Biofuels

towards a greener and secure energy future

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Introduction

Moving towards biofuels for a secure and clean energy future

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Major changes have taken place recently in the global energy market. The most prominent among these is the unexpected increase in oil prices during the past few months, which went beyond the predictions and expectations of most analysts who are knowledgeable about oil market developments. While the US (United States) continues to be the largest consumer and importer of oil, China and India – while registering rapid rates of economic growth – have also increased their imports of oil. These trends and expectations of growth in the future have had an impact on the oil market, which generally exhibits extreme sensitivity to changes on both the demand and the supply sides. Combined with increased oil prices, the increasing awareness on the global impacts of climate change, which is influenced by the increasing concentration of greenhouse gases in the atmosphere, has led to concerns about increasing the worldwide consumption of fossil fuels. These and other factors have, therefore, recently created growing interest in the possibility of large-scale production and use of biofuels.

If biofuel crops are cultivated and used on a sustainable basis then this option not only becomes environmentally preferred but also reduces threats to the security of energy supply in the future. At a basic level, the production of biofuels represents efficient conversion of solar energy for use in human activities, because the energy produced from crops

is basically a process, which results from photosynthesis that draws on the energy of the sun. India is not only a large importer of oil with the prospect of increased imports in the future, but also has significant potential for production of biofuels in the country. India actually has large areas of wasteland, which could be utilized for the production of biofuels, but there is also a substantial quantity of biomass residue from agriculture and other activities, which presents a scientific and organizational challenge for conversion to usable forms of energy for a variety of applications.

This publication provides an assessment of the state-of-the-art knowledge on the production, conversion, and use of biofuels, which is the collective result of experiences provided by a diverse group of distinguished persons who have been dealing with this subject for some time now. In this era of information flow and knowledge sharing, it is important that any country that embarks on the path of innovation in any field builds on the experience and existing know-how and avoids the danger of reinventing the wheel. Since India and many countries in the world are on the verge of devising and implementing programmes for production, conversion, and use of biofuels, it is essential to base these on the rapidly expanding knowledge that already exists in this area.

Currently, there are a number of liquid biofuels that can be used for various purposes.

Biologically produced alcohols

- Ethanol produced from sugar cane is being used as transport fuel in Brazil and to a very small extent in India. On the other hand, states in the USA are using ethanol produced from corn. A new technology uses cellulosic biomass from plants for ethanol production, but efforts in this field need substantial development and scaling up.
- Methanol is being currently produced from natural gas, but technically it can also be produced from biomass. This technology has significant potential, although the process is not commercially viable at present. The methanol option is an interesting alternative to the hydrogen option, but

again requires considerable R&D (research and development) efforts.

- Butanol is another fuel formed by ABE (acetone, butanol, ethanol) fermentation by the bacteria *Clostridium acetobutylicum*. It can be burned directly in existing gasoline engines without any modifications; can produce larger quantities of energy (higher octane fuel value); and is less corrosive and less water-soluble than ethanol. Also, it dramatically reduces vehicular emissions and can be distributed through existing infrastructures.

Biologically produced oils (bio-oils)

These can be used in diesel engines either directly or after transesterification.

However, not all these fuels are commercially viable at present. Our country has chosen two main biofuels for large-scale deployment— bio-ethanol based on ethanol produced from sugar cane (molasses) as a substitute for petrol (gasoline) and bio-diesel produced from oil-bearing seeds of jatropha (*Jatropha curcas*) as a substitute for HSD (high-speed diesel). The challenge here is to produce large quantities of these biofuels at prices competitive with those of currently used fossil fuel products.

For a country like India, biofuels, especially bio-diesel production promises a number of economic, environmental, and social benefits, such as large-scale employment generation, particularly in the rural sector. The bio-diesel programme will open up a large number of land-based employment opportunities through the raising of plantations and their subsequent maintenance, collection of seed, the processing of jatropha seeds into oil, and transesterification. It is estimated that raising a plantation of jatropha over one hectare of land would generate an average employment of 116 to 122 person-days. Large-scale jatropha plantations will also help the country to achieve high agricultural growth, which is essential if the economy is to achieve and maintain the projected overall growth rate of 8%.

Several cities all over the world are currently affected by high air pollution levels that affect the health of inhabitants adversely. In this respect, biofuels offer an opportunity for reducing pollution levels from vehicular tailpipe emissions. In the case of biofuels these have significantly lower levels of sulphur and also help reduce unburnt hydrocarbons, carbon monoxide, and particulate matter.

Equally important as the scientific and technological challenge in harnessing the potential of biofuels is the need for devising policy measures that would provide due place for this form of energy in the future. The first step that is required for promoting rational and optimal use of biofuels is the proper pricing of existing sources of energy. For instance, the provision of subsidized electricity in rural areas of many parts of the developing world only distorts the market by discouraging appropriate levels of production of renewable forms of energy, including biofuels. As it is, in several rural areas where commercial energy supplies are inadequate, erratic, or uncertain, biofuels are being used for running diesel pump-sets and tractors, etc. Proper pricing would, therefore, provide biofuels and other forms of energy with a level-playing field.

Governments also have a responsibility for fostering R&D, and adequate funding should be made available for this purpose as well as for demonstration projects covering various aspects of biofuels development. It would be critically important to ensure that such funding is utilized through the involvement of proper research organizations, academic institutions, and most importantly, local communities and user groups whose participation would ensure proper matching of solutions with the needs of the consumer.

All in all, the prospect of substantial use of biofuels appears bright at this juncture; but if the full potential of this option is to be tapped adequately, clear strategies and policies need to be developed and put in place for ensuring early results. Chapters included in this book, it is hoped, would provide adequate information, knowledge, and perspectives on how an important element of transition to a new energy future, of which biofuels would be an important component, can be made smoothly and as rapidly as possible.