

# Biomass Energy



## Introduction to the lecture



- Lecture Biomass introduces the basic concept of biomass energy, its energy conversion processes and environmental impacts.
- In this lecture has 3 parts.
- Part 1 provides an overview of fundamental concept of biomass, types of biomass, sources of biomass, carbon neutral, global energy sources of biomass, use of biomass and converting biomass to other forms of energy.

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## Introduction to the lecture



- Part 2 provides theoretical concept of biomass conversion technologies, bioenergy technologies, biomass direct combustion, biogas-gasification, biofuels, biorefineries and biochar.
- Part 3 provides an overview of environmental impacts i.e. advantages for biomass energy and disadvantages.

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## Aim and Learning outcomes



- The aim is to build upon the previous lecture but shift the focus from the investment to the investors and, in so doing, raising the issue of the sources of finance and the terms under which it is provided.
  - After completion of Lecture "Biomass" students will be able to:
    - Explain how to obtain energy from biomass.
- Have a broad knowledge of the main sources of biomass, the origins of these sources, and the means by which they can be exploited for electricity generation.

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## Aim and Learning outcomes



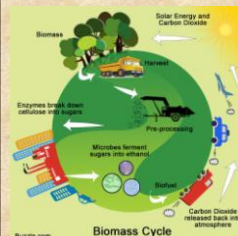
- After completion of Lecture "Biomass" students will be able to:
  - Understand the principles underlying the design and operation of waste and biomass to energy systems.
  - Production of clear and concise analyses of benefits and problems relating to the production and use of different forms of biomass energy

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## Talk outline



- Part-I
- Introduction – Biomass Energy
  - Fundamentals

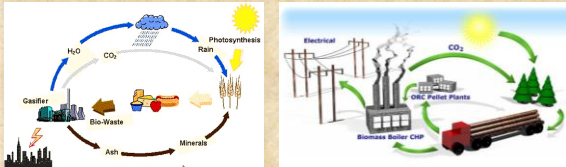


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## Talk outline



- Part-II
- Biomass Energy Conversion Processes



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## Talk outline



- Part-III
- Environmental impacts



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## Biomass Basics

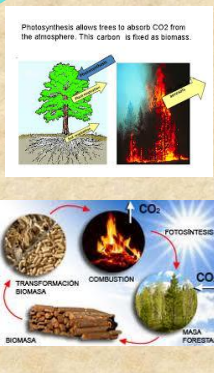


## Biomass —Plants and Animals



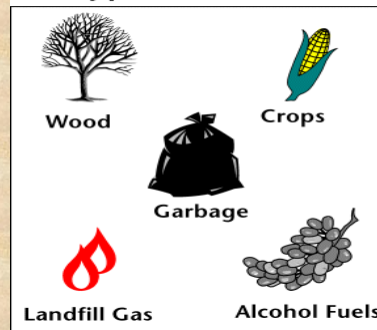
- Biomass is **organic material** made from plants and animals.
- Biomass contains stored **energy from the sun**.
- Plants **absorb** the sun's energy in a process called **photosynthesis**.
- The **chemical energy** in plants gets **passed on** to **animals** and **people** that eat them.

## Cont'd.....



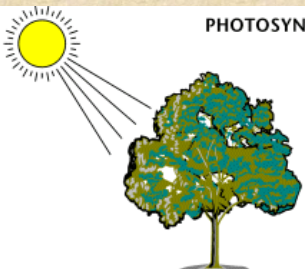
- Biomass is a **renewable** energy source because we can always **grow more trees and crops**
- Some examples of biomass fuels are **wood, crops and some garbage**.
- When **burned**, the **chemical energy** in biomass is **released as heat**
- Wood waste or garbage can be **burned to produce steam** for making **electricity**, or to provide heat to industries and homes.

## Types of Biomass



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## PHOTOSYNTHESIS




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

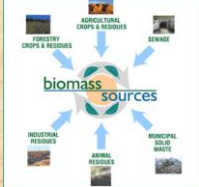
water + carbon dioxide + sunlight → glucose + oxygen  
 $6 \text{ H}_2\text{O} + 6 \text{ CO}_2 + \text{radiant energy} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6 \text{ O}_2$

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## Sources of Biomass



- Agriculture
- Residues from forestry, specific industries (e.g. furniture production), food processing
- Solid municipal and industrial wastes
- Used wood e.g. from old furniture, used timber
- Marine systems: the oceans of our world contain much more biomass than existing on the continents



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## Corn



<http://www.geo.msu.edu/geo333/corn.html>

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## Soybeans



<http://agproducts.uni.edu/>

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## Sugar Cane



<http://www.nrel.gov/biomass/photos.html>

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## Grass



<http://www.nrel.gov/biomass/photos.html>

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# Wood Chips & Sawdust



<http://www.rnel.gov/biomass/photos.html>

<http://www.energytrust.org/RR/bio/>

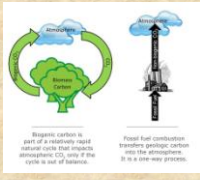
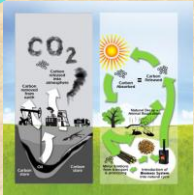
# Municipal Solid Waste



<http://www.eeingeorgia.org/eic/images/landfill.jpg>

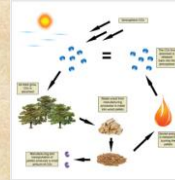
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# Carbon Neutral



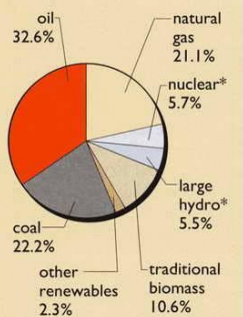
- Energy is produced from biomass by basically burning organic matter to release its stored chemical energy
- That it has accumulated through the process of photosynthesis
- Using biomass contributes very little to the build-up of greenhouse gases

# Carbon Neutral



- Although plants will release their stored carbon dioxide (CO<sub>2</sub>) when burned
- That CO<sub>2</sub> is recaptured and used by other plants as they grow
- Therefore, theoretically there is no net gain of carbon dioxide because of a cycle of usage

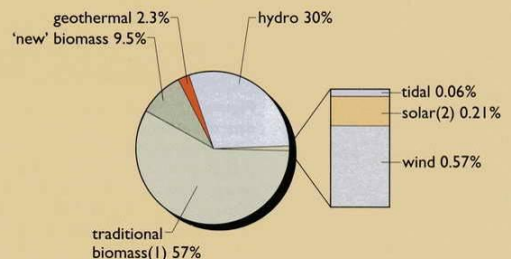
# Global Energy Sources 2002



Boyle, Renewable Energy, Oxford University Press (2004)

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# Renewable Energy Use – 2001



Boyle, Renewable Energy, Oxford University Press (2004)

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## Converting Biomass to Other Forms of Energy

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- Burning biomass is not the only way to **release its energy**
- Biomass can be **converted** to other useable forms of energy, such as **methane gas or transportation fuels**, such as ethanol and biodiesel



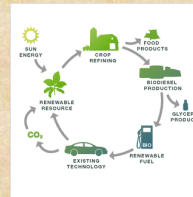
- Methane gas is the main ingredient of natural gas
- Smelly stuff, like rotting garbage, and agricultural and human waste, release methane gas — also called "**landfill gas**" or "**biogas**."

## Cont'd.....

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- Crops like **corn and sugar cane** can be **fermented** to produce **ethanol**
- **Biodiesel**, another transportation fuel, can be produced from **left-over food products** like vegetable oils and animal fats



## Cont'd.....

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- **Burning Wood Is Nothing New**
- The most common **form of biomass** is **wood**
- For **thousands of years** people have burned wood for heating and cooking



- **Wood** was the **main source** of energy in the United States and the rest of the world until the **mid-1800s**
- **Wood** continues to be a **major source of energy** in much of the **developing world**

## Biomass Conversion Technologies or Creating Energy from Biomass

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## Bioenergy Technologies

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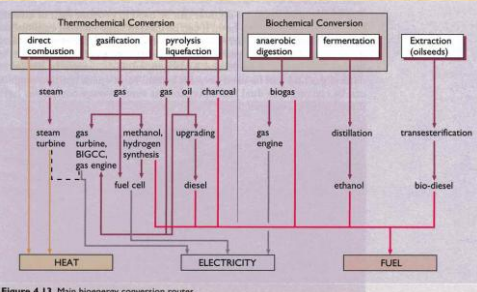


Figure 4.13 Main bioenergy conversion routes

## Biomass Direct Combustion

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- Biomass power technologies **convert renewable biomass fuels** to **heat and electricity**
- The biomass fuel is **burned** in a boiler to **produce high-pressure steam**
- This steam is introduced into a **steam turbine**, where it flows over a series of **turbine blades**, causing the turbine to **rotate**
- The turbine is **connected** to an **electric generator**
- The electric generator rotates, **producing electricity**.

## Biogas - Gasification



- By **converting** biomass into a **gas**, it can then be made available for a broader range of energy device
- **Gasifiers** operate by **heating biomass** in an environment where the solid biomass breaks down to form a **flammable gas**
- **Anaerobic digestion** is a commercially proven technology and is widely used for recycling and treating wet organic waste and waste waters
- It is a type of **fermentation** that converts organic material into biogas
- Which mainly consists of methane (approximately 60%) and carbon dioxide (approximately 40%) and is comparable to landfill gas.

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## Biofuels



- Liquid biofuels include pure plant oil, biodiesel, and bioethanol.
- Biodiesel is based on **esterification** of plant oils
- Ethanol is primarily derived from sugar, maize, and other starchy crops
- **Global production** of biofuels consists primarily of ethanol, followed by biodiesel production

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## Biorefineries and Biochar



- An emerging concept is biorefineries.
- A biorefinery involves the **co-production** of a spectrum of bio-based products (food, feed, materials, chemicals) and energy (fuels, power, heat) from biomass
- Biochar is a fine-grained charcoal high in organic carbon and largely resistant to decomposition
- Biochar is produced by heating biomass in the absence (or under reduction) of air.

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## Environmental Impacts



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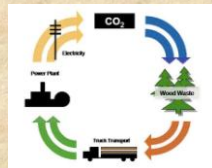
## The advantages for biomass energy



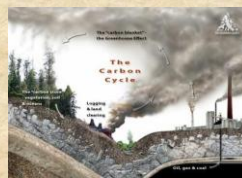
- Most of them are **renewable**, e.g., wood, mustard oil and crop residues
- **Solve energy crisis** in the future
- Some of them are **re-using the waste**, e.g., crop residues, sewage
- **High energy efficiency**
- Generally it **does not pollute** the atmosphere as much as oil and coal.



## The disadvantages



- Serious **air pollution** was found when burning plants matters, e.g., **CO<sub>2</sub>**, **CO**, **solid particulate matter**



- Emission some toxic gases and ash

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## Cont'd....



➤ It takes too **much energy** to collect, dry and **transport** the residues to power plants

➤ **Reduce soil nutrient** replenishment



➤ The **source of biomass** can use **fertilize soil**, e.g., crop residues and animal manure.

➤ **Cutting too many woods** is a kind of **deforestation** can cause, soil erosion and natural disasters

## Cont'd....



➤ **Raising** the price of food, wood and wood products indirectly

➤ May cause accident

➤ **It uses large area** to grow biomass

