Biomass Energy

Slide 2: ***Biomass Energy: What is Biomass?***

- Biomass energy is energy derived from plants and animal waste which are, or were recently, living material.
- Through photosynthesis, light energy from the sun is converted to chemical energy which is stored in plants.
- Animals eat plants and store the chemical energy.
- The evasive species like seaweed are also used as biomass in recent research.
- Biomass contains stored chemical energy that can be converted into electricity, fuel/Bio-fuel and heat.
- Bioenergy can be subsequently divided into woody, cellulosic and oil rich plants.

Slide 3: ***Biomass Energy: Resources***

- Biomass is available almost everywhere in the world.
- Biomass sources are divided into primary and secondary sources.

Primary biomass energy sources are plant materials grown for energy production, for example:

- Wood, crops, fruits, maze, sugar cane and sunflower seeds (converted to sunflower oil).

Secondary biomass energy sources are ‘waste’ materials which can be used for energy production, for example:

- Plant residues: agricultural and forestry residues.
- Fish and animal waste: manure, fish heads and abattoir waste.
- Waste yeast from the beer-brewing industry.
- Paper mill sludge.
- Sewage.

Slide 4: ***Biomass Energy: Resources***

- Good primary biomass energy resources have a high yield of dry material and use minimal land.
- Crops should generate more energy than their production consumes.
- Biological power sources are renewable and if harvested sustainably, CO_2 neutral.
- This is because the gas emitted during their transfer into useful energy is balanced by the CO_2 absorbed whilst the plants were still growing.
- Unfortunately biomass is not easily stored and transport is expensive.

Slide 5: ***Biomass Conversion Technologies and products***

- Combustion: process of burning of material to produce heat.
  - The heat produced can be used to produce steam to generate electricity.
- Anaerobic Digestion is a series of biological processes where microorganisms break down biodegradable material in the absence of oxygen.
  - The product is biogas (CO_2 and CH_4) and liquid fertilizer. Biogas can be burnt directly for cooking or produce electricity.
- Fermentation process is actually a conversion of sugar into acids or alcohol with the help of bacteria or yeast.
- Mechanical Processing can be done by grinding seeds to extract the oils they contain to produce biofuels.

Slide 6: ***Uses of Biomass: Combustion (Heating & Cooking)***

- The most common way of harvesting energy from biomass is creating fire.
- Wood can be burned for heating living spaces or to prepare food.
- Using more advanced machinery, Biomass can be used to produce electricity.

Slide 7: ***Uses of Biomass: Combustion (Electricity)***

Generating Electricity:

- When wood is burned the chemical energy in biomass is released as heat and light energy.
- Biomass power plants work on a similar principle to natural gas or coal power plants.
- The heat energy being released boils water to form steam, which then turns a generator.
- In combined heat and power systems, the surplus heat energy can also be utilized, for example for heating water or nearby homes.

- These power plants are usually not as large as coal power stations because their fuel supply has lower energy content and is not as abundant as coal.

Slide 8: ***Uses of Biomass: Anaerobic Digestion (Biogas digester)***

- Anaerobic digestion is the process where microorganisms break down organic materials into sugars and then into various acids which are further broken down to produce bio-gas. **Biogas** is a mixture of CO_2 and CH_4. CH_4 (Methane) is a combustible gas that can be used directly in biogas stoves for cooking, or can be used in gas engines to produce electricity.
- A biogas digester consists of one or more airtight reservoirs into which a suitable feedstock – cow dung, human waste, and abattoir waste or plant material – is placed. The waste should have high moisture content.
- Small-scale digesters for household use are commonly made of concrete, bricks, metal, fibreglass, or plastic.
- Larger commercial biogas digesters are made mainly of bricks, mortar, and steel.
- An odourless phosphorus- and nitrogen-laden slurry is produced as waste – an excellent fertilizer!
- Depending on temperature and moisture content, it takes about 6 – 25 days to fully process a batch; simpler digesters may take longer.
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Slide 9: ***Uses of Biomass: Anaerobic Digestion (Landfill Power Plant)***

- Landfill power plants work on the same principle as a bio-digester.
- Decomposition is taking place in the absence of oxygen, hence an anaerobic process done by micro-organisms.
- A variety of gases are formed of which the most are methane and carbon dioxide.
- Landfill gas utilization is a process of gathering, processing, and treating the methane gas emitted from decomposing garbage to produce electricity, heat, fuels, and various chemical compounds.

Slide 10: ***Small-scale Biomass Power Plants in South Africa***

- The first bidding round of the Renewable Energy Independent Power Producer Procurement Programme started in 2011.
- Up to date, four bidding rounds have been completed.
- The following website contains a map which provides the details of each REIPPPP project in South Africa: http://energy.org.za/knowledge-tools/map-of-sites

The following details can be viewed on the website:

- **Name** of the project
- Type of **technology** being build
- The **capacity** of the power plant and the
- Current **status** of the project

Bidding round	Number of Projects		Capacity allocated (MW)
	Biomass	Landfill	
Window 1	-	-	-

Window 2	-	-	-
Window 3	1 (16MW)	1 (18 MW)	34
Window 4	1		62
Total	**2**	**1**	**96 MW**

Slide 11: *Uses of Biomass: Biofuels*

- Biomass fuel, or biofuel, is a broad term to describe material of biological origin that can be used as a source of energy.
- Biomass can be converted into liquid biofuels.
- First-, second- and third-generation biofuels can be used in these processes.
- First-generation biofuels are made from maize, sugar cane, sunflower oil, soybeans, etc., which are traditionally seen as food crops.
- Second-generation biofuels are produced from plant residue, for example maize cob, sugarcane and sweet sorghum bagasse. The food products are harvested, as well as the residue but the yield in terms of energy is lower.
- Third-generation biofuels are cultivated from algae to produce biodiesel from the oil.
- There is controversy around first-generation biofuels regarding the ethical question of whether food can be used for fuel.
- Therefore the tendency is that more and more research is focused on second-generation biofuel, where one will have the benefit of the food as well as the usefulness of the residue.
- With biofuels we need to ask the following questions:

  1. Can we use food for fuel?
  2. What is the effect of mono crops on nature?

Slide 13: *Uses of Biomass: Mechanical Processing (Biodiesel)*

- Biomass fuel, or biofuel, is a broad term to describe material of biological origin that can be used as a source of energy.
- Biomass can be converted into liquid biofuels through mechanical processing and fermentation.
- First-generation food crops like sunflower seed oil, soybeans and other crops can be converted into biodiesel through mechanical processing.
- Oil from these fuels are often more effective than wood, since they represent a more concentrated energy source.

Slide 14: *Uses of Biomass: Fermentation* (*Biofuel)*

- First- and second-generation crops like maize, sugar cane and sweet sorghum bagasse can be converted into fuel or gas through a fermentation process.
- Through fermentation, maize and sugar cane are converted into:

  1. Ethanol – a liquid biomass fuel.
  2. Methane – a gas.
- In Brazil, ethanol from sugar cane crops is a major contributor to fuel resources, and is called gasohol.

- This reduces the amount of fossil fuels needed to power cars.

Slide 15: *Uses of Biomass: Algae*

Third-generation biomass algae produce biofuels.

It is still in **research phase.**

Benefits

- Fast growing
- Contains oil; contains no sulphur; non-toxic
- Algae fuel is also known as algal
- Algae can be grown because it is not in competition with crops.
- It can be grown with seawater in the desert and won't use agricultural space.

Concerns

- It is expensive to develop.
- It cannot provide enough oil to satisfy the total transport demand, although it can meet the aviation demand, because it is smaller.