

"There is a compelling need to pursue biofuels"

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There have been mounting concerns across the world about the detrimental effects of carbon emissions emanating from fossil fuels. The emphasis on renewable energy has been greater than ever before. When it comes to energy, storing energy is as important as generating it. Biofuels have the unique feature of stored and portable energy which enables them to be used for niche applications such as transportation fuels. Transportation fuels are one of the major and critical energy needs of our country. Hence, biofuels are synonymously associated with transportation fuels.

At present, our transportation fuels are fossil-fuel based. About 80 percent of India's crude oil consumption is imported (185 million tonnes/year). This places a huge strain on the nation's economy. Our crude oil import bill is Rs 6,000 billion per year, which amounts to 34 percent of the total import bill. There is a compelling need to pursue biofuels for transportation for energy and economic security in addition to the environmental benefits. But development of biofuels will require well-strategized R&D efforts and policy frameworks. The present transportation fuel consumption of India is 92 million tonnes per year. It is projected to increase to 400-500 million tonnes per year by 2050. So the preparations and developmental plans must be devised now.

There are different types of biofuels which merit attention. The biofuels first intended for development in India were bioethanol from sugarcane molasses and biodiesel from wasteland *Jatropha* plantations. The production of these biofuels and their

blending with petrol and diesel was initiated under National Biofuels Mission from 2003. A National Policy on Biofuels was adopted in 2009. However, the production levels have been modest. Bioethanol production has fluctuated between 0.1 and 0.3 mtoe/year recently and biodiesel production between 0.01 and 0.05 mtoe/year. Ethanol tends to get diverted to portable and industrial markets due to better prices and present *Jatropha* germplasms are not adequate for wasteland cultivation. The overall scope of these biofuels is limited - about 1 mtoe/year and 10 mtoe/year respectively, due to feedstock availability.

New Generation Fuels

Lignocellulosic biofuels are the next generation biofuels and these are under development. In India, these refer to biofuels from non-fodder agricultural residue and lignocellulosic bioenergy plantations in marginal/waste lands. The scope of these biofuels is high - about 60 mtoe/year. There are different types of fuel conversion technologies and final fuel products. A biochemical process involves pre-treatment of lignocellulosic biomass, hydrolysis of cellulose to sugars and fermentation to ethanol. A thermochemical process involves pyrolysis of biomass and upgrading of resulting bio-oil to drop-in transportation fuels. Commercial production of these fuels is expected to begin in a few years.

Algal biofuels are more advanced biofuels. Algae refers to microalgae (unicellular suspensions in water) and macroalgae (seaweed). These are very fast-growing. Microalgae produce lipids and their lipid yields could be 20-50 times higher than oil crops. Sea water could be used as water resource. The scope of the algal biofuels is much higher. To produce 150 mtoe/year of algal biofuel, 3-6 million hectares of land may be required. This is about 1-2 percent of the total land area of India. The land requirement is among the lowest. However, algal biofuels are in an early stage of development compared to other biofuels, and are expected to take time to attain commercially viability.

There are many challenges associated with the development of biofuels. Germplasms that would thrive on marginal lands need to be developed for *Jatropha*. Transportation and supply chain logistics need to be addressed for liquid fuel production from agricultural residue. Pre-treatment and enzyme costs need to be lowered for the lignocellulosic ethanol process. Harvesting, outdoor yields and capital cost are some of the challenges associated with microalgal biofuels. But such challenges are in any case expected during the development of any new technology. The petroleum industry has been around for about hundred years now, whereas the biofuel field has done intensive R&D only during the past decade.

When we think of replacing petroleum, one must remember that in addition to transportation fuel, petroleum caters to many other products such as plastics, chemicals, adhesives and tar. So the development of biofuels should also address development of similar by-products to add value and facilitate the viability of biofuels.

The National Policy on Biofuels, 2009, has provided necessary impetus to initiate the biofuel program in India. But time has come to chart out a clear and detailed roadmap for the development of biofuels. A strong impetus must be provided to expand and accelerate R&D efforts in this direction. The US and EU have come up with such plans. Active engagement from industries is crucial as well. It would be an industrial product after all and they would be the stakeholders marketing and selling it. Some industries have taken the lead, but more participation and efforts are expected.

If we undertake efforts to develop local and indigenous production of transportation fuels, we may meet up to 40 percent of the transportation fuel market in the future. This relates to a reduction in oil imports by 350 mtoe/year. Clearly, we need to push biofuels in the energy sector, which is crucial to attain a sustainable and secure future!