



Contextualizing Alternative Energy Usage

*Modhurika De

School of Biosciences and Technology, VIT University, Vellore-632014, Tamil Nadu, India

*Email: modhurika.de@gmail.com; +91-9790211503

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Abstract

“The world has enough for everyone’s need but not for everyone’s greed”.

- M.K Gandhi

With the concern of global warming increasing with every passing day, ‘alternative fuels’ is an area, which is the most explored in recent times. Governments throughout the world are seeking alternative technologies to reduce their reliance on fossil fuel and minimize their carbon footprint. This paper will primarily focus on bio-fuels as an alternative energy source. It will endeavor to portray the ways in which bio-fuels started their ascent as an important energy source, and the scenario in the world market today. Most articles on bio-fuels tend to list out the basic pros and cons of using these forms of energy as opposed to others. In this paper, the objective has been to analyze the current status quo of bio-fuel usage and how it can evolve as a source of energy. The key idea of this paper is to propose a realistic point of view about the topic. A number of alternative/renewable energy sources already exist, yet the search for more efficient sources continues. This paper will endeavor to explore all possible aspects of this issue and propose a solution for the same. The discussion of the topic will be divided into a number of subtopics such as:

The present scenario of bio-fuel usage in the world.

- The origin of bio-fuels as alternative energy sources.
- The ways in which the world can obtain more out of bio-fuels.
- The future of renewable energy.

This paper proposes to explore bio-fuels as an alternative energy source at the disposal of the global citizen, especially Indians, while keeping in mind the economic ground realities. It will endeavor to look into other alternative energy sources and models in application so that our present is not borrowed from our children’s’ futures. “The use of vegetable oils for engine fuels may seem insignificant today. But such oils may, in the course of time, become as important as petroleum and coal tar products of present time”.- Rudolph Diesel, 1912.

Keywords—second generation biofuel, energy intensive; marketing margin; Brazilian success story;

Introduction

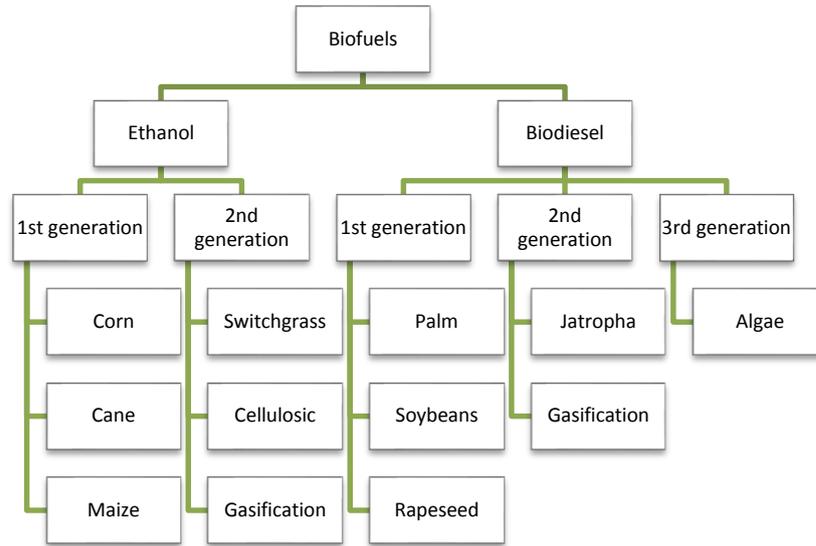
A biofuel is a fuel that contains energy from geologically recent carbon fixation such as plants. These fuels are produced from living organisms: microalgae etc. They are made by biomass conversion, using heat, chemicals or bio chemicals. They may be solid, liquid or gas. (Wikipedia: 21/11/2014). A biofuel is that which is easy to grow (less input cost), high in yield and adaptable to severe climates. (biofuel.org.uk: 21/11/2014). Examples of biofuel are Biomass, methane, ethanol, switch grass. (gonature.com: 21.11.2014). The focus of attention as an important means of saving ourselves from a powerless future, bio fuels have thus been the subject of much discourse in the past decade.

The first significant large-scale push for the production and use of bio fuels occurred in Brazil & USA as a response to the 1973 oil export embargo imposed by the Arab members of OPEC (Organization for Petroleum Export Countries) against Japan, The European countries and USA. Then, the focus on bio fuels was supply driven. Today, in a bid to reduce GHG (Green House Gasses) it is demand driven.

By 2030 global consumption of marketed energy is projected to rise by 71%. Three quarters of this increase is predicted to come from developing countries like China & India. (‘The Promises and Challenges of Bio fuels For the Poor in Developing Countries’ – Joachim von Braun and R K Pachauri).

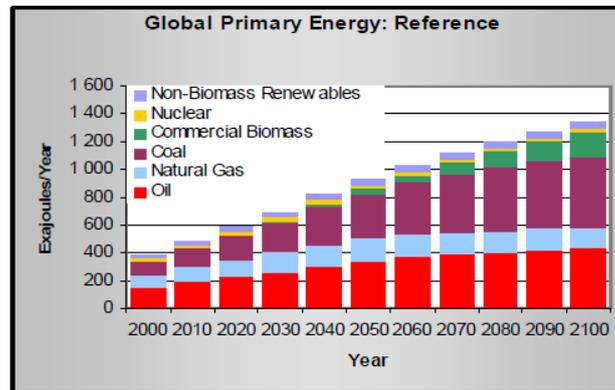
India is the world’s 4th largest energy consumer in the world today. Though there are proposals to make ourselves energy self reliant by 2030, it is only through increased consumption of hydrocarbon fuels and shale gas. Since thermal energy comes at huge environmental cost, India, along with the rest of the world has been looking at alternative fuels to power economy.

Figure I: Classification of Biofuels



(Narasimhan Santhanam - Energy Alternatives India)

Figure II: Global Primary Energy Reference



Source: CCSP (2007).

(United Nations Conference on Trade and Development

The Bio fuels Market: Current Situation and Alternative Scenarios page 34)

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Figure III: India's Energy Consumption

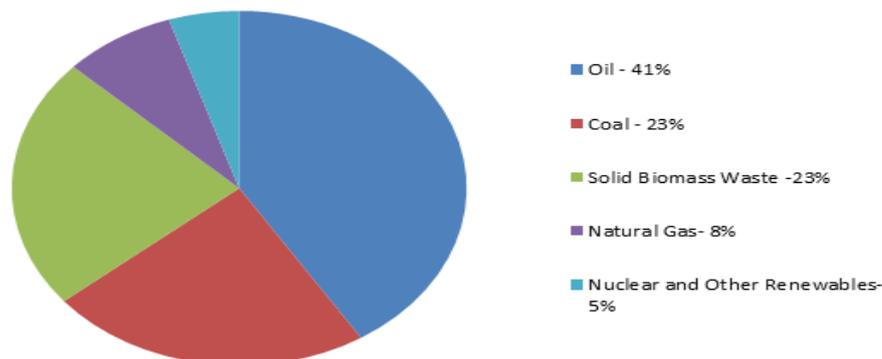
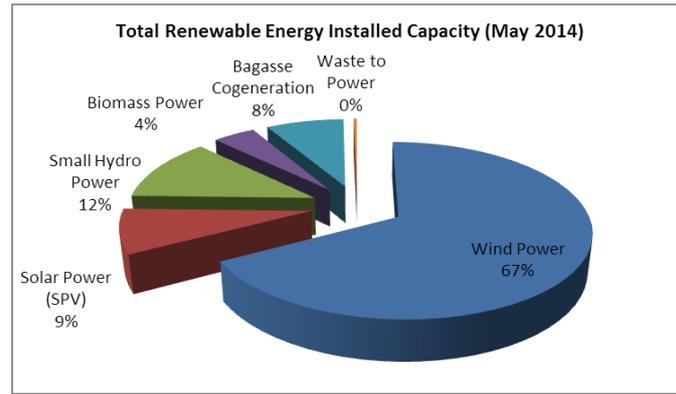


Figure IV: Total Renewabl



Current sources of bio fuels include those of the past i.e. fuel wood and charcoal, along with those discovered as feed stock recently, producing ethanol, biodiesel and bio gas. These products if produced hygienically (with reduced CO₂ emissions) may ameliorate the ills of climate change. Ethanol is made from beets, sugarcane, maize and wheat. Biogas is made from waste products of crops or municipality wastes. Biodiesel is also made from oilseed crops, waste oils and greases. Incidentally, Brazil produces nearly half of the world's total ethanol. According to National Sample Survey of India 1999, 86% of rural and 24% of urban households of India rely on biomass as primary cooking fuel. The competitiveness of bio fuels however, depends on prices of oil and of agricultural feed stock. If feed stock begins to cost more, so will bio fuels and hence it will cease to be a cost effective alternative,

Akin to an industry vs. agriculture debate, the current situation begets a food vs. fuel debate. Will farmers now produce the ingredients for energy markets of the future, namely maize, soya bean, palm oil, rapeseed – all of which are feedstock for ethanol production, at the cost of food? If this were to happen, perhaps there would be larger financial returns for the cash crop investors. The land owners would benefit, the government would benefit, as would the environment. But would the poor benefit? The farmers? The answer is not unambiguous. There is very little incentive for a poor farmer to grow feedstock in lieu of food grains.

The Brazilian success story started with criticism in the mid-1970s when they were just shifting to ethanol production. However, to their credit, they continued to produce sugar and ethanol simultaneously at their factories, using bagasse (the residue of the sugar manufacturing process) to generate electricity to power the biodiesel manufacturing process. Also, the Brazilian government incentivized alternative energy production through subsidized power.

1VDiscussion

In India, the Government of India approved a National Policy of Bio fuels in December 2009, and launched the National Biodiesel Mission (NBM) identifying *Jatropha curcas* as the most suitable tree born oilseed for biodiesel production, while simultaneously proposing a 20% biofuel blending (Biodiesel and Bio ethanol) by 2017.

Jatropha curcas is grown on approximately 1.5 million hectares of waste lands and needs very little irrigation. For obvious reasons it is the best feed stock option for alternative energy in India. The amount of wasteland in India presently is around 63.9 million hectares ([http:// doir.nic.in/wasteland.htm](http://doir.nic.in/wasteland.htm)). While the net cropped area is around 150 million hectares of this, less than 30% of which is irrigated and the rest is rain fed. The projected area to be brought under cultivation by 2015 is 1.9 million hectares.

Figure V: *Jatropha* viable areas in India



(Satish Lele. http://www.svlele.com/jatropha_why.htm)

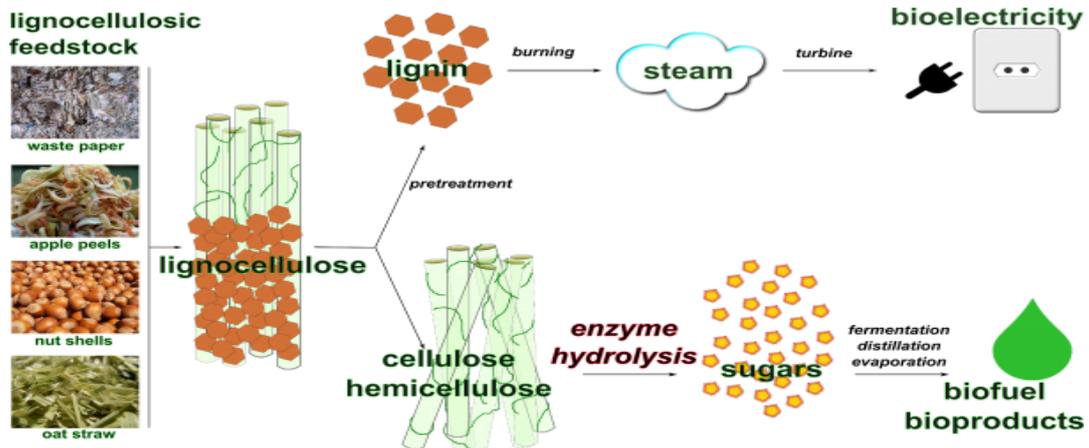
The area shown in Red is fertile (Food Basins where *Jatropha* plantations are unviable) while that shown in Pink are desert and that shown in Blue are high mountains (where it is difficult to grow *Jatropha*). It can be grown in all areas shown in green.

However there are issues owing to which *Jatropha curcas* is yet to catch on as a readily farmable option. The fruit of the *Jatropha curcas* is inedible, the leaves are unusable for fodder and the wood is unusable for timber because it is insufficient. The National Oilseeds and Vegetable Oil Development Board states that the oil content of *Jatropha curcas* varies from 21% to 48% ('Rethinking Current Strategies for Biofuel Production in India' Deepak Rajagopal, Energy and Resources Group, University of California, Berkeley). Tamil Nadu Agricultural University, Coimbatore, mentions susceptibility of *Jatropha curcas* to pests like bark eaters, stem borers etc. Also, higher gestation periods for *Jatropha curcas* crops (3 to 5 years) result in longer payback period, thus reducing market margins. Short duration crops like castor, illicit better investment response. *Jatropha curcas* also does not produce sufficient seeds for commercial plantation. Hence minimum support prices are the need of the hour.

Thus, non-availability of sufficient feedstock and lack of research and development to evolve high yielding and drought resistant / tolerant *Jatropha curcas* seeds, are major stumbling blocks for the biodiesel program in India. Most of the biodiesel produced is therefore used for self-transport by some transport companies on trial basis (www.bioenergyconsult.com: 20/11/2014). Though there are sufficient waste lands in India, not all of it is arable. There are deserts, snowfields, sheet rock and saline land tracts that come under this category and hence are useless for *Jatropha curcas*. Only 10% of the countries wasteland may be put to use in farming *Jatropha curcas*. A study on planting *Jatropha curcas* as part of the Horticulture Program of the Employment Guarantee Scheme in Maharashtra shows that government subsidies mainly benefit farmers who are adopters.

The problems associated with ethanol production, generally referred to as first generation bio fuels, bring us to the second generation bio fuels. Second generation biofuel technology focuses on ligno-cellulosic conversion. Cellulosic ethanol (made from grass, trees and municipal waste) requires less energy to be produced than, for example, maize ethanol, the production of which is energy intensive.

Figure VI: The Biofuel Process



(<http://www.semanticsoftware.info/genozymes-project>)

The advantage of 2G bio fuels is that it does not directly compete with food, as it is made from switch grass or maize stover. Its energy yield is higher than 1G bio fuels. MIT's Emissions Prediction and Policy Analysis (EPPA) model estimates biomass to be the main energy supplier till 2100. (UNCTAD, Geneva and New York 2009, 'The Biofuel's Market: Current Situations and Alternative Scenarios'.) Poplar, willow, bamboo etc are some quick growing trees that may serve as fuel source for a biomass power plant. As they contain high amounts of lignin, they are called ligno-cellulosic biomass sources. They can be converted to ethanol by fermentation, or into liquid fuel through a high temperature process. Algae

are also a source of 2G bio fuels. But are these enough to sustain our energy demands? A cost / benefit study in 2006 (Hill et al) found that even if all America's maize and soya bean were used to produce bio fuels it would only meet 12% of USA's demand for gasoline and 6% of diesel's. The potential of Cellulosic ethanol in India is modest in that India produces about 440 million tons of crop residues annually; this translates to about 130 million T of ethanol per annum. If all of India's wasteland could be brought under cultivation, which is not realistic, 63 million ha waste land would translates to a maximum potential of over 500 million T of cellulosic ethanol per annum. This is equivalent to

350 tons of petroleum. It may be kept in mind that India’s total crude oil import is about 110 MT per annum. While Cellulosic Ethanol contributes to effective utilization of waste biomass and could someday take care of all India’s gasoline substitute needs with a model which is a scaled up version of current production practices, there are some inherent problems too:

- Technology not yet commercially applicable
- Production costs are high
- Lack of R&D in India

Currently, however, 2G biofuels have not made any notable impact in India on energy market. This is because Government has not enforced the blending mandates nor has incentivised the production. There is very little involvement of the government or private sector with respect to R&D. But there are definite opportunities going forward. Logistics Companies may benefit significantly from the 2G biofuel production process as large-scale material

handling and transportation are integral to conversion of biomass fuel. Employment opportunities in the process are manifold. From the feed stock stage to the fuel generation and delivery; both skilled and unskilled labour would be the need of the day. Oil companies, Farmers, Agricultural R&D companies, equipment manufacturers, vegetable oil companies, sugar mills and distilleries are some of the sectors that directly stand to benefit from the generation of 2G biofuels.

The benefits that will accrue to us, Indians, from this alternative energy generation process are that we may finally be able to lower the fuel import bill and dependence on Middle East for oil. We will contribute to a safer environment and therefore better climate. It will also enable employment generation. One could also diversify into other agricultural or energy product verticals if one or other residue or by products could be commercially utilized. To contextualize the discussion precisely, let us look at the projected demand for petrol, diesel and bio fuels.

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

Year	Petrol Demand Mt	Ethanol 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

(‘Indian Biofuel Scenario: An Assessment of Science and Policy’ Vijai Pratap Singh, Project Officer – Climate Change, Lead India) Gasohol is approved by BIS (Bureau of Indian Standards) since 2004. It comprises 5% ethanol and gasoline. In terms of energy policy, India mandates a 5% ethanol blend in 9 states, while China mandates 10% in 5 of its provinces. India is preparing to push to E10 as soon as adequate production infrastructure is in place. Maharashtra is the only state, which being the largest sugarcane producer in India, has already approved 10% ethanol blending. Biodiesel is being produced locally for use in stationary engines and slow transportation engines like some trains, trucks and tractors. It is used, blended with gasoline, to run State Transport Corporation buses in Karnataka. The Government of Karnataka has distributed several million saplings of Pongamia and Jatropha to farmers for planting along borders of farmland and on wastelands. Large scale plantations have been initiated in the North East and Jharkhand. The Indian Oil Corporation has tied up with Indian Railways to introduce biodiesel feed stock crops for

over 1 million sq kms. Also Biodiesel Society of India has been formed to encourage alternative fuel plantations.

Some of the companies currently using biodiesel in India are Reliance India, Kakinada; Labland BioDiesel, Mysore; Mohan Breweries and Distilleries; Dharani Sugar and Chemicals Ltd., Tamil Nadu; HPCL, Maharashtra; Mission Bio Fuels India Pvt. Ltd.; Godrej Agrovet Ltd.; Reliance Energy etc. The State Bank of India has signed an MOU with D1 Oils Plc to give 1.3 billion Rupees to local farmers to go green.

The problems faced by these organizations have largely been threefold:

1. The food vs. fuel conflict
2. Prices of food going up, impacting feedstock
3. Inflation of processing costs

Some of the better known global companies that have gone green are Coca Cola and Wal-Mart. The bio fuels commonly used in:

- USA and Brazil - Ethanol and Gasohol
- EU – Bio ethanol

- China – Ethanol based fuels
- Thailand and Malaysia – E 10 and Oil Palm

The problems faced in these countries have been that

1. There has been a destruction of natural habitats to expand production of biofuel feed stocks. This may have greater climate impacts. (Delucchi 2006, Buchanan et al 2008)
2. In case of oil palm, the major drawbacks are an increase of CO₂ emission, caused by removal of rainforest and reduction of biodiversity (Koh and Wilcove 2008, Pimental et al 2010)
3. Poor persons lose land because they cannot compete with government / biofuel producers.
4. In 2007 – 08, food prices peaked because most farmers opted to cultivate feed stock for larger monetary profits.
5. Increasing global preference for meat and dairy products now require more land to be apportioned for pasture.

Conclusion

While it is undeniable that alternative energy sources in general and bio fuels in particular are definitely the way forward to meet our country's burgeoning energy needs; it is time to think of plugging the gaps and alleviating the concerns that drag this discourse down.

Some thoughts that come to mind, perhaps naively, are:

1. A focus on ligno-cellulosic biomass sources in complement to *Jatropha* and *Pongamia*
2. A probe into the viability of marine algae as a possible biomass source,
3. A possibility of creating genetically engineered seeds of *Jatropha* and *Pongamia* in order to make them faster growing, yield maximizing and pest resistant,
4. A possibility of framing policies like CSR, which incentivises or makes mandatory for every registered enterprise to partake of a role in alternative fuel generation,
5. Incentivizing farmers into growing equal portions of food crops along with feed stock by ensuring a healthy minimum support price,
6. Assessing the worth of political representatives and decision makers by taking into account the productivity of land (farmland as well as wasteland) within his or her jurisdiction,
7. And most importantly, funding and fast tracking, through infrastructural support and increased number of scholars, research into this field.

References

- [1] Raja Gopal, Deepak, 'Rethinking Current Strategies for Biofuels Production in India'.
- [2] Braun, Joachim von and R.K. Pachauri. 'The Promises and Challenges of Biofuels, for the Poor in Developing Countries'.
- [3] UNCTAD, Geneva New York 2009, 'The Biofuels Market: Current Situation and Alternative Scenarios'.
- [4] Singh, Dr Vijai Pratap. 'The Indian Biofuels Scenario: An Assessment of Science and Policy'.
- [5] Santhanam, Narasimhan. 'Second Generation Biofuels in India – Relevance and Status' Energy Alternatives India

Webliography:

- [1] <http://www.bioenergyconsult.com> accessed on 20/11/2014
- [2] <http://www.doir.nic.in/wasteland.htm> accessed on 21/11/2014
- [3] <http://www.semanticsoftware.info/genozymes-project> accessed on 28/11/2014
- [4] (Satish Lele. <http://www.svlele.co>)