BIOMASS FOR POWER AND ENERGY GENERATION

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Abstract
Biomass is a scientific term for living matter, more specifically any organic matter that has been derived from plants as a result of the photosynthetic conversion process. The word biomass is also used to denote the products derived from living organisms – wood from trees, harvested grasses, plant parts, and residues such as stems and leaves, as well as aquatic plants. The solid biomass processing facility may also generate process heat and electric power. As more efficient bioenergy technologies are developed, fossil fuel inputs will be reduced; biomass and its by-products can also be used as sources for fuelling many energy needs. The energy value of biomass from plant matter originally comes from solar energy through the process known as photosynthesis. In nature, all biomass ultimately decomposes to its elementary molecules with the release of heat. During conversion processes such as combustion, biomass releases its energy, often in the form of heat, and the carbon is re-oxidised to carbon dioxide to replace that which was absorbed while the plant was growing. Essentially the use of biomass for energy is the reversal of photosynthesis.

Introduction
The need for energy and energy sources has multiplied exponentially with the industrial revolution. The need for fuels for automotive was realized with the invention of steam engines and steam heating equipment. Initially wood, sawdust[1] and other agricultural products were directly used of different size reduction, the need for high energy content, size reduction for convenience and other aspects and the experience of man in dealing with different natural products like coal, vegetable oils made new thought to look for alternate fuels.

After few centuries at low cost and its convenient form resulted in invention of new engines running on petrol, diesel, kerosene and petroleum gases. All conventional fuels were replaced with petroleum in the developed countries.

Human being with his basic nature for easy living has over used this limited non-renewable resource .In 1973 crises there is a hike in the petroleum product price. It had necessasiated the western countries and petroleum starved countries to look for alternate fuels [2]. Another major compelling reason to look for alternates for fossil fuel is the global warming [3].

The major culprit contributing in global warming is carbon dioxide. The major culprit contributing in global warming is carbon dioxide. More than 50% of CO_2 is emitted from the transport sector and 70% is from the power sector

Biomass
Biomass is renewable source of energy produced in nature through photosynthesis achieved by solar energy conversion and it play dual role in greenhouse gas mitigation [4] both as an energy source and as a carbon sink. It is available in the form of wood, agricultural residues, and food grains. Solid biomass is commonly used as fuel for cooking and other thermal process [5] in small industries, fuel for

boilers, but it can be transformed into gaseous and liquid fuel in the form of ethanol and bio-diesel.

Technology

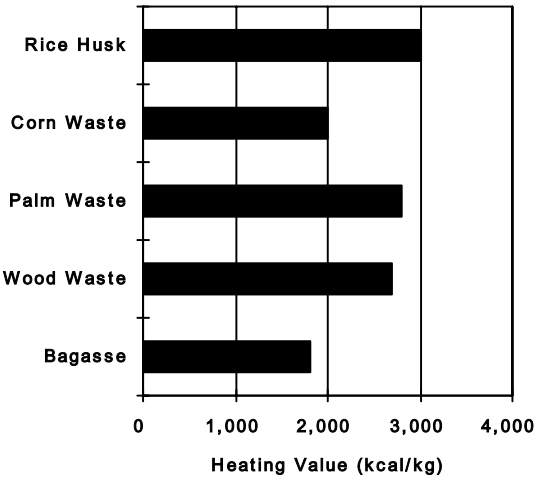
The paper addresses a power generation system for rural India using biomass that has evolved at the Centre for Energy Technology, Osmania University, Hyderabad, India. In that different kind of biomass fuels can be used in the same gasifier without changing its orientation and technology. The conversion of gasification is by thermo chemical reactions of a fuel with oxidizer under sub-stoichiometric conditions, the energy in biomass being realized in the form of combustible gases (CO, CH_4 and H_2). The generation of gas occurs in two significant steps. The first step involves exothermic reactions of oxygen in air with the pyrolysis gas under fuel-rich conditions. The second step involves the endothermic reaction of these gases largely CO_2 and H_2O with hot char leading to product gases namely, CO, H_2 and CH_4.

The technology field pertaining to updraft advanced biomass gasification system coupled with the internal combustion engine or gas turbine is brought out. The advanced gasifier reactor design uses dual air entry – air nozzles, air is moved with a special channels to combustion chamber, in the pyrolysis zone having two sections primary and secondary, the later zone having thermo chemical conversion process to produce synthetic fuel oil/charcoal to help in establishing high temperature zone for remove the contaminants in the product gas.

The contribution of biomass as energy source in India is commendable. Estimated world wide the energy stored in biomass through photosynthesis is approximate $3x10^{21}$J/year. Out of which nearly 90% is stored in trees.

The total energy stored in biomass 10 times the energy consumed today and far exceeds the total energy requirement. The reason for the low utilization [6] of biomass energy is for its heterogeneous nature. The heating values of biomasses [7] are also lower than coal and petroleum products. They are available mostly in oxygenated form.

Biomass Fuel Heating Value



Primary energy use in India is dominated by coal (40% of total primary energy supply and 59% of power generation); followed by fuel wood (34%); and petroleum fuels (15%). The share of fossil fuels is projected to increase from around 60% during 1995-96, and 74% of total energy use by 2010.

Gasifier Complete gasification stages

- Drying of feedstock *(~1200C)*
- Pyrolysis(Two Zones) *(200~6000C)*
- Combustion *(900~12000C)*
- Reduction *(900~6000C)*

Applications

- Cooking
- Drying
- Water heating
- Steam generation
- Mechanical / Electrical power generation
- Fuel for Internal combustion engine

Evolution of the world energy mix

	2005 Consumption	2020 Consumption	Gain (Loss)
(Business as Usual Scenario)	(million TOE)	(million TOE)	(million TOE)
TOTAL *(sum of components below)*	11,409	15,544	4,135
Oil	3,678	4,300	622
Natural gas	2,420	3,600	1,180
Coal(conventional)	2,778	3,193	415
Traditional biomass and waste	793	1,400	607
Nuclear fission	624	790	166
Hydro	634	750	116
Coal (liquefaction, gasification)	0	500	500
Other biomass, methanol, ethanol	370	388	18
Unconventional oil (tar sands and shale)	88	350	262
Solar(PV,thermal)	11	100	89
Wind	8.5	100	92
Geothermal	4.8	50	45
Methane gas hydrates	0	22	22
Tides	0.1	1	1

Population relying on traditional biomass

Country /Region	Millions	Percentage of Population
China	706	56
Indonesia	155	74
Rest East Asia	137	37
India	**585**	**58**
Rest South Asia	128	41
Latin America	96	23
Middle East and N. Africa	8	0.05
Sub-Saharan Africa	575	89
All developing countries	2,390	52

Biomass is not only for energy/power generation it also provides more job opportunity to the people in the rural area and ultimately leads to gradual improvement in the quality of their life. It's going to solve social problem of the people.

Biomass Components

a) Lignin: 15-25%

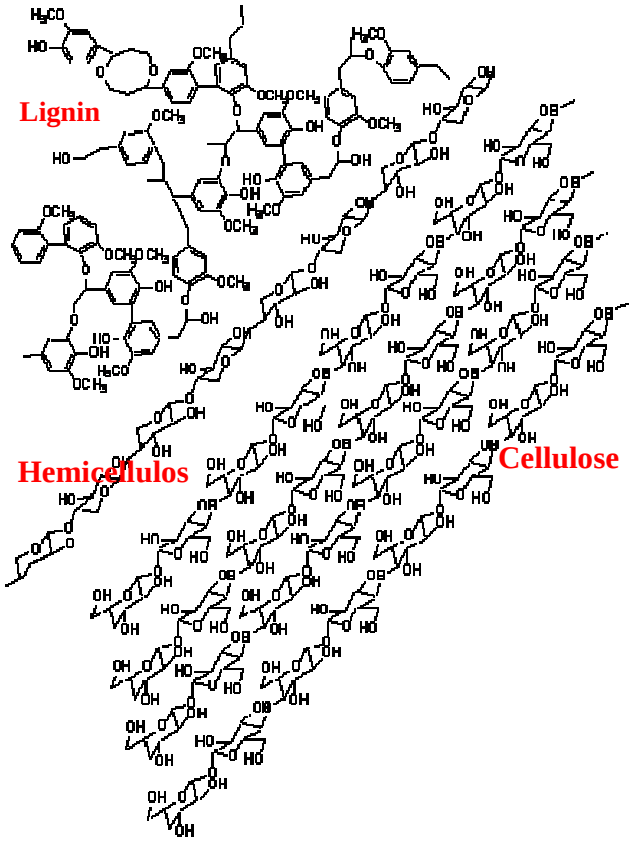
Complex organic structure
Very high energy content
Structure (Hard), Difficult to Decompose

b) Hemicellulose: 23-32%

Polymer of 5 & 6 carbon sugar
Easy to Decompose

c) Cellulose: 38-50%

Polymer of glucose, very good biochemical feedstock, Concrete (Soft)



Typical the volumetric composition of biomass based producer gas are as follow

CO	→	20 – 22%		Tar and particulate materials
H_2	→	16 – 19%		
CH_4	→	3 – 4%	+	
CO_2	→	9– 11		
N_2	→	50– 54%		

The ratio of products varies with the chemical composition of the biomass and the operating conditions.

Table 1 : Total Availability of Biomass (10^6 metric tones/year)

Wastes	**India**	**Brazil**	**Sudan**	**USA**	**Sweden**
Bio mass	**140**	496.8	192.3	427	14
Agricultural residues	200	47	8.1	573	12.6
MSW	135.5	44	2.3	148	5.3

Table 2: Comparison of biomass with solar & wind (Source : "21 Century by Biomass Energy", Sakai Masayasu)

Power Generation	Solar Cell	Wind	Biomass
Total Investment (million US$)	1,830	12,700	6,300
Facility Scale (kW/year)	1,000,000	10,000,000	10,000,000
Yearly Operation Rate (%)	12	20	70
Yearly Electricity Generation (million kWh)	1,100	17,500	61,300
Unit Investment (US$/kW)	1.66	0.72	0.10

The table 2 is showing the investment cost of solar cell, wind and biomass and yearly operation cost. Biomass having the higher electricity generation with low Investment.

In India the Biomass power plants commissioned 52 x 290MW by the year 2004, under implementation 41 x 284MW.

Summary

Biomass is a sustainable fuel that can both offer a significant reduction in net carbon emissions compared with fossil fuels and also many ancillary benefits. Most preferred fuels for gasification have been charcoal and wood. However biomass residues are the most appropriate fuels for on-farm system and offer the greatest challenge to researchers and gasification system manufactures.

During photosynthesis the trees store carbon in their woody tissue and oxygen is released back to the atmosphere. Biomass can be considered as low carbon fuel and biomass CO_2 absorption and emission is in balance. Biomass will provides more job opportunity to the people in the rural area.

Compression Ignition Engines to produce 1kWh of energy they consume 1kg of biomass and 0.08 liters of diesel. Consequently the effect 80-87% diesel saving. A Spark ignition engine on an average produces 0.56-0.78 kWh of energy from 1 kg of biomass.

Biomass use covers a wide area from household cooking [8], rural electrification, fertilizer (municipal wastes, composting, etc.), process heat in small industries in the rural area and fuel for cogeneration facilities in oil palm and sugar plantation

Future applications of biomass for methanol [9] production, using producer gas in fuel cell for developing countries offer the greatest potentialities

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