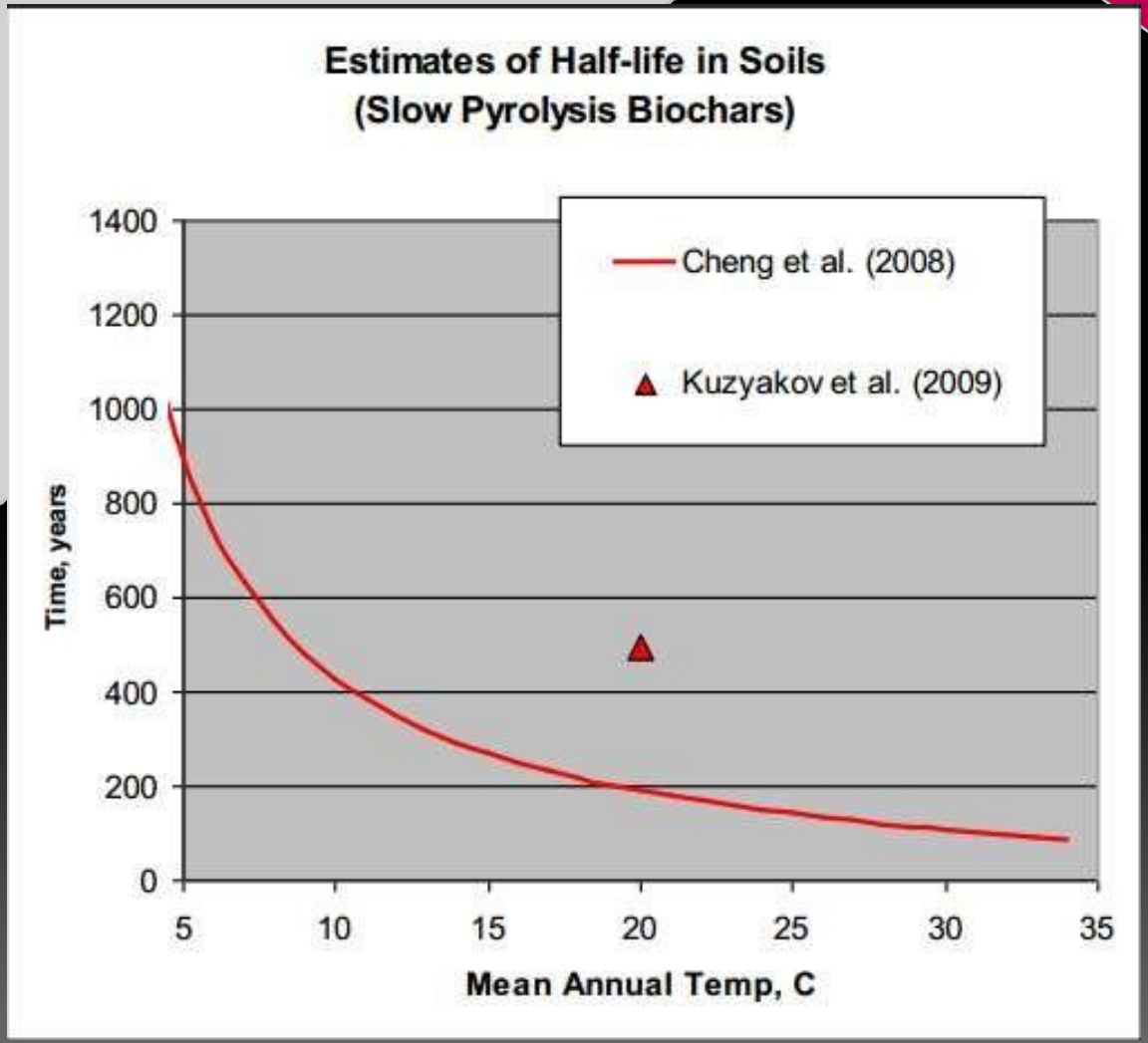
- ✓ Enhanced sorption of heavy metals and toxins (mine reclamation)
- ✓ Liming agent
- ✓ Evidence of increased mycorrhizal populations
- ✓ Carrier for microbially-based remediation

BIOCHAR IMPROVES SOIL

- Improved nutrient retention in soils
- Improved pH and reduced aluminum toxicity
- Improved soil moisture
- Lasts for thousands of years

CARBON SEQUESTRATION USING BIOCHAR

- Slow pyrolysis biochars are highly recalcitrant in Soils: half-lives of 100-900 years
- Half lives of >80 years sufficient to provide a credible C sink
- Recent study shows no evidence for enhanced rates of soil humic carbon degradationin agricultural soils (Kuzyakov et al.,2009)




3a
1a
With Biochar
Control: no Biochar

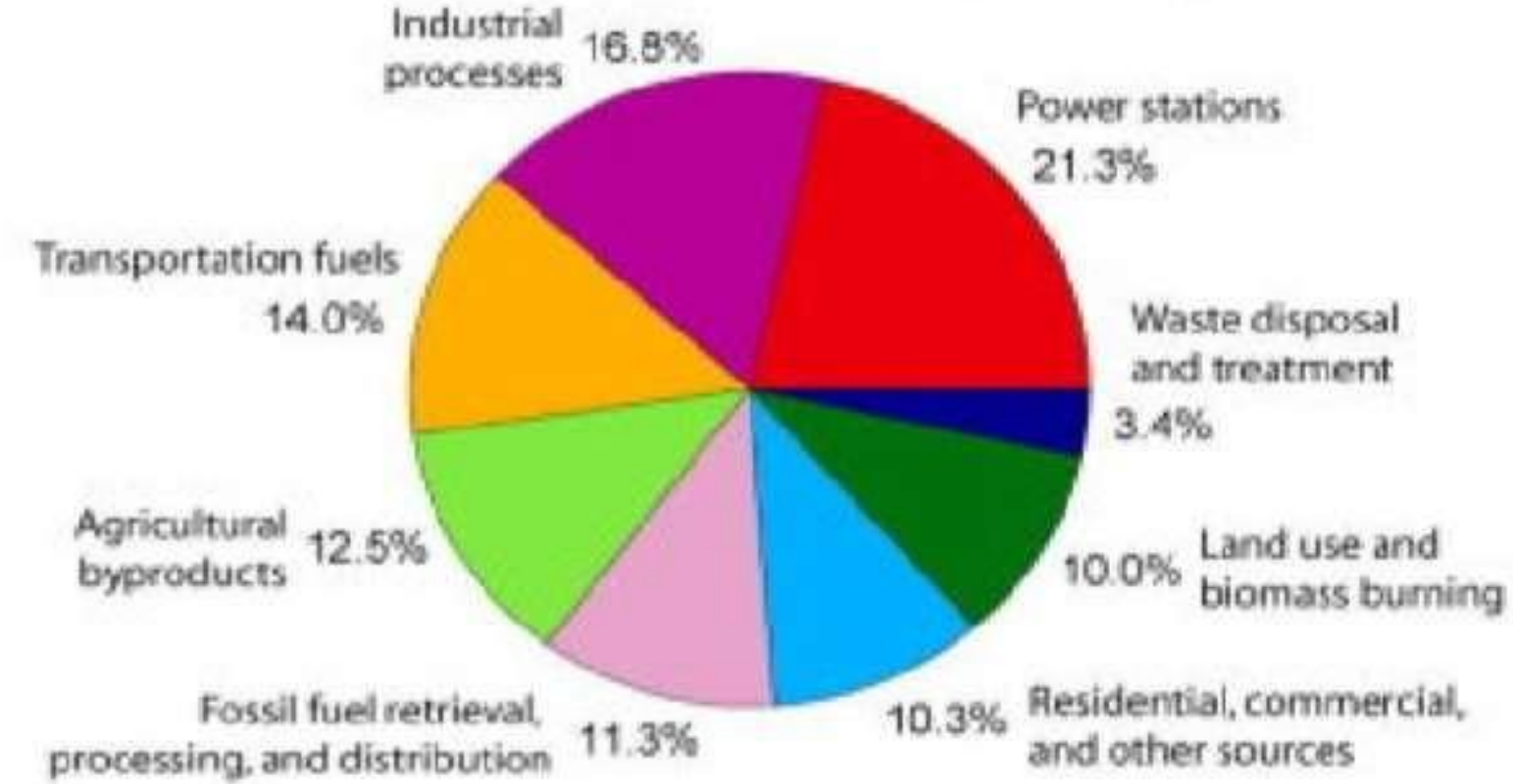

Hardwood
Rice hulls
Switchgrass
Bagasse
© J. Major 2008

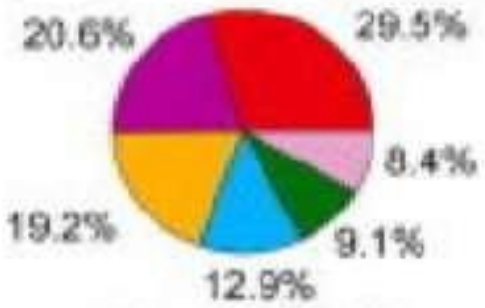
ZERO WASTE & CARBON NEGATIVE

Biomass, now a waste product, becomes:

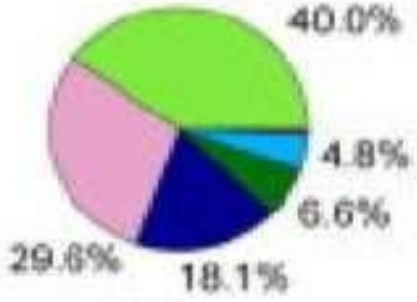
- Energy—process heat, bio-oil and gases (steam, volatile hydrocarbons convert to energy)
- Soil Amendment—holds water and nutrients persistently, raises pH, reducesfertilizer needs, reduces N2O emissions by 50-80%
- Water Quality Enhancer- mitigates N and P run-off, holds heavy metals, raises pH, and…
- Climate Change Mitigation—sequesters carbon for 1000's of years, minimizesCO2 ,N2O and CH4 emissions, creates carbon neutral energy, increased net primary productivity (plant growth & absorption of CO2)

Annual Greenhouse Gas Emissions by Sector

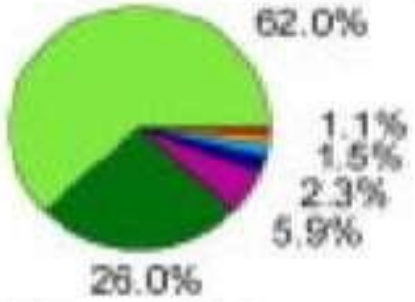




Carbon Dioxide
(72% of total)



Methane
(18% of total)



Nitrous Oxide
(9% of total)

Thank You