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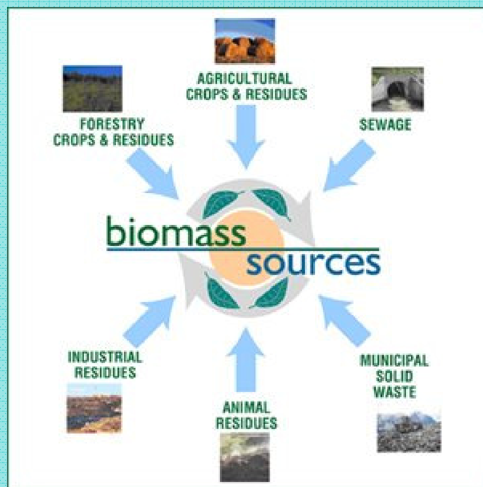
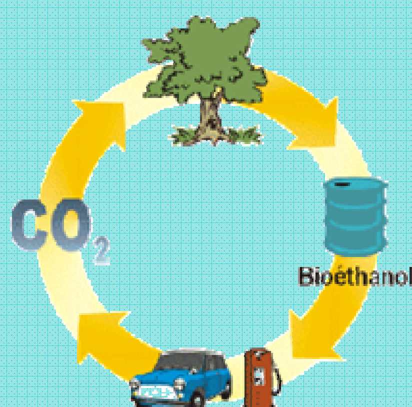
NEWS LETTER





BIOENERGY IN THE CONTEXT OF SUSTAINABLE ENERGY MANAGEMENT

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ENVIS Newsletter on Environmental Biotechnology is a half-yearly publication publishes articles related to the thematic area of the ENVIS Centre. Popular or easily intelligible expositions of new or recent developments are welcome

Manuscripts should be typewritten (font should be Times New Roman and font size ought to be 12) on one side of the paper in double spacing with maximum of 6-8 typed pages

Figures and typed table should be in separate pages and provided with title and serial numbers. The exact position for the placement of the figures and tables should be marked in the manuscript.

Articles should be sent to

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EDITORIAL

Bioenergy is an essential energy option

In a world facing growing energy demand, high oil prices and an urgent need to reduce greenhouse gas emissions, bioenergy is an essential energy option for a range of applications as part of a mix that includes energy efficiency, renewable energy, and changed patterns of production and consumption.

Since the discovery of fire, human societies around the globe have converted the bioenergy of plants and animals to provide light, heat and motive power. Today, bioenergy provides about 14% of global primary energy, although the share in some developing countries can be as high as 90%. In many developing countries, however, bioenergy is currently derived from poor quality sources and used inefficiently, resulting in harmful impacts on the environment and human health.

Thus in this volume – 18 we have attempted to provide an in depth analysis of Bioenergy issues in global context.

Further we appreciate the views from the readers / user groups about this newsletter we also invite relevant articles, news, events on this topic for further publication in News letters in future.

(S. C. Santra)

IN THIS ISSUE:

BIOENERGY IN THE CONTEXT OF SUSTAINABLE ENERGY MANAGEMENT

Introduction

Many nations have the ability to produce their own efficient and sustainable bioenergy from agriculture, forestry and urban wastes. Produced locally, bioenergy can reduce the need for imported fossil fuels – often a serious drain on government budgets. Furthermore, by diversifying the sources of energy, bioenergy can increase the energy security of a country or region.

Triggered by high oil prices and biofuel targets put into place by a number of governments around the globe, investment into bioenergy increased from US$ 2.6 billion in 2005 to $21 billion in 2006, according to a report by the Sustainable Energy Finance Initiative (SEFI). In addition, a number of government and companies are heavily investing in R&D for so called 2nd generation technologies (see 'Useful Terms'). These investments will lead to an increase in the share of bioenergy to overall energy supply. The International Energy Agency has estimated that bioenergy could supply up to 25% of world primary energy by 2050.

Bioenergy can have both positive and negative environmental impacts

Unlike fossil fuels, bioenergy can be a carbon-neutral or even carbon-negative energy option, but only if the emissions of greenhouse gases produced during the use of biofuels are re-absorbed from the atmosphere during the growth of feedstocks. This is not always the case, however, and *some bioenergy options can even lead to higher greenhouse gas emissions over the entire life-cycle from production, conversion, transport and end use.* Net GHG emissions will depend on the type of land used, choice of crops in different geo-climatic conditions, agricultural practices (including whether carbon-intensive chemical fertilizers are used and the level of mechanization requiring fossil fuel input), and end-use efficiency. Particularly, land use changes can lead to signifi cant GHG emissions if new land is brought into production by converting forests and wetlands into cropland. This creates a 'carbon debt' that may not be 'paid back', even over a long period of time. If land use changes are direct, the impact can be calculated and traced back. In the case of 'indirect land use changes', i.e. where bioenergy feedstocks do not directly replace forests, wetlands or other areas with high carbon storage capacity, but push into other usages which in turn replace carbon storing areas, both within a country or even across boarders, the effect is more difficult to assess and to trace.

Assessment of the net GHG effect of a bioenergy pathway or project is currently done under several methodologies. To enable choices for the most GHG efficient option in a given context, a common methodology is urgently needed for different pathways over their entire life cycle, including direct and indirect changes in land use. This is particularly important for an evolving carbon market that can promote bioenergy pathways with substantial net greenhouse gas reductions.

While bioenergy development should generally lead to significant GHG emission reductions, some bioenergy pathways in developing countries, however, may be pursued for their development and environmental benefits, even if they do not produce significant greenhouse gas reductions.

Finally, with expected impacts of climate change on agricultural productivity (IPCC), *crop choices need to be made in light of the need for adaptation measures.*

As with every other energy option, the production and use of bioenergy can produce both positive and negative impacts on the environment, and present a complex challenge of land use and natural resource management. Consequently, the most efficient methods of bioenergy production and use will produce the maximum benefits and least costs. Monitoring and management of these impacts are essential activities to both minimize negative impacts, and maximize positive ones.

Because current production is based principally on agriculture, bioenergy tends to have similar environmental impacts, particularly on water resources. Agriculture accounts for more than 70% of total water used in most countries, so cultivating energy crops can put further pressure on scarce water resources. Farmers may pump 250 billionlitres of underground water to raise the corn feedstock for an ethanol production facility. If managed poorly, energy crops can lower sub-surface water tables, as well as rivers and lakes, particularly if these crops are irrigated. To avoid this potential problem, particularly in countries with scarce water resources, crops need to be carefully matched to available water resources. Efficient irrigation and rainwater harvesting can help reduce negative impacts. Considerable amounts of water are also required to convert bioenergy feedstocks into fuels. A 200 million-litre ethanol plant, for example, might use 600 million-litres of water to make fuel - more water than some small towns use in a developed country. Hence, the choice of the end product should be influenced also by the considerations on water availability, e.g. straight vegetable oil requiring less water than biodiesel. Bioenergy can also improve water resources. For example, the roots of some energy crops can reduce rainwater run off, and the energy ‘harvested’ can be used to power pumps and purifying water.

Bioenergy can support rural development and the Millennium Development Goals (MDGs)

Bioenergy provides an opportunity for developing countries to utilize their own resources and attract the necessary foreign and domestic investment to achieve sustainable development goals.

Particularly in developing countries where 75% of the world’s poor depend on agriculture for their livelihoods, producing bioenergy can harness agricultural growth for broader rural development, reducing poverty and the drain on government budgets to pay for fossil energy imports. Employment is a key element of rural development. In many developing countries, bio- energy has a large potential to create jobs in their labour intensive agricultural sectors. Additional job creation opportunities can also be found in the conversion process from feedstock to bioenergy as this process generally takes place close to where the feedstock is produced. The additional income from new jobs is likely to have a multiplier effect when spent locally, which can further spur development. Access to cheaper energy from local bioenergy sources, particularly higher quality energy forms, can help increase agricultural yields and efficiency, particularly through some forms of mechanization, and enable crop preservation. In addition, additional businesses and services requiring energy can be developed.

Higher quality energy such as biogas and electricity can reduce the time women and girls spend in a number of manual activities, such as fetching water and firewood. Electricity generated from biofuels can contribute to the goal of universal education by providing light for learning and power for telecommunications. Electricity can improve the health of rural households by purifying water, refrigerating medicine, sterilizing equipment, and powering health care centres.

The job creation, education and health benefits from improving access to higher quality energy can also help reduce the disparity between rural and urban amenities, thus lowering the migration rates to urban centres. Achieving these benefits, however, depends substantially on the way in which the bioenergy is produced. A poorly managed bioenergy expansion can impact social values such as local customs, and may undermine traditional sustainable agricultural and land-use practices. In many regions, economies of scale and global trade tend to favor large, highly mechanized producers that provide higher skilled and better-paid jobs but less overall employment. If bioenergy crops become more valuable, the consolidation of land into larger holdings may favour larger landowners and displace small farmers. There is inherent in this argument the concept of scale – what's good for a large multinational corporation may not be appropriate for smaller communities or regions.

This is particularly difficult as scale relates directly to the economics of biofuel production. However, most economic assessments only look at return on investment, and do not take into account the side-benefits for local development. *To obtain the maximum development benefits, however, a focus on small farmers is crucial,* and needs to be strengthened, through both policies and measures helping them to participate in this new business directly, through organization in cooperatives and through participatory concepts in large scale operations.

The impact of bioenergy on food security and prices is complex

Assessing the impact of bioenergy production on food prices requires careful analysis of many variables. It is certainly true that bioenergy production can change the availability and price of food by competing for land with food crops or livestock for land. Although this "fuel versus food" competition is widely recognized, the extent of the impact needs further research as current estimates vary widely and depend on the type of crop and region. Crops currently used specifically for biofuels utilize 0.025 billion hectares – approximately 2% of the 1.5 billion hectares used to produce arable crops. In Brazil, over 40% of total gasoline demand is provided by ethanol produced from sugarcane grown on 1% of the 320 million hectares of arable land.

A number of recent studies have attempted to estimate the impact of biofuels on the 40% rise in food prices during 2007 (FAO). Although the World Bank has estimated this share at 80%, the IEA reports that increased demand for biofuels has contributed about 10% of the recent rise in grain prices, while the International Food Policy Research Institute estimates the overall share at 30%.

Food prices have been affected by higher oil and fertilizer prices, record bad harvests due to weather events, commodity speculation and changing to meat based diets with higher energy input. Further, food prices themselves have previously been on a long-term downward trend, and have not reflected the true cost of production. Price rises now are starting to reflect market realities, and higher prices can have both positive and negative effects. Rising farm incomes in developing countries from higher prices, for example, can help to reduce poverty and encourage farmers to produce more food, which may thus increase the availability of food in the medium to long term. In the short-term, however, access to food may decrease for poorer urban dwellers who must spend either more of their limited incomes on food, or can afford only insufficient quantities of food.

Biofuels have put additional pressure on grain markets that have had little time to react. Over time, however, improved farming methods, flexible markets and new technologies helping to use marginal land can overcome the current competition between choices of 'food vs. fuel'. In Brazil, for example, production can be flexibly switched between sugar as a foodstuff and ethanol depending on prices.

In addition, agricultural production in much of the world is below potential. Improved management practices can increase yields substantially, which could then release land for a certain amount of bioenergy crops. In the long-term, however, other forces may push prices higher and increase pressure on land for food production, including a global population that continues to grow towards 9 billion, and changing diets. The current 1% increase in annual crop yields over the past several decades has only barely kept pace with an increasing global population.

The concern over competition between crops for food or fuel is already being reflected in changing investment patterns. Under higher corn prices, investment in the US ethanol industry fell from $1.7 billion in the first quarter of 2007 to just $311m in the first quarter of 2008, while investment outside the US fell by 15%. Agricultural subsidies and trade restrictions also play an important part and can greatly distort markets and prices, particularly for the poor who often pay 80% of their income for food. Addressing the complex issue of subsidies can produce significant benefits to both the bioenergy, energy, and food sectors. *Much of the food vs fuel debate could be eliminated if bioenergy feedstocks were produced on land that is not suitable for food, or from waste and residues.* This is the focus of 'second generation' bioenergy technologies, which can be accelerated through additional support for R&D. Utilizing the one billion hectares of marginal and degraded lands unsuitable for food production (such as land affected by rising salinity levels) may even be able to restore environmental values.

Biofuel Mission of India:

The country's energy demand is expected to grow at an annual rate of 4.8 per cent over the next couple of decades.

Most of the energy requirements are currently satisfied by fossil fuels – coal, petroleumbased products and natural gas. Domestic production of crude oil can only fulfill 25-30 per cent of national consumption rest we are importing from other countries. In these circumstances biofuels are going to play an important role in meeting India's growing energy needs. Projected requirement of biofuel for blending under different scenario are given in table 1.

Table 1: Projected demand for petrol and diesel and biofuel requirements

Year	Petrol Demand Mt	Ethanal blending requirement (in metric ton)			Diesel Demand Mt	Biodiesel blending requirement (in metric ton)		
		@5%	@10%	@20%		@5%	@10%	@20%
2006-07	10.07	0.50	1.01	2.01	52.32	2.62	5.23	10.46
2011-12	12.85	0.64	1.29	2.57	66.91	3.35	6.69	13.38
2016-17	16.40	0.82	1.64	3.28	83.58	4.18	8.36	16.72

Source: Planning commission Govt. of India, 2003

Biodiesel Policy:

The demand for diesel is five times higher than the demand for petrol in India. But while the ethanol industry is mature, the biodiesel industry is still in its infancy. India's current biodiesel technology of choice is the transesterification of vegetable oil.

The Government of India has developed an ambitious National Biodiesel Mission comprising six micro missions covering all aspects of plantation, procurement of seed, extraction of oil, trans-esterification, blending & trade, and research and development to meet 20 per cent of the country's diesel requirements by 2011-2012. Diesel forms nearly 40% of the energy consumed in the form of hydrocarbon fuels, and its demand is estimated at 40 million tons.

As India is deficient in edible oil and demand for edible vegetable oil exceeds supply, the Government decided to use non-edible oil from *Jatropha curcas* oilseeds as biodiesel feedstock. Extensive research has shown that *Jatropha curcas* offers the following advantages: it requires low water and fertilizer for cultivation, not browsed by cattle or sheep, pest resistant, easy propagation, high seed yield and ability to produce high protein manure. Some development works have been carried out with regards to the production of transesterified non edible oil and its use in biodiesel by Indian Institute of Science, Bangalore.

Jatropha Curcas seed

Advantages of using Jatropha Curcas

- The oil yield per hectare for Jatropha is among the highest for tree-borne oil seeds. The seed production ranges from about 0.4 tons per hectare per year to over 12 t/ha. There are reports of oil yields as high as 50 per cent from the seed. Typically, the seed production would be 3.75 t/ha, with an oil yield of 30-35 per cent, giving a net oil yield of about 1.2 t/ha.

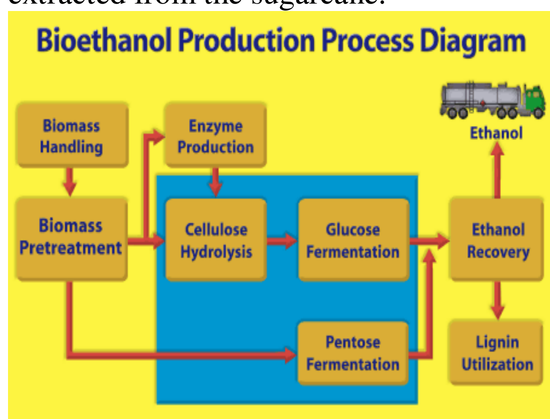
It can be grown in areas of low rainfall (200 mm per year), on low fertility, marginal, degraded, fallow and waste lands. Canals, roads railway tracks, borders of farmers' fields as a boundary fence/hedge in arid areas and even alkaline soils are appropriate for the crop.

- Jatropha is easily established in nurseries, grows relatively quickly and is hardy.
- Jatropha seeds are easy to collect as they are ready to be plucked before the rainy season and as the plants are not very tall.
- Jatropha is not browsed by animals.
- Being rich in nitrogen, the seed cake is an excellent source of plant nutrients.

Ethanol Blending:

The production of biofuels has already began in India, however many implementation problems remain and current plans do not necessarily benefit the rural poor. In October 2004, ten states (Andhra Pradesh(except Chittor and Nellore districts), Goa, Gujarat, Haryana, Karnataka, Maharashtra, Punjab, Tamil Nadu (only in districts Coimbatore, Dindigul, Erode, Kanayakumari, Nilgiri, Ramanathpuram, Tirunelveli, Tuticorin and Virudhunagar), Uttar Pradesh and Uttaranchal) and three union territories (Daman and Diu, Dadra and Nagar Haveli and Chandigarh) were mandated by the Government of India to sell a 5 percent blend of ethanol and gasoline called gasohol as per Bureau of Indian Standards specifications if the price of sourcing indigenous ethanol for supply of ethanol-blended petrol is comparable to the price of indigenous ethanol for alternative uses, and the delivery price of ethanol at the location is comparable to the import parity price of petrol at that location and the indigenous ethanol industry is able to maintain the availability of ethanol for ethanol-blended petrol programme at such prices.

Currently, most ethanol in India is made from molasses after the sugar has been extracted from the sugarcane.



The Environmental Debate and Biofuels:

Earth Summit held in Rio de Janeiro, Brazil in 1992 resulted in two important Conventions: the Convention on Biological Diversity (the CBD) and the United Nations Framework Convention on Climate Change (UNFCCC). The Kyoto Protocol is one of the most concrete products of the UNFCCC processes which came into force in 2005. Responsibilities for the most polluting countries, including quotas for greenhouse gas emission reductions are first time defined in Kyoto Protocol. Current policies to gradually increase renewable energy use in transportation sectors are part of a broader agenda of reducing dependence on fossil fuels and reducing greenhouse gases to mitigate climate change and its impacts through carbon sequestration. A wide range of technologies are being introduced to increase use of renewable sources of electricity, including wind power, photovoltaic panels, small hydropower plants, biogas and biomass conversion plants. The only products currently available to significantly replace liquid fossil fuels in transportation on a global scale are biodiesel and ethanol fuels, however, despite advances of electric cars and hydrogen powered ones. As a result, several policies have been proposed recently to support biofuels research and production (Amaral and Pezzo 2007)

Algal bio-fuels research - Macro algae:

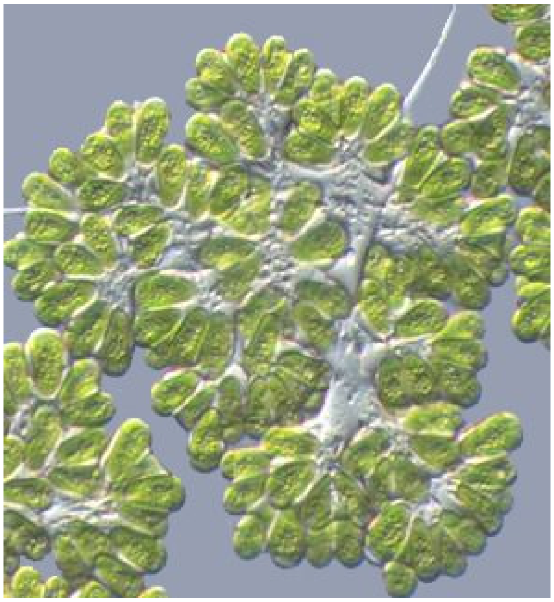
Extensive work has been done by Indian scientists on utilization of seaweeds for food and pharmaceutical applications. In India, seaweeds collected from natural vegetation are used for the production of phycocolloids such as agar and alginates. CSMCRI has long been working on the cultivation of various seaweeds and recently forayed into value addition for seaweed products. Seaweeds like *Gracilaria*, *Gelidium*, *Kappaphycus* etc are being cultivated in large scale. Rengasamy, CAS in Botany, University of Madras, has also successfully demonstrated outdoor cultivation of two species of *Sargassum* for the first time (Rengasamy, 2008). But very few investigators have concentrated on bio-fuels from seaweeds. CSMCRI, Bhavanagar for the first time in India has been able to produce ethanol using a seaweed polysaccharide. Rengasamy and his team have successfully developed a technology to produce biogas from seaweeds (Rengasamy, 2009). More work has to be done before these can be commercialized.

Algal Bioreactor

Micro algae: Freshwater algae

Ravishankar and his team from Plant Cell Biotechnology Department, Central Food Technological Research Institute, Mysore have done extensive work on isolation and characterization of hydrocarbon producing micro alga *Botryococcus braunii* from Indian waters.(Dayananda *et al*. 2005, 2006 and 2007; Dayananda *et al*., 2005; Tripathi *et al*., 2001) Recently, Rengasamy and his team from University of Madras have successfully cultivated *Botryococcus braunii* in open raceway pond without any contamination (Rengasamy, 2007, 2008 and 2009).

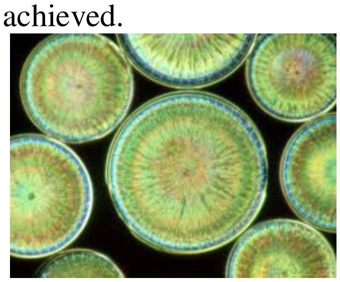
Simrat Kaur et al., (2009) from Bio-energy Division, Defense Research Laboratory, Tezpur 784 001, India and Department of Biotechnology, Gauhati University, India have done preliminary work on Algal diversity as a renewable feedstock for biodiesel. Thajuddin (2009) from Bharathidasan University, Tiruchirappalli, Tamilnadu has started working on algal biodiesel production from micro algae.



Botryococcus in Cultural Condition

Marine phytoplankton:

Many research laboratories in India are also involved in developing biodiesel technology based on marine phytoplankton species including diatoms. Rengasamy and his team (2009) from University of Madras are in the process of isolation and characterization of suitable marine phytoplankton for biodiesel production. Ramachandra *et al*., (2009) have done studies on bio-fuels production from species of diatoms. Vivekananda Institute of Algal technology (VIAT) has been working on cultivation of selected diatoms species in seawater and extraction of oil. Work on standardization of nutrient supplement, harvesting and extraction is complete. Further work is on progress to optimize other parameters to enhance the production of oil by diatoms in pilot scale open race way ponds. Oil percentage of 30 to 40 % could be achieved.



Marine Diatoms

Algal biomass production for biofuel production integrated with Phycoremediation

Sivasubramanian and his team from Vivekananda Institute of Algal technology (VIAT), Chennai, have been involved in developing algae based technology to treat industrial effluents and wastewater. Algal technology for treating effluents has been implemented in a number of industries by VIAT for the past 10 years. Algae based solution has been delivered to alginate industry, leather processing chemicals industry, detergent industry, electroplating industry, confectionery industry, textile dyeing industries, oil drilling effluent treatment plant and more recently copper smelting industry (Mohan *et al*., 2009; Gurukasi Rajan *et al*., 2009; Ranjithkumar *et al*., 2009; Sivasubramanian *et al*., 2009; Hanumantha Rao *et al*., 2009; Murugesan *et al.,* 2009; Bharanidharan et al., 2009).

The main advantage of phycoremediation is complete avoidance of chemicals normally employed by various industries to correct pH, remove colour and odour, remove sludge etc. The industries save lot of chemicals and huge amount of energy. Algal technology involves maintenance of the critical level of algal biomass for effective remediation of effluents. *World's First Phycoremediation plant* to treat industrial effluent was commissioned in SNAP Natural and Alginate products at Ranipet, Tamilnadu based on the research support from VIAT (Sivasubramanian *et al*., 2009). This industry generates huge volume of highly acidic effluent with a high TDS. Algal technology is being effectively employed to correct pH and reduce sludge with lots of benefits to industry as well as to the environment. In the process this industry also generates huge amount of algal biomass which is being incorporated into a bio-fertilizer product. VIAT is working on other possibilities of utilizing algal biomass including biogas, bio-ethanol and biodiesel. Studies conducted by VIAT have shown that algae grown in the effluent is highly suitable for biodiesel application.

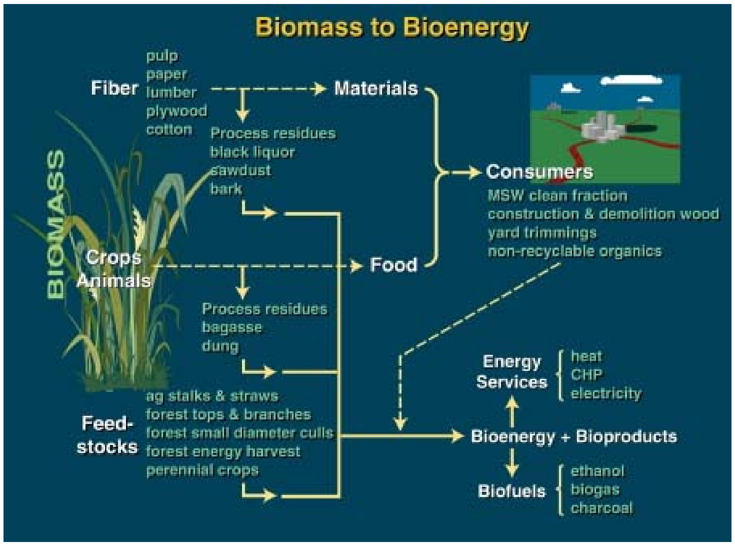
Other industrial effluents which VIAT has found favourable for algal biomass production are textile dyeing industry effluent and effluents from confectionery industries. VIAT has successfully grown *Chlorella* species in confectionery industry effluent to correct pH and remove sugars. *Chlorella* sp grown in confectionery effluent produces higher amount of lipids. One of the textile dyeing industries which employs algal technology to remove dyes and reduce BOD and COD, is harvesting algae, dry the slurry and the dried algal cakes are being used in boilers along with firewood. The calorific value of algal cake has been analyzed by VIAT and it was found to be superior. Sludge produced by various industries could be also used as nutrient source for growing certain types of micro algae. VIAT has investigated the biochemistry of sludge grown algae and found highly suitable for biodiesel production. Algal biomass production integrated with remediation is the best option since it will not encroach upon agricultural land and water. Growing algae in waste water will make the whole process very cheaper and economically viable one.

Senthil Chinnasamy *et al*., (2009) from Laboratory of Soil Microbiology, Division of Soil Science and Microbiology, Central Rice Research Institute, Cuttack, Orissa has done investigations on biomass production potential of waste water alga *Chlorella vulgaris.*

Biogas from Biomass

Biomass and Bioenergy

Biomass as the solar energy stored in chemical form in plant and animal materials is among the most precious and versatile resources on earth. It provides not only food but also energy, building materials, paper, fabrics, medicines and chemicals. Biomass has been used for energy purposes ever since man discovered fire. Today, biomass fuels can be utilised for tasks ranging from heating the house, producing electricity or fuelling a car. Biomass as the solar energy stored in chemical form in plant and animal materials is among the most precious and versatile resources on earth. It provides not only food but also energy, building materials, paper, fabrics, medicines and chemicals. Biomass has been used for energy purposes ever since man discovered fire. Today, biomass fuels can be utilised for tasks ranging from heating the house to fuelling a car and running a computer.



The Chemical Composition of Biomass

The chemical composition of biomass varies among species, but plants consists of about 25% lignin and 75% carbohydrates or sugars. The carbohydrate fraction consists of many sugar molecules linked together in long chains or polymers. Two larger carbohydrate categories that have significant value are cellulose and hemicellulose. The lignin fraction consists of non-sugar type molecules. Nature uses the long cellulose polymers to build the fibers that give a plant its strength. The lignin fraction acts like a "glue" that holds the cellulose fibers together.

Where does Biomass Come From?

Carbon dioxide from the atmosphere and water from the earth are combined in the photosynthetic process to produce carbohydrates (sugars) that form the building blocks of biomass. The solar energy that drives photosynthesis is stored in the chemical bonds of the structural components of biomass. If we burn biomass efficiently (extract the energy stored in the chemical bonds) oxygen from the atmosphere combines with the carbon in plants to produce carbon dioxide and water. The process is cyclic because the carbon dioxide is then available to produce new biomass.

In addition to the aesthetic value of the planet's flora, biomass represents a useful and valuable resource to man. For millennia humans have exploited the solar energy stored in the chemical bonds by burning biomass as fuel and eating plants for the nutritional energy of their sugar and starch content. More recently, in the last few hundred years, humans have exploited fossilized biomass in the form of coal. This fossil fuel is the result of very slow chemical transformations that convert the sugar polymer fraction into a chemical composition that resembles the lignin fraction. Thus, the additional chemical bonds in coal represent a more concentrated source of energy as fuel. All of the fossil fuels we consume - coal, oil and natural gas - are simply ancient biomass. Over millions of years, the earth has buried ages-old plant material and converted it into these valuable fuels. But while fossil fuels contain the same constituents - hydrogen and carbon - as those found in fresh biomass, they are not considered renewable because they take such a long time to create. Environmental impacts pose another significant distinction between biomass and fossil fuels. When a plant decays, it releases most of its chemical matter back into the atmosphere. In contrast, fossil fuels are locked away deep in the ground and do not affect the earth's atmosphere unless they are burned.

Wood may be the best-known example of biomass. When burned, the wood releases the energy the tree captured from the sun's rays. But wood is just one example of biomass. Various biomass resources such as agricultural residues (e.g. bagasse from sugarcane, corn fiber, straw and even nutshells), wood waste (e.g. sawdust, timber slash, and mill scrap), the paper trash and urban yard clippings in municipal waste, energy crops (fast growing trees like poplars, willows, and grasses like switchgrass or elephant grass), and the methane captured from landfills, municipal waste water treatment, and manure from cattle or poultry, can also be used.

Biomass is considered to be one of the key renewable resources of the future at both small- and large-scale levels. It already supplies 14 % of the world's primary energy consumption. But for three quarters of the world's population living in developing countries biomass is the most important source of energy. With increases in population and per capita demand, and depletion of fossil-fuel resources, the demand for biomass is expected to increase rapidly in developing countries. On average, biomass produces 38 % of the primary energy in developing countries (90 % in some countries). Biomass is likely to remain an important global source in developing countries well into the next century. Utilisation of biomass as the energy source in the world.

Over 16,000 MW of Potential Biomass Power generation estimated in India!

Globally, India is in the fourth position in generating power through biomass and with a huge potential, is poised to become a world leader in biomass energy production. India can generate as much as 16,000MW of biomass power, according to the Biomass Resource Atlas of India, an Indian Institute of Science (IISc) project to map biomass potential in the country, but only about 700 MW is on stream now. The upcoming capacity expansion opportunities in India's growing Biomass to Power sector will be a key area of focus at the upcoming **Biomass & WtE** (Waste to Energy) conference in Shanghai on **28-29 October**.

In fact, a key player in India's upcoming Biomass to Power sector will be presenting insights at the conference. **Anil Lala**, Corporate Director at **AllGreen Energy India Pvt. Ltd**, a subsidiary of Singapore-based AllGreen Energy Pte., Ltd, will be sharing an update on All Green's ambitious **10 Biomass-to-energy projects** development plan. AllGreen plans to raise US$100 Million to set up ten 6.5MW biomass-to-energy projects across India over three years. The first three, projected to go on-stream by March 2010, will be in Karnataka, Tamil Nadu and Madhya Pradesh.

India has an installed power capacity of 147,000MW and experiences a 15% shortfall during peak hours, between 7pm and 10pm, according to the Central Electricity Authority, which advises the Union government on power policies. While **AllGreen**'s 6.5MW power plants may seem paltry in the larger scheme of things, biomass is touted to have the potential to light up rural India, and Biomass to energy has tremendous potential in this agrarian country.

Current News

Nanolipoprotein Particles for Hydrogen Production

Hydrogen is a renewable energy carrier that has the potential to replace fossil fuels in our economy. The majority of hydrogen produced today is from natural gas, heavy oils, and coal. The Department of Energy Hydrogen Program technical plan calls for the development and commercialization of hydrogen production, generation, and distribution technology by 2015 and market incorporation by 2020.

Biological production technologies show promise for true renewable biohydrogen from bio-mass. Breakthroughs in biological hydrogen production have been due to genetic engineering of microorganisms for conversion of glucose through both biophotolysis and fermentation; the latter is dependent on hydrogenase enzymes enabling reduction of protons to produce hydrogen. When isolated and used in solution, higher production yields are achieved through tunable reaction conditions and elimination of competing cellular processes that inhibit hydrogen conversion. These processes though suffer from difficult isolation protocols and oxygen sensitivity of soluble hydrogenase enzymes.

Lawrence Livermore National Laboratory (LLNL) has developed a method using nanolipoprotein particles (NLP) to solubilize and isolate membrane bound hydrogenases; these constructs are less sensitive to oxygen. Hydrogenases isolated within NLPs retain their functional proton to hydrogen conversion activity. The February/March 2008 Innovation highlights extemophile hydrogenase incorporation in to NLPs by LLNL researchers. For more information on membrane bound protein isolation using NLPs see a recent publication in Journal of Proteome Research, 2008, 7, 3535-3542.**Benefits**

- NLP method provides for rapid, easy isolation, solubilization and stabilization of functional hydrogenases for hydrogen production.
- Hydrogenases have higher selectivity, lower temperature requirements, and higher abundance than inorganic catalysts currently used in fossil fuel based production processes.
- Immobilization in NLPs introduces the capability to use high oxygen sensitive membrane bound hydrogenases.
- NLP-hydrogenases can be immobilized on dense, high surface area materials for modular, continuous hydrogen production and direct hydrogen storage interfacing.

Microbial Fuel Cell

Israeli startup company producing wastewater-to-electricity technology has received investment from GE and other major global players in its latest funding round, announced on 28 June 2011.

Emefcy, based in Caesarea, has developed a system based on a microbial fuel cell (MFC) with an ion-exchange membrane at its heart. Its Megawatter™ system enables direct electricity generation or hydrogen production from wastewater while simultaneously providing wastewater treatment. Based on the degradation of organic matter, which liberates electricity, Emefcy's MFC has an anode chamber and a cathode chamber. The anaerobic anode chamber is most commonly connected internally to the cathode chamber by an ion-exchange membrane, and the circuit is completed by an external wire.

The benefits are both economic and environmental. Conventional wastewater treatment, says GE, uses 2% of global power capacity (80,000 MW) and

57 million tons per year of CO_2, costing US$ 40 billion/year. Rather than using conventional energy-intensive aerobic processes or methane-producing anaerobic digestion to treat wastewater, Emefcy harvests renewable energy directly from the wastewater and feeds it to the power grid, creating an energy-positive wastewater treatment plant. Energy Technology Ventures - a GE, NRG Energy and ConocoPhillips joint venture - is making its first non-US and first water-related investment by providing capital to Emefcy. Also in the funding round were Pond Venture Partners, Plan B Ventures and Israel Cleantech Ventures. Financial details were not disclosed. The primary initial applications for Emefcy's technology are for wastewater treatment in the food, beverage, pharmaceutical and chemical industries, with total market potential of US$ 10 billion annually.

Biofuel Market: India

Since 2006, India accounted for 4% of global ethanol production (2m kilo litres) from sugar cane and has plans to expand its production of biofuels. R&D&D on Cellulosic Ethanol is increasing with PRAJ Industries developing technology for cellulosic etahnol. Reliance Life Sciences is also active in developing biodiesel (from Jatropha and other non-food oil seed crops), ethanol (from cellulosic biomass) and biobutanol. In February 2009, India and the US exchanged a memorandum for cooperation on biofuels development, covering the production, utilization, distribution and marketing of biofuels in India.

Biodiesel Application Initiative in India

The study estimates that if the blending initiative of two per cent Jatropha based Biodiesel are achieved in year 2011-12, India will save around Rs. 30 billion and will generate revenue of around Rs. 55 billion in the rural economy with an opportunity of investment to the extent of Rs. 17 billion on an annual basis.This initiative would also help in reduction of Green House Gas emission by 3 Million Metric Tonnes (MMT) on an annual basis.

The CII study recommends that the present procurement price of Rs. 26.50/litre as per the Government declared Biodiesel Policy, should be reviewed and corrected realistically to sustain the investment and required growth of the Biodiesel sectors. The study says the Government should create a suitable policy framework (incentives, grants etc. and the distribution mechanism) to make this price of Biodiesel self-sustainable and have an average procurement price of Jatropha seeds at Rs 6,000/tonne to ensure no migration of food land for fuel crops and business viability for conversion of seeds to Biodiesel. This will create a pull for Biodiesel demand to accelerate the development of the industry, which requires periodic revisits (bi-annually).

Railways to Build Biodiesel Plants

Indian Railways has put forward plans to set up four biodiesel plants costing about Rs 1.2 billion.

According to a report in the Indian *Economic Times*, two of the plants are to be built at Raipur and Chennai during the next two years, the other two units will be built later. Each plant is expected to cost Rs300 million and will produce up to 30 tonnes of biodiesel a day. The plants will use waste oil, fatty acid and non-edible vegetable oil as a feedstock and the biodiesel will be blended with the HSD oil for running the trains the report says. The use of biodiesel is expected to ear the railways Rs20 million a year in carbon credits. The Railways currently consumes 2.2 billion litres of diesel a year.

(Compiled by ENVIS Staffs)

FORTHCOMING EVENTS		
The 1st International Conference on Algal Biomass, Biofuels and Bioproducts	July 17-20, 2011	St. Louis, MO www.algalbbb.com
UK Biogas Training Course	July 18-22, 2011	Huntingdon, Cambridgeshire, http://www.biogas-training.co.uk/
Biomass '11	July 26-27, 2011	Grand Forks, ND, http://www.undeerc.org/Biomass11/email/RegistrationOpen.asp
Biofuels Catalysis	14-15, September 2011	Philadelphia, PA http://www.bioenergy.psu.edu/news/shortcourses.asp
7th International Conference on Biomass for Energy	20-21 September 2011,:	Kyiv, Ukraine
International Bioenergy Days	27-29 September 2011	Lidköping, Sweden:
Advanced Biofuels Market 2011	8-10 November 2011	San Francisco, California, USA:
Bioenergy International Asia Expo & Conference	7-8 December 2011,:	Kuala Lumpur, Malaysia

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