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Energy Security in India: A Review of the Liquid Bio-Fuels Production from Renewable Sources

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Abstract: *Any growing nation will always require economic expansion, and that growth will also always create a need for energy. Oil use makes over 36% of India's total energy consumption. India is now one of the top 10 oil-consuming countries in the world. Nearly 24% of commercial energy-consuming industries are accounted for by the transportation industry. The primary goal of energy security for India is to achieve energy independence. This necessitates a diversity of oil import sources. Biofuels are steadily becoming one of the most important energy sources in India for sustainability and aid in limiting greenhouse gas emissions. An overview of several methods and procedures for producing liquid biofuels from renewable sources is provided in this review article, which improves India's energy security.*

Keywords: Bio-Fuels, Bio-Ethanol, Bio-Methanol, Bio-Diesel and Bio-Gas

I. INTRODUCTION

This article is a survey of relevant literature since there is a need to look for alternative fuels owing to rapidly depleting fuel and oil supplies in our nation and progressively developing environmental problems linked to the usage of petroleum products.

Bio-fuels are clean, renewable fuels that have gained popularity in recent years. The most popular ones are bio-methanol and bio-ethanol, which are made from sugarcane or grains, and bio-diesel, which is made from vegetable and animal fats. At a Paris exposition in 1897, German inventor Rudolf Diesel produced his engine that ran on peanut oil, while Henry Ford, a car maker, constructed his machinery to operate on ethanol (Paula-Bianca MARICA, 2009).

The most popular sources of the biofuels are as follows:

- Cellulose, algal oil, corn, soybeans, sugar cane, jatropha and camelina, rapeseed, methane, animal fats, paper scraps, and biomass are some examples of these materials.
- Because it is now the greatest alternative, bio-mass-based fuels are gaining more attention from researchers. The majority of nations use agricultural waste and biomass residues as biofuel resources because they are renewable and because they can be converted into liquid biofuels using accessible techniques. Chemical transformation processes might be costly, necessitating more research into cost-effective, goal-oriented processes.

II. LITERATURE REVIEW

Search for Environmental Friendly Energy Resource

Fossil fuel use in the transportation sector is 58% (Escobar JC et al., 2009). In order to fulfill the growing need for energy, green house gas emissions, commonly known as GHGs, are rising (Zhao R., 2009; Singh A. et al., 2010; Prasad S. et al., 2009). Due to these emissions, a number of negative impacts also worsen, including glacier retreat, general climate change, and biodiversity loss (Gullison R.E. et al., 2007). Increasing crude oil prices have had a direct negative economic impact on the global economy because of the growth in energy consumption (He Y et al., 2010). According to studies by Singh A. et al. (2010), Prasad S. et al. (2009), Singh A., Smyth B.M. et al. (2010), Singh A., Smyth B.M. et al. (2010), and Singh A., Smyth B.M. et al. (2010), alternative, renewable but sustainable, efficient, and economical energy sources should be pursued. Natural gas, syngas (synthesis gas), biofuels, and hydrogen may emerge as the most

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valuable fuel sources with sustainability among energy options in the years to come. The most environmentally friendly energy source out of these four is biofuels. As they are renewable, biodegradable, and produce exhaust emissions below specified limits, biofuels are chosen (Bhatti HN et al., 2008).

Bio-Mass as Renewable Source for Generation of Bio-Energy

The development of sustainable bio-power and biomaterials, which will also result in a new developed paradigm, has the potential to be facilitated by the inclusion of agro-energy crops and industrialized bio-refinery technology.

Bio-Fuels

Biofuels produced from biomass are the sustainable fuel solution. Numerous fuels may be created from bio-mass, including Fischer-Tropsch diesel, bio-diesel, ethanol, methanol, methane, and hydrogen (Demirbas A, 2008).

III. CLASSIFICATION OF BIO-FUELS

Primary and secondary biofuels exist. Fuel wood and chips are used raw for electricity, cooking, and heating. DME, bio-diesel, ethanol, and other secondary biofuels are made from biomass and utilized in cars and industry. First, second, and third-generation secondary biofuels are categorized by production. Biofuels are categorized by kind and source. Wood, charcoal, and pellets are solid biofuels, whereas ethanol and biodiesel are liquid.

Renewable biofuels utilise natural bioresources, ensuring energy independence and security. Low GHG emissions from lignocellulosic biofuel production lessen environmental impacts.

Biodiesel is sustainable, easy to use in diesel engines, and needs minimal modification, according to a USDA research (USDA, 2003). Recycled or agricultural resources make it biodegradable and nontoxic. Biodiesel's low flash point makes it superior than petroleum-based fuel. Transportation is straightforward and safe (Demirbas A, 2009; Bajpai D et al., 2006). The latest liquid biofuel categorization (Larson ED, 2008) covers "First-Generation" and "Second-Generation" biofuels.

First- and second-generation biofuels differ in feedstock and technology. Timilsina et al. (2009)

a) The first generation of biofuels refers to technologies that typically employ the sugar or starch portion of plants as feed to manufacture ethanol and those that use oil seed crops to produce biodiesel.

b) The second generation of biofuels is created by converting agricultural and forestry waste, as well as advanced feedstocks like jatropha and microalgae. (P. Singh Nigam et al., 2011; A.L. Smith et al., 2013)

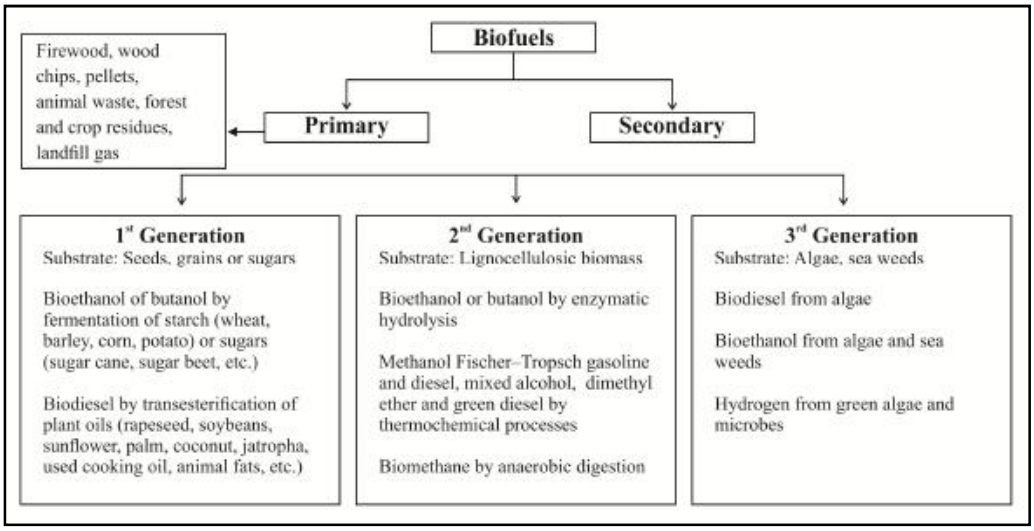

Fig. 1: Categorization of Bio-Fuels based on Technology (A.L. Smith, 2013)

First Generation of Liquid Bio-Fuels

First-generation liquid biofuels are made from sugars, grains, or seeds (Zhao R et al., 2009; Gibbons WR et al., 1989; Suresh K et al., 1999; Turhollow AF, Heady EO, 1986). Ethanol, the most popular first-generation biofuel, is made by fermenting plant sugar extract and starch from maize kernels or other starchy crops (Larson ED, 2008). Hydrolysis

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converts starch into glucose from grains used as basic ingredients (International Energy Agency, 2004). The germs in seeds and grains were used to make ethanol, which left a lot of residue (Escobar JC et al., 2009).

Second Generation Liquid Bio-Fuels

Second-generation liquid biofuels are made by biological or thermochemical processing of agricultural ligno-cellulosic biomass, which can be whole plant biomass or crop production residues like grasses or trees planted for energy. Larson (2008) states that most second-generation biofuels will have reduced prices and considerable environmental and energy advantages due to feedstock features. Second-generation biofuels derived from ligno-cellulosic biomass may employ cheap non-edible feedstocks to separate food and fuel battles (Barron N et al., 1996).

Thermo-chemistry produces all second-generation biofuels except butanol and ethanol, which are biochemically created. Thermochemical processes differ from biochemical processes in their ease of feedstock modification and range of fuel products (Farias FEM et al., 2007).

Third Generation Liquid Bio-Fuels

Bio-Ethanol

Molasses, wheat, sugar cane, maize, and other crops now make alcohol. Yeast ferments sugar into alcohol. Sugars from carbs were formerly needed. Alcohol is sold using wet or dry maize milling (A. Demirbas, 2009, 2011; Energy Conversion and Management, 2009).

Ethanol beats gasoline. Ethanol replaces gasoline in several countries. Brazil uses 25% ethanol as gasoline. Indian desert terrain might supply some need (Energy Conversion and Management, 2009; Ayhan Demirbas, 2008). Ethanol reduces engine knocking and emits less pollutants than gasoline.

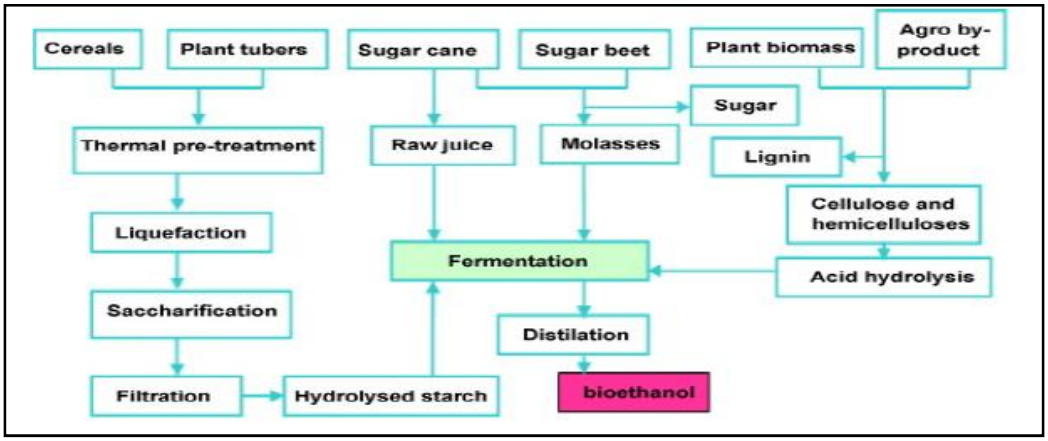

Fig. 2: The Detail Flow Sheet for Production of Bio-Ethanol (G. Najafi et al., 2009)

Bio-Methanol

Methanol, which has gained popularity as a fuel used mostly in the transportation sector, is a fuel mixed to various degrees. The biomass may be used to produce methyl alcohol. Since bio-mass is seen as a renewable resource, bio-methanol is also essential to the production of biofuels. Any waste, such as home or agricultural waste, is included in biomass. Biomass now accounts for 10.8% of global energy, according to a 2001 assessment by the International Energy Agency (EIA) (B. Amigun et al., 2010). In the illustration, methanol production from biomass is shown.

Bio-Diesel

The direct replacement for diesel is bio-diesel. For the most part, diesel is the main fuel used in the transportation industry. Therefore, it is necessary to discover diesel alternatives. The manufacturing of biodiesel comes from a wide variety of sources, the majority of which are vegetable oils including Jatropha oil, algal oil, soybean, palm oil, Pinari tree oil, etc. as well as animal fats. These vegetable oils' free fatty acids are used to create bio-diesel. Jatropha seeds and

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soybeans are the primary sources of biodiesel in India since they can be produced in accordance with the country's climate. The production of palm oil and other choices is not without its problems.

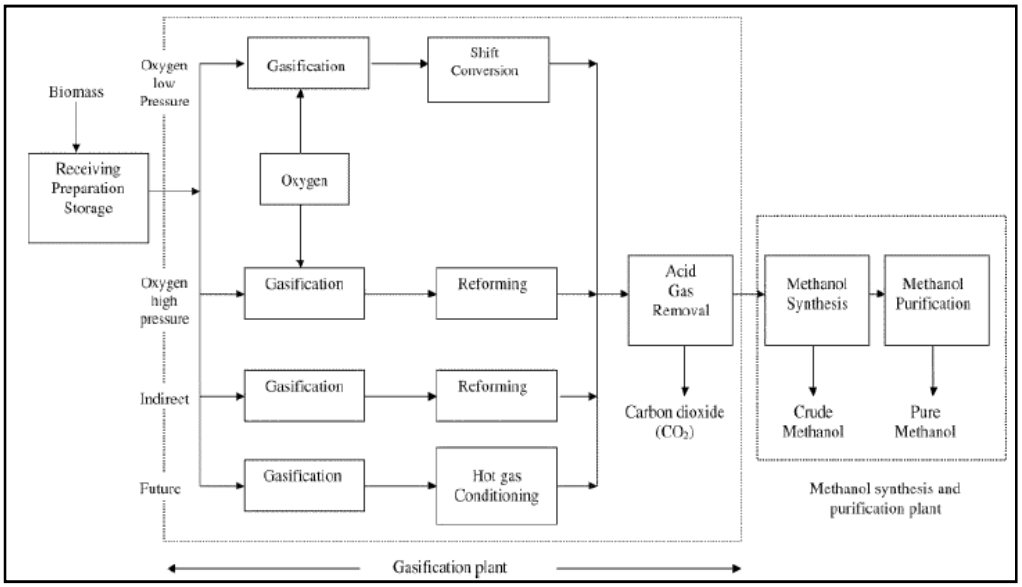

Fig. 3: Production Flow Sheet of Bio-Methanol (B. Amigun, 2010)

Table 1

Oil	FFA Content (%)
Jatropha seeds	14
Soybeans	18
Palm oil	3 to 6.5
Pinari oil	3.5 to 4

Trans-esterification is the method used to create bio-diesel. It's a really simple procedure.

Figure 4 depicts the flow chart for the manufacturing of biodiesel.

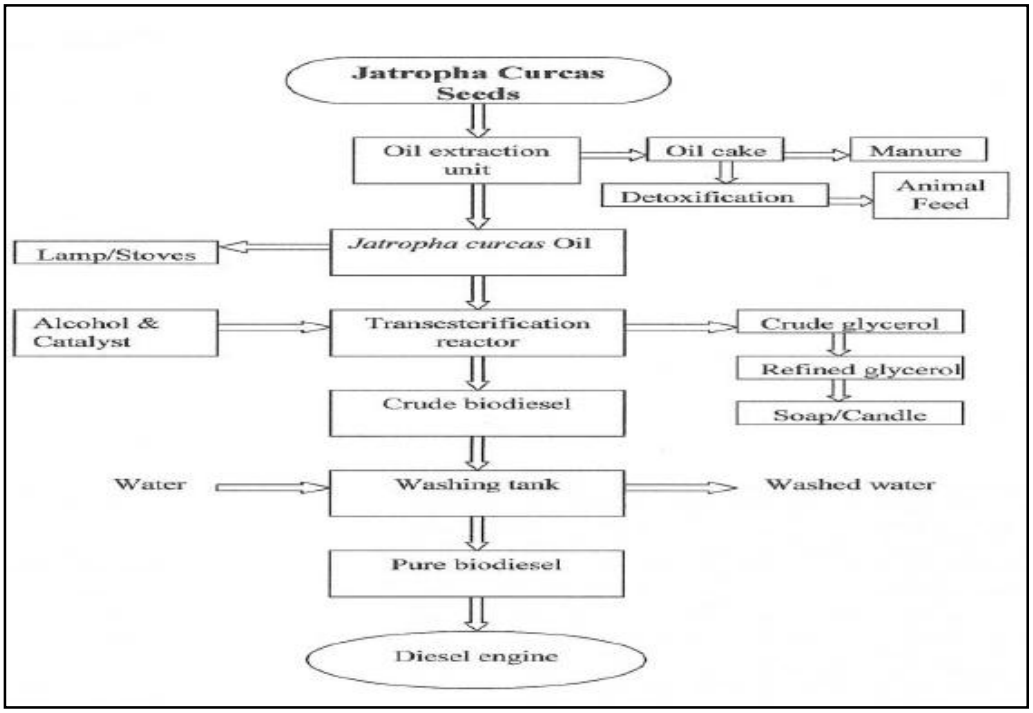

Fig. 4: Flow Sheet for the Production of the Bio-Diesel

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The biodiesel that is created has excellent properties for burning fuels. Although it has a higher viscosity than conventional diesel, diesel engines may still use it. Because bio-diesel has superior lubricity and combustion properties than diesel and has a higher Cetane rating, it allows engines to operate more smoothly and quietly.

Bio-Gas

Bio-gas replaces natural gas. Biogas is made from residential and agricultural waste. Purohit, Kandpal, T.-C., 2007; Vijay, V.K. Anaerobic biomass breakdown produces mostly methane. Household appliances utilise biogas's ethane, propane, and butane. The best-known biogas plants are Janata, Deenbandhu, Deenbandhu II, and Himshakti. R.S. Khoiyangbam, 2004.

Energy Security and Challenges for India

India was a modest energy player until recently. That story is changing fast. India relies heavily on fossil fuel imports. Thus, it worried about global oil shocks and macroeconomics. India's daily oil market share will reach 12.5% by 2030. However, 2014 saw 7.4%. India's energy consumption will rise fastest among major economies. India will be Europe's successor in the global energy market.

"Energy Security" Redefined

Energy security has changed for major economies.

The International Energy Agency encourages its members to consider short- and long-term energy security. In summary, although the goal to rely less on foreign suppliers remains, the world's leading economies have realized that energy security and energy independence are different.

There is no global energy organization. Global energy governance is disorganized. India must host a global energy security and governance discussion. several reasons:

Energy has changed dramatically since the 1970s oil crisis.

One fresh worry is oil market disruption. Arctic resources, gas uncertainty, low-carbon energy conversion, or nuclear safety concerns. While these developing developments are embroiled in techno-economic and scientific arguments, diplomatic energy engagements continue to rely on outdated, restricted energy security conceptions.

Second, the lack of frameworks, concepts, and theories to understand the changing world of international energy may explain the silence.

Many conversations focus on the anxieties of industrialized countries rather than the promise and problems of rising economies, which will again drive demand, innovation, and energy investment and trade.

Thirdly, many international relations scholars and practitioners live in a state-centric universe.

Energy is difficult. State-centric views of energy security as a zero-sum game squander resources and miss opportunities to assist energy R&D, commercialization, and investment.

Fourthly, many energy system concerns are ignored. These include (i) climate risks affecting energy infrastructure (water stress for numerous power plants, recent coastal flooding); (ii) cyber attacks on increasingly integrated energy grids and systems; (iii) financial collapse for established and emerging energy firms (such as fossil fuels and renewable energy); and (iv) limited access to critical minerals needed for new energy technology production and operation.

Billion people lack electricity, which hurts gender equality, economic productivity, and health.

IV. DISCUSSIONS

Food vs. Fuel

Biofuels are only beneficial if developed with sustainability, biodiversity, and the "food vs. fuel" dilemma in mind. Groom (Groom MJ et al., 2008) examined ecologically friendly oil crop production controls. They promote carbon-neutral and biodiversity-focused biofuel crops. They also support low-impact feedstocks including Karanja, Jatropha, and Switchgrass.

On abandoned farms, oil-producing Jatropha, Switchgrass, and prairie grasses may flourish without fertilizer or water. Algae contains 200 times more oil per acre than fertile soil.

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Energy Security

Access to affordable, reliable, sustainable energy services for everyone is a key sustainable development goal that was conspicuously left out of the Millennium Development Goals. India has to develop its voice, communicate its issues in a clear and concise manner, and negotiate the junction of crucial factors including energy markets, energy transitions, and energy diplomacy. It must lead this discourse since few others will, and it must imagine new concepts for global energy administration.

V. CONCLUSION

Biofuels should be generated on a commercial scale to fulfill future demand. The biggest disadvantage of producing biofuels is that it takes a lot of area to grow the cereal grains, jatropha, soybeans, and other ingredients; however, there is a solution as well. There are 60 million hectares of unused land in India, which may be used to grow these products. Farmers would benefit most from it, and it will also assist to promote the agricultural industry. The Indian government further promotes it by providing subsidies.

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