

Assessment of Biofuels Future in India: A review

Yogendra Rathore¹, Dinesh Ramchandani², R K Pandey³

¹H.O.D., Mechanical Engineering Department, Government Polytechnic College, Raisen

(MP) & Research Scholar, Mewar University Chittorgarh Rajasthan, e-mail:- yogendra_ap@yahoo.com

²Assistant Professor, Sagar Institute of Technology, Bhopal & Research Scholar, Mewar University Chittorgarh Rajasthan, e-mail:-dvramchandani@gmail.com

³Director & Professor in Mechanical Engineering, Radha Raman Engineering College

Bhopal (M.P.) Research Supervisor, Mewar University, Chittorgarh(Rajsthan), E-mail: rkpmanit@gmail.com, rirtdirector@gmail.com

Abstract : *Energy security is the constant availability and supply of affordable energy for consumers and industry. Risks to energy security include, for example, disruptions to the supply of imported fossil fuels, limited availability of fuel, and energy price spikes. The possibility of deriving biofuels from locally grown sources and using them as alternatives to petrol products is attractive for many countries, Like INDIA, which currently depends largely on fossil fuels. Investment in biofuels could lead to a significant boost in economic development, including the creation of new jobs and new sources of income for farmers. This would be of particular benefit to developing countries in which a large proportion of the population are employed in agriculture like ours. In INDIA, transport accounts for high greenhouse gas emissions. It is hoped that, with appropriate production methods, biofuels will produce significantly fewer greenhouse gas emissions than are currently produced by fossil fuels. This paper contains the requirement felt for energy security with the alternative ways to petrol products, Use of Biofuels will reduce the green house gas emissions as well as it will give a boost to the economy by providing a new dimension to the agriculture and will enhance the job opportunities as well. The apparent potential of biofuels will have a role so as to make an attractive biofuel policy to face the future challenges of energy security.*

Keywords: Biofuels, Potential, biodiesel, diesel engine, green emission and Alternative fuels.

1. Introduction

The last one and a half decades has escalated the concerns of developed as well as developing powers of the world over the increase in global warming and environmental meltdown occurring due to massive carbon footprints left by them due to exponentially amplified demand in transportation and agro purposes [1]. Alternatives ranging from hydrogen based vehicles to natural gas vehicles have been developed and it has been found that none of them are as effective and efficient as biofuels especially biodiesels both from commercial as well as

environmental perspective. Considering the potential in agro based industries and transport sector, in India the scope for replacement of a substantial amount of conventional fuel (diesel oil) by biodiesel is huge and a clear trend in that direction has already begun. In last couple of years, the production and consumption of biofuels have entered a new era of global growth, experiencing expansion both in the scale of the industry and the number of countries involved. Shooting up of oil prices across the globe is sizeable due to the rise in demand in comparison to the meagre 7% appreciation in world oil production has led to development of more efficient conversion technologies and introduction of stronger government policies that have resulted in huge investments in biofuel production [2]. The production of fuel ethanol has more than doubled since 2000, while production of biodiesel has expanded nearly four-folds [3]. Compared to petroleum, the use of bio fuels for transport is still quite low in all the countries. By far the largest production and use of ethanol is in Brazil and the United States, with almost similar volumes, but much higher than any other country [4]. Currently, ethanol is blended with gasoline and biodiesel is blended with petroleum-based diesel for use in conventional diesel-fuelled vehicles. However in India, considering the market potential in diesel usage as well as plantation potential on wastelands and hilly areas, according to the Economic Survey of Government of India, out of the cultivated land area, about 175 million hectares are classified as waste and degraded land. Thus, given a demand-based market, India can easily tap its potential and produce biodiesel in a large scale. The seed cake (Non-edible Seeds) is a good fertilizer. Since the Non-edible seed oil is made domestically even in village, it reduces the dependence on imported petroleum based oils saving considerable foreign exchange for better national economy. Biodiesel obtained from non-edible oils like Jatropha Seed Oil, Karanja Seed Oil, Rape Seed Oil, Castor Seed Oil etc. which are low maintenance plants need to be given more prominence hence biodiesel has the potential to leap-frog the developments for the alternative fuel. Fuels derived from renewable biological resources for use in

diesel engines are known as biodiesel. Biodiesel is an environment friendly liquid fuel similar to petrol-diesel in combustion properties. It is an oxygenated fuel containing 10% - 15% oxygen by weight. Also it can be said a sulphur-free fuel [5]. These facts lead biodiesel to more complete combustion and less most of the exhaust emissions from diesel engines

2. Literature Review

Import of gasoline and petroleum products were 40 percent short of total consumption, as early as Indian Fiscal Year (IFY) 2000. However, with growing reliance on imports, the gap reduced to 5 percent by fiscal 2005 [6] and outgrew consumption in the following year (fiscal 2006). Since then, imports have been growing at more than 7 percent and are expected to reach 238 billion litres in fiscal 2012, up 40 billion litres over estimated consumption for the same period. While India's domestic energy base is substantial, India continues to rely on imports for a considerable amount of its energy use [7], consequently accelerating India's oil import expenditure to over \$144 billion in fiscal 2012, up 3 percent over previous year (Figure 1).

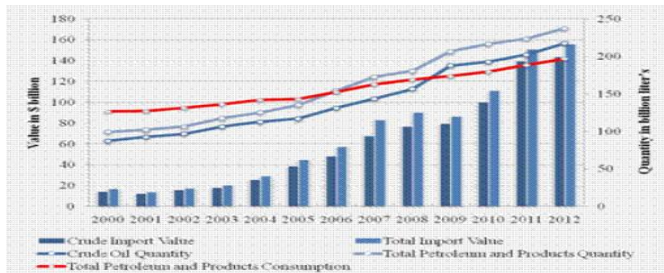
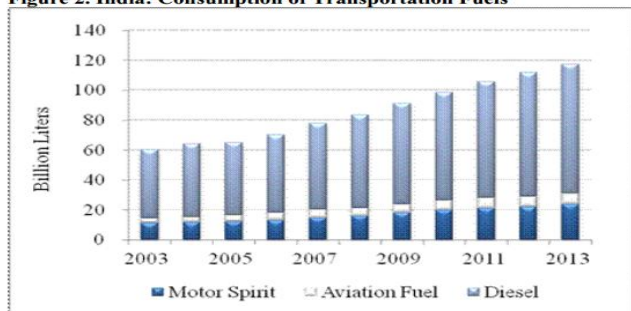


Figure 1. India: Import of Crude Oil, Petroleum Products and Total Consumption [8]

Source: Petroleum Planning and Analysis Cell, Government of India (GOI)

Note: Time scale is Indian fiscal year Currently, diesel alone meets an estimated 73 percent of transportation fuel demand followed by gasoline at 20 percent (Figure 2) [8].

Figure 2. India: Consumption of Transportation Fuels



Source: Petroleum Planning and Analysis Cell, Government of India (GOI)
*: Estimated for IFY 2014

Further, it's estimated that by end of this decade, the average demand for transport fuels will rise from an estimated 117

In India use of edible oil for production of biodiesel is very lucrative but it may pose a threat to the country's food security. Thus one of the better alternative fuels is biodiesel derived from non-edible oils for the usage of these as fuel in the conventional diesel engines without making any changes to the design.

billion litres in CY 2013 to 167 billion litres and would grow further to reach 195 million litres by CY 2023 [8].

Calendar Year	2015	2016	2017	2018	2019	2020	2021	2022	2023
Gasoline Total	28	30	32	35	37	40	43	47	50
Diesel Total	94	97	101	106	110	115	119	124	129
On-road	56	58	61	63	66	69	72	74	78
Agriculture	11	12	12	13	13	14	14	15	16
Construction /mining	4	4	4	4	4	5	5	5	5
Shipping/rail	5	5	5	5	5	6	6	6	6
Industry	10	11	11	12	12	13	13	14	14
*Heating	7	8	8	8	9	9	10	10	10
Jet Fuel Total	8	9	10	10	11	12	13	14	15
Total Fuel Markets	130	136	143	151	159	167	176	185	195

Source: Industry and trade sources

*: Heating / power generation

Proportion of diesel consumption through 2023 are indicative only.

Biofuel is a safe alternative fuel to replace traditional petroleum diesel. It has high-lubricity, is a clean-burning fuel and can be a fuel component for use in existing, unmodified diesel engines. Biofuels seek to supplement conventional energy resources for meeting rapidly increasing requirement of transportation fuels and meeting energy needs of India's vast rural population by use of non-food feed stocks and as a result to reduce dependence on import of fossil fuels. The intent is to provide a higher degree of national energy security in an environmentally friendly, cost-effective and sustainable manner [8].

Bio-diesel is an eco-friendly, alternative diesel fuel prepared from domestic renewable resources that is vegetables oils (edible & non-edible oil) and animal fats. Biodiesel is a biofuel produced from various feedstocks's including vegetable oils (such as oilseed, rapeseed and Soya bean), animal fats or algae. Biodiesel can be blended with diesel for use in diesel engine vehicles. Biodiesel is a fuel made from plant oils that can be used in a conventional diesel engine and it is an environmentally safe and low polluting fuel [9].

2.1 Benefits of Bio fuels (Biodiesel)

- It is a clean burning fuel, biodegradable & does not have any toxic emissions like mineral diesel
- It is made from any vegetable oil such as Soya, Rice bran, Canola, Palm, Coconut, mustard or peanut or from any animal fat like Lard or tallow.
- It is a complete substitute of Mineral diesel (HSD) & is made through a chemical process which converts oils and fats of natural origin into fatty acid methyl esters (FAME).

- It is intended to be used as a replacement for petroleum diesel fuel, or can be blended with petroleum diesel fuel in any proportion..
- It does not require modifications to a diesel engine to be used.
- It has reduced exhaust emissions & lower toxicity compared to petroleum diesel fuel.
- It is safer to handle compared to petroleum diesel fuel.

Biofuels offer an attractive alternative to fossil fuels, but a consistent scientific framework is needed to ensure policies that maximize the positive and minimize the negative aspects of biofuels. Numerous countries are moving towards the partial and gradual replacement of fossil fuels with biofuels, mainly ethanol and biodiesel. The increased move towards biofuels is spurred by global political, economical and environmental events, especially rising crude oil prices [10]. High viscosity, low volatility and polyunsaturated character of neat vegetable oils cause choking and gumming in the stock fuel injector system installed in diesel engines due to deposit formation, carbon build up and lubricating oil contamination [11]. Several methods can be employed for reducing viscosity of vegetable oils such as preheating, blending and transesterification. The transesterification is a chemical reaction widely used in the production of biodiesel. In the transesterification process, a triglyceride reacts with three molecules of alcohols in the presence of a catalyst producing a mixture of fatty acids alkyl esters and glycerol [12]. The monoesters produced by transesterification of vegetable oils or animal fats are known as biodiesel.

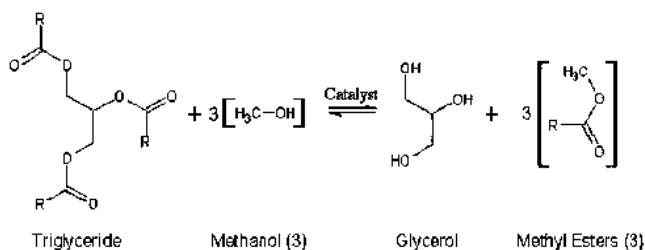


Figure- 3 shows chemical reaction for transesterification.

3. Biodiesel in India

Biodiesel production in India is a special case which has much more positive development effects than biodiesel production elsewhere. India is different because there is far-reaching consensus there that biodiesel production will only be promoted on the basis of non-edible oil seeds on marginal lands. Hence the risks of driving up prices for edible oil or crowding out food production are relatively low. In addition, cultivating tree-borne oilseeds on degraded lands stabilizes soils and creates carbon

sinks, and production requires low inputs, which serves to further improve the carbon balance.

Even within India, however, the development effects of the biodiesel industry vary greatly, depending on how the value chain is organized. This study identifies no less than 13 different ways of organizing the value chain, ranging from cultivation on large plantations to contract farming arrangements, farm-based production for rural electrification, and social forestry projects. Between these different types of value chains, there are marked differences in terms of income generation, participation and empowerment, food security, natural resources management and climate change, and economic sustainability. Development effects thus vary greatly depending on the type of value chain organization to be promoted. The report identifies on the basis of varying local conditions and power relations in five Indian states. These have been grouped into three different categories, namely government-centred cultivation, farmer-centred cultivation and corporate-centred cultivation [13]

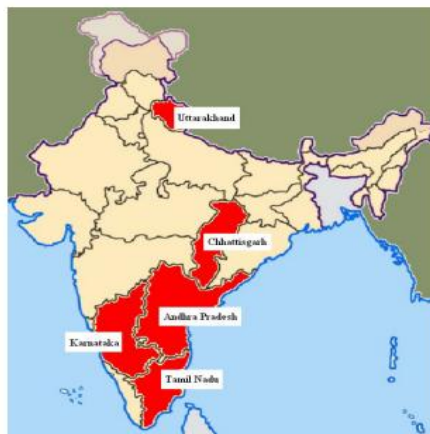


Figure shows Map of India, with the five states highlighted [12]

3.1 Feedstock for India's biodiesel

Biodiesel is typically made from vegetable oil though animal fat can also be used. Rapeseed oil [14] has 82per cent of the share of the world's biodiesel feedstock, followed by sunflower oil (10 per cent), soybean (5 per cent) and palm oil (3 per cent). The choice of feed is country specific and depends on availability. The United States uses soybean, Europe rapeseed and sunflower, Canada canola, Japan animal fat and Malaysia palm oil. In India, non-edible oil is most suitable as biodiesel feedstock since the demand for edible oil exceeds the domestic supply. It is estimated that the potential availability of such oils in India amounts to about 1 million tons per year[15], the most abundant oil sources are sal oil (180,000 t), mahua (180,000 t), neem oil (100,000 t) and Pongamia Pinnata, also known as Karanja oil (55,000 t). However, based on extensive research carried out in

agricultural research centres, it was decided to use *Jatropha Curcas* oilseed as the major feedstock for India's biodiesel programme.

3.2 Biofuels Potential in India

Consumption of diesel oil in India is: 60% in transportation with the remainder being utilized in industry, and agriculture (including fuelling tractors, diesel powered generators, and pumps commonly used for irrigation) [16]. Summing it all up the net diesel consumption in India was estimated to be 52.3 mn tons (61.3 bn liters) in 2006 [17]. In the view of environmental and economic aspects Indian consumers have already begun replacement of diesel fuel with greener and better fuels like biodiesel and bio-ethanol in both urban and rural areas in nearly every application where diesel is used. The following paragraphs will provide a briefing of the potential market segments and replacement potential of diesel fuel by biodiesel.

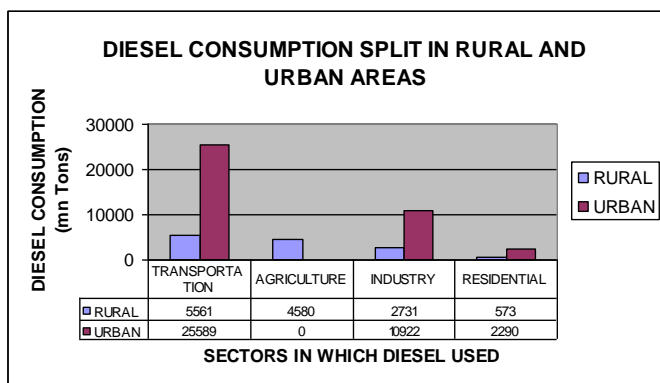
3.3 Estimation of total diesel oil consumption in India

A rough sketch of major sub-segments of diesel consumption split in rural and urban areas is presented in Table-1

Table- 1: Diesel consumption split in rural and urban areas

Geography	Transportation	Agriculture	Industry	Residential
Rural	5,561	4,580	2,731	573
Urban	25,589	-	10,922	2,290
Total	31,239	4,580	13,653	2,863

Source: TERI [10]



3.4 Estimation of total potential penetration

The National Mission on Biodiesel optimistically targets the replacement of 20% of total diesel consumption with *jatropha* based biodiesel by 2010-11. Assuming growth rates of diesel consumption in line with current levels (between 5-6%), total diesel consumption will be 66 mn tons in 2010-2011, requiring 13 mn tons (14.4 bn liters) of biodiesel to full fill the 20% target [16]. Projected demand of diesel and biodiesel for various blends of biodiesel is shown in Table-2.

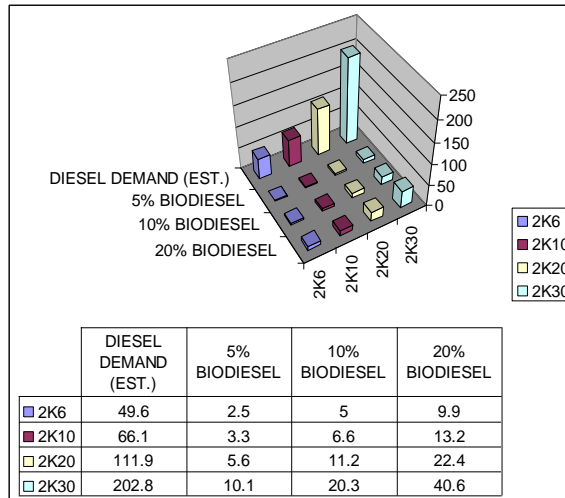


Table- 2: Projected demand of diesel and biodiesel for various blends of biodiesel

Year	Diesel demand (est.)	5% biodiesel	10% biodiesel	20% biodiesel
2006	49.6	2.5	5.0	9.9
2010	66.1	3.3	6.6	13.2
2020	111.9	5.6	11.2	22.4
2030	202.8	10.1	20.3	40.6

Source: TERI [10]

The current state of feedstock sources, expeller and transesterification capacity makes the ambitious plans of the government to replace 20% of diesel by biodiesel a little bit unrealistic. Thus an upper limit can be given to the market and production potential for biodiesel in the coming years. The potential markets for replacement of pure diesel oil by 20% blend of biodiesel are as follows:

- ✓ In rural areas two major segments which consume diesel as their main fuel are transportation and agriculture which have a huge potential in terms of replacement by low cost biodiesels. Cost of fuel being the major investment in both the sectors and thus reducing the involved expenses by introduction of low cost biodiesel will become a lucrative option for the consumers.

- ✓ Again, in the rural domain, another important sector is the irrigation sector where diesel powered pumps are the mainstay and used widely across the country owing to the lack of proper electricity facilities in such areas. Roughly eight million diesel engines currently power irrigation systems across the country, typically in areas with limited or inconsistent access to electrical power [18].

- ✓ Another incentive to the rural areas being the fact that the non edible oil seeds can be grown crushed and processed to form biodiesels locally and at a smaller scale thus leading to major cost reductions, thus making the idea of a cheaper and greener fuel more realizable.

- ✓ On the urban front immense potential can be tapped from the urban transport sector which makes use of diesel fuel

for the running of the busses, jeeps, cars, trains etc. Proper channelizing and advertising can help in replacing pure diesel by B20 blends of biodiesel.

✓ Rise in the use of diesel generators in offices and homes make this sector another generous patch in the diesel fuel replacement plan giving a huge boost in the potential market for biodiesels in the country.

4 Future of Biofuel in India

India has great potential for production of biodiesel. Wild crops cultivated in the wasteland also form a source of biodiesel production in India and according to the Economic Survey of Government of India, out of the cultivated land area, about 175 million hectares are classified as waste and degraded land. Thus, given a demand-based market, India can easily tap its potential and produce biodiesel in a large scale. Agriculture, and Non-Conventional Energy Source can all play leading roles in this program. Industry and research institutes have also the vital role for the success and a clear supply chain mechanism with utilization plan is necessary in national level like elsewhere across the globe. Research organizations should be encouraged to undertake Life Cycle Analysis exercise in biodiesel production.

5 Problems faced by farmers

Farmers may face problems regarding vegetable oil cultivation for biodiesel:

1. Lack of confidence in farmers due to the delay in notifying, publicizing and explaining the government biodiesel policy.

2. No minimum support price.

3. In the absence of long-term purchase contracts, there are no buy-back arrangements or purchase centres for Jatropha plantations.

4. Lack of availability certified seeds of higher yield containing higher oil content.

5. No announcement of incentives/subsidy and other benefits proposed to be provided to farmers.

6 Solutions to farmers' problems

1. The government needs to take confidence-building measures and clearly formulate its policy and explain to farmers that their role is vitally important in the success of the biodiesel programme.

Financial assistance should be given to NGOs in developing a large-scale awareness/training program for farmers.

2. The government should arrange tours for reputable NGOs and progressive farmers to other countries/States to enable them to witness the success of biodiesel production first-hand.

3. The government should establish a minimum support price for Jatropha just as it did for sugarcane and farmers assured of timely government payments. The government should also guarantee a buy-back programme for limited periods when prices reach distress levels.

4. The government should supply high-quality certified seeds to farmers, either free of charge or at subsidized rates.

5. Easy loan facilities should be provided to unemployed rural youths for the establishment of oil expellers and oil extraction plants and collection centres at minimum interest rates and without collateral security.

7 Conclusions

From the above study, we concluded that biofuels offer several significant benefits which includes reduced emission of pollutants such as carbon monoxide, unburnt hydrocarbons, particulate matter, polycyclic aromatic hydrocarbons (PAH) and nitrated PAH. Biofuels contain virtually no sulphur. Reduced emission of the greenhouse gas carbon dioxide, which contributes to global warming.

Enhance energy security and decreased dependence on oil imports by diversifying energy supply. Improved social well-being. A large part of India's population, mostly in rural areas, does not have access to energy services. The enhanced use of biofuels in rural areas is closely linked to poverty reduction as greater access to energy services can improve access to pumped drinking water and reduce the time spent by women and children on basic survival activities (Gathering firewood, fetching water, cooking, etc).

Generation of income for smallholder farmers and generation of employment in rural areas in the various ancillary units like cracking, transesterification, transport etc. Biodiesel can prove to be a boon for the poor farmers by reducing their fuel bills involved in running agro machineries.

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