International Journal of Advance Research in Science and Engineering
Volume No.07, Issue No.09, September 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354

A Review on Prospects of Biofuel in India

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ABSTRACT

The aim of this paper is to review the potential biomass for biofuel, various technologies or methods used for conversion to biofuel, the opportunities of biofuel in India and the challenges to commercialize the biofuel and also the national policies for the use of biofuel which needed to be make aware of for successfully implementation and mass use of biofuel for reducing the dependency on fossil fuel. In Indian economy, more reliant of imports of energy which affects the energy security, as well as addition severally pollution to environment because of the transport and traditional cook stove which use biomass inefficiently. The decline global capacity of oil production and depletion of fossil fuel reservoirs combined with rise of demand forces the find the new alternative energy resources. Renewable and carbon neutral biofuel are needed to be search for environmental and economic sustainability, biofuel demand increases but yet not able to replace the fossil fuel. Also the use of edible oil, food crops and first generation biofuel manufacturing having the conflict with the food supply. For correct and optimal exploitation of the biomass resources needed to quantify the district-wise availability of biomass in India and to prepared area-wise recommendation for adopting technologies for manufacturing biofuel at most economical way. India is lagging in the front of the awareness of the biofuel, its manufacturing, marketing and infrastructure to promote the use of biofuel and also the national policies regarding veracious incentives, and grants to promote the research and development in the biofuel area.

Keywords : *Indian Scenario, Biofuel, Sources, Opportunities, Challenges, Biofuel Policy, Production.*

I. INTRODUCTION

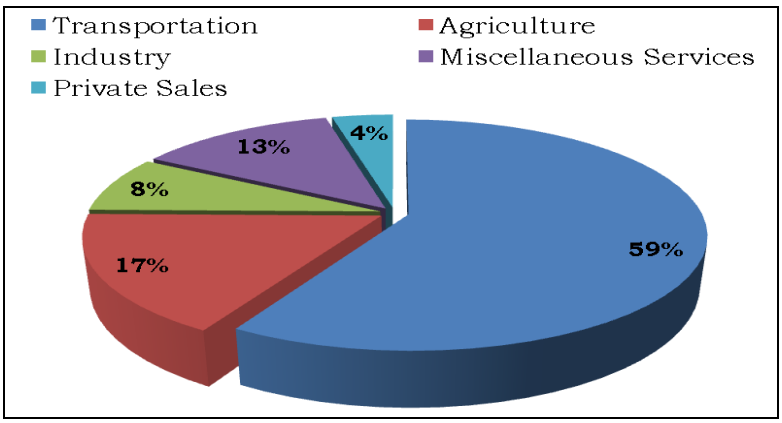
India is a fast grwoing contry and its growth increses consumption of energy sources to a very high rate, which soon facing the heavy sacracy problme of the fuel sources of energy. This causes the hike in price rate of petroleum fuels and also on the second front it is causing very serious prolem of environmental pollution which is contibuted by the use of the fossile fuel. As the technogogy advances the nature get detorated continuously because of the addition of the pollution into environment. India imports petroleum fuel about $3/4^{th}$ of its total consumption and this will be reach to the extend of $3.6/4^{th}$ by the year 2030 [1,2].

Table 1. Projection of biodiesel demand in India [4]

Year	Deiesel Demand (million tonnes)	Biodiesel Demand (million tonnes)		
		At 5% blend	At 10% blend	At 20% blend
2011-12	64.19	3.21	6.42	12.84
2016-17	92.15	4.61	9.21	18.43
2020-21	123.06	6.15	12.31	24.61

Currently crude oil produced worldwild is approximately 86 million barrels a day and it is projected to 118 milion barrels a day by the year 2030, but tremendous continuous increase of demand depleting the reserviors of energy sources at a fastest rate in the combination with changes in climate conditions due to addition of pollutants into the environment [2]. If the same senario continues and the complete world remain firm with the present fossile fuel polices, then about 60% more energy will be required by the world as compared to todays requirement by the year 2030, and its 45% will consumed by only China and India together. Among all the secotr the most promising sector of the fastest growing is the transportation which uses alone 27% of the energy [3]. This trend predited that all known sources as on today of the fossile fuel will exhausted completely before 45 years from now, India's annual growth rate is about 5% to 6% which having more than $3/4^{th}$ of fossile fuel import dependency and result heavy financial burden of $ 68 billion on foreign exchange [3,1].

Figure 1. Sectore-wise Diesel Consumption in India



India's scenario of diesel consumption by sector-wise brake-up is given as in figure – 1. Diesel consumption in the sector of transportation is highest among all and all the time, in India diesel used in automobile sector is five times more than the petrol which is completely opposite to other countries of the world which consume more petrol as compared to diesel in transportation. Diesel having complex molecular composition which when combusted produce a very high carbon dioxide, sulphur dioxide and oxides of nitrogen emissions. The large part approximately 50% of green house gases contributed by the combustion of oil, which lead to rise of earth temperature by 1.5 to 4.5ºC by the year 2030 [1,2].

This motivate the researcher to find the alternatives to diesel to fulfill the future demand, and biotechnology having that potential which use renewable feedstock to generate the biofuel, this can achieve a low cost alternative as well as control greenhouse gas level, especially CO_2.

The aim this work is to do a broad review of the biodiesel /biofuel, current scenario of biofuel in India, biofuel national policies, technologies and environmental issues.

II. CATOGORIES OF BIOFUELS

Biofuels are usually categorised as first generation, second generation and third geneation biofuels [2].

- **First Generation Biofuel** : those which are produced from sugar, starch and vegetable oils etc, as listed below.

  Bioalcohols – this is made by the action of micro-organisms and enzymes through the fermentation of sugar or starches or cellulose.

  Biodiesel – this is made by transesterification of oil or animal fats and it having composition similar to fossil or mineral diesel.

  Green Diesel – this is the form of diesel fuel, derived from renewable feedstock rather than the fossil feedstock.

  Vegetable Oil – lower density oil can be used in straight unmodified form, but thses are not used normally.

  Bio Ethers – bio ethers also referred to as fuel ethers or oxygenated fuels that act as octane rating enhancers.

  Biogas – this is methane produced by using anaerobic digestion of organic material.

  Syngas – this is a mixture of carbon monoxide, hydrogen and other hydrocarbons which is produced by combustion of biomass in diffused atmosphere.

  Solid biofuels – wood, sawdust, grass. Domestric refuse charcoal, agricultural waste, non-food energy crops and dried manure etc are counted as solid biofuels.

- **Second Generation Biofuel** : those which are produced from sustainable feedstock, in this categories, may types of biofuel are under the research for its development like, Cellulosic ethanol, algae fuel, bio-hydrogen, bio-methanol, mixed alcohols and wood diesels etc.

- **Third Generation Biofuel :** these are produced by direct cellulose fermentation which utilizes cellulolytic bacteria.

III. INDIAN SCENARIO BIOMASS FOR BIOFUEL

The conventional sourses of energy are coal, oil and natural gases in addition to this there is next largest source is a biomass which is derived from plants and composed of mixture of carbon, hydrogen, oxygen, nitrogen, alkali, alkaline etc. and these are considered as agricultural residues, this may obtain from agriculture harvesting and processing, crops especially grown for energy used, domestic waste and industrial waste, dead wood forest residues etc.

India in the same contest is rich and majority of population used biofuel traditionally but very unscientific way which lead to health problems and pollution issues [5, 8].

Table 2. Sourses to Biofuel Routes [8]

Biomass Resource	Technology	Product	End Use
Oil Seed, Algae	Transesterification	Biodiesel	Diesel Engine
Algae, Cattle Slurry, Domestic Waste	Anaerobic Digestion	Biogas	Gas Engine
Wood, Agricultural Residues, Municipal Waste	Gasification	Syngas	Gas Engine
Cellulosic Biomass	Fermetation	Ethanol	Petrol Engine

IV. GENERATION OF BIOMASS RESIDUES

Technology Information, Forecasting & Assessment Council (TIFAC) study covered the total 14 types of crops and 20 types of potential biomass residues, which are as, Rice, Wheat, Sugarcane, Maize, Cotton, Chilli, Jowar, Ragi, Bajra, Pulses (Gram, Tur, and Lentil), Oilseeds (Groundnut, Castor Seed, Mustard / Rapeseed, Niger Seed, Safflower, Soyabean, Sesame, Linseed, Sunflower etc.), Forestry Biomass (Bamboo, Pine needle) and Aquatic Biomass (Water Hyacinth) etc. [5]

Table 3. Crop-wise Biomass Residues (* Million Metric Tonnes) Availability [5]

Crop	By-Product	Generation (MMT*)	Top Three States
Rice	Straw	112.0	West Bengal, UP, AP
	Husk	22.4	
Wheat	Straw	109.9	UP, Panjab, Haryana
	Tops	97.8	UP, Maharashtra, Tamil Nadu
Sugarcane	Bagasse	101.3	UP, Maharashtra, Tamil Nadu
	Stover	22.7	Karnataka, AP, Bihar
Maize	Cob	4.2	Karnataka, AP, Bihar
	Husk	2.7	Karnataka, AP, Bihar
Cotton	Stalk	18.9	Gujarat, Maharashtra, AP
Chillies	Stalk	0.6	AP, Karnataka, Orissa
Jowar	Stover	15.6	Maharashtra, Kranataka, MP
Ragi	Stalk	4.6	Karnataka, Tamil Nadu, Uttaranchl
Bajra	Stalk	12.2	Rajastan, UP, Maharashtra

Pulses	Waste	18.9	MP, Maharashtra, UP
Oilseeds	Waste	57.7	MP, Rajasthan, Maharashtra
Bamboo	Top, Root, Leaves	5.4	North East State, MP, Chhattisgarh
Pine	Needle	1.6	J&K, Himachal Pradesh, Uttaranchal
Water Hyacinth	Whole Plant	15.0	Orissa, AP, Tamil Nadu

V. PRODUCTION OF BIOFUELS

There are many techniques to produce the biofuel from the bio-resources like biomass, plants, algae, microbes etc. Biodiesel is a fuel may used as substitute for the diesel and produced from various feedstocks. [2, 4, 8]

Pyrolysis Process – in this method of production of biodiesel, biomass crushed powder is fed to thermal cracker along with nitrogen and heated to 500 – 600 ºC in the absence of oxygen which gives pyrolysis vapors, gas, and char which are separated from vapor and then after condensing thses vapors we get pyrolysis oil. In case of vagetable oils, oils are heated into thermal cracker upto 500 – 600 ºC which results into emission of fumes which are then passed through condenser where it get condensed into pyrolysis oil and uncondensed part are removed out as it is.

Gasification Process – in a biodiesel production, biomass feedstock in crushed powder form is pour into the fluidized bed reactor where it mixes with sand and steam bubbles at temperature 600 – 800 ºC. This mixture of solid, vapor and gas fed to thermal cracker where forms syngas which is a combination of hydrogen and carbon momoxide with the tars and some other solids, after removal of all other content from the syngas, it is then cooled and filtered and then used as biodiesel.

Tranesterification Process – vegetable oils normally contain more free fatty acids, phospholipids, sterols, water, odorants and many other impurities which cause these it become more viscous and denser to use directly as alternative fuel. This problem is overcome by transesterification process, in which oil is reacted with alcohols in the presence of some catalyst under the control temperature about 50 – 60 ºC, then a chemical compound produced known as alkyl ester which is also called as biodiesel along with the glycerol which then seperated out.

Blending Process – in this method a vegetable oil is directly mixed with the neat diesel and this blend is used as fuel to diesel engine. In this method the major problem is with the higher viscocsity of the vegetable oil which may reduced to required level by pre-heating the fuel supply system. Straight vegetable oil blending with 20% is sucessfully used and shows the very close results to that of diesel fuel. But the prolong use of this kind of blend causes the problems like coking of injecotrs, deposition rate is increased, rigns sticking and increase in viscosity of the lubrication oil are observed.

Micro-Emulsification – the problem of the high viscosity related to used of vegetable oil is addressed by micro-emulsions with solvents such as methanol, ethanol, and butanol. In this method the colloidal equilibrium dispersion of optically isotropic fluid microstrutures with dimensions in the range of 1 -150 nm formed spontaneously from two immiscible liquids. The micro emulsions with salvents like butanol, hexanol and octanol meets with the viscosity limit of diesel engines.

VI. NATIONAL BIOFUELS POLICY

The aim of the national biofuel policy is to make availability of biofuel which will meet the demand and the suggested target is of 20% blending of biofuel [6, 8].

Strategy and Approach –

- Avoiding a conflict of fuel –vs- food security by promoting the biofuel based on non-food feedstocks biomass.
- Plantation and harvesting of the non-edible oil seeds plants for production of biodiesel will be encouraged.
- Financial and fiscal measures will be considered to support the development of biofuel.
- Research, development will be supported for the feedstock production and manufacuring of biofuel.

Plantations – plantations of various non-edible oil seeds tree on the government / community wasteland, degraded land in forest and non-forest areas. Constract farming on private wasteland also be taken up through the minimum support price mechanism in the policy.

Processing – ethanol is produced from molasses which is a by-product of the sugar industry. 5% blending of ethanol with gasoline and 10% blending of biodiesel with diesel will be promoted. For this the sugar industries are permited to produce ethanol using sugarcane juice. The sugar and distillery industries are encouraged to produce the ethanol to meet the requirement of blending.

Distribution & Marketing of Biofuel – biofuel storage, distribution and marketing responsibility will be given to the Oil Manufacturing Companies through their infrastructure and marketing networks and if required allow to modified or upgraded for the supply of biofuels.

Financing – National Bank of Agriculture and Rural Development, Indian Renewable Energy Development Agency, Small Industries Development Bank of India and other financing agencies and commercial banks will be involved in providing finance for plantation of non-edible oil plants, setting up oil extraction and processing units for manufacturing of biofuel.

Finanical Incentives – this is considered for various subsidies and grants on the basis of merit for new and second generation biofuel feedstocks, improved or new technologies and conversion process and production untis. A National Biofuel Fund will be used for providing these financial incentives.

Research & Development – research and development in the field of biofuel will be focus on plantation of biomass trees, biofuel processing and production methods and technologies and optimizing the efficiencies of end use applications and utilization of byproducts. High priority of research and development will be given to develop the local feedstock and resoureses of biomass.

VII. CHALLEGES FOR BIOFUELS

There are various challenges in the commercialize biofuels in India as listed below, [6, 8]

Financial Challenges – as the production of biofuel is still costly because of lack of the mass production setup and cultivation of biomass plants and related awareness and research are not upto the mark yet done in India.

Technical Challenges – as the quality of the biofuel is yet not maintain constant as various feedstock biofuel varies in qualities and at the same time the conversion of feedstock into biofuel technologies are yet not upgraded to mass production level of commercialization.

Trade Challenges – as for many biofuels still there is not setup the qualities standards exist so there is challenges to use the biodiesel into unmodified engines.

Infrastructure Challenges - various different biofuel needed different and modified infrastructures are needed, especially for the bio-hydrogen and bio-methane fuels.

Ethical Challenges – the use of biomass for conversion into biofuel, may arise a shortage of edible oil supply for domestic use and food demand and supply chain.

Knowledge Challenges – there is lack of knowledge in the field of biofuel in the general public as well as decision makers and politicians which cuases lagging in strategy making and promotion and commercialization of biofuel in India.

Political Challenges – governments giving some subsidy to some fossil fuel like kerosene but fail to stop from promoting inefficient and illegal use of it, though with the application of available technologies the target population could have been equally benefitted with the use of biofuels but for political will and policy.

Conflict of Interest Challenges - conflict between promoters of first and second generation Bio-fuels may weaken the overall development of biofuels.

VIII. CONCLUSIONS

This review paper is underlined the resources and technologies for the production of biofuel from the various biomass feedstock, and also it gives brief of the national policies of biofuel.

Without taking constructive action for mass production and commercialization of biofuel, India will rely heavily on fossil fuels and its consequences of hike in price, air pollution and greenhouse gas emissions.

India is 4th largest energy and crude and petroleum product consumer in the world and it will be reach to more than 8 million barrels per day by the year 2035. Thus it is top priority to do research for developing alternative sources of energy from the second generation of biofuels.

The cost point of view the biofuel use will be popular if the tax-exemption policy is implemented to substitute the diesel by biofuel.

In present scenario of biofuel in India, identification of new potential biofuel feedstock on the basis of local environment and climate are to be search and unlock the full potential in the respective area by promoting the research and development.

There must be create environment to promote the awareness about the biofuel and it importance in the domestic energy sector, potential and opportunities in upgrading the transportation infrastructure to support the economy especially at rural areas.

Biofuels can be manufacture from the various means like, lignocellulosic wastes, plants, algae, starch, vegetable oils even though plastic and tyre fuel etc.

Vegetable oil biodiesel shows the good performance and lower emission characteristics and closer to the diesel fuel, so it is closely acceptable to diesel fuel, but edible oils are usually consumed for the food market, and some unfavorable properties as high density and high viscosity, drying with time and formation of gumming and lower cetane number.

There is always a debate for the food verses fuel but Indian biofuel policy make a guidelines that, not to use any edible feedstock for bio-energy production and not to use agricultural land for the plantation for the same.

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