Economics of Bio fuel Energy: Challenges and Future Prospects

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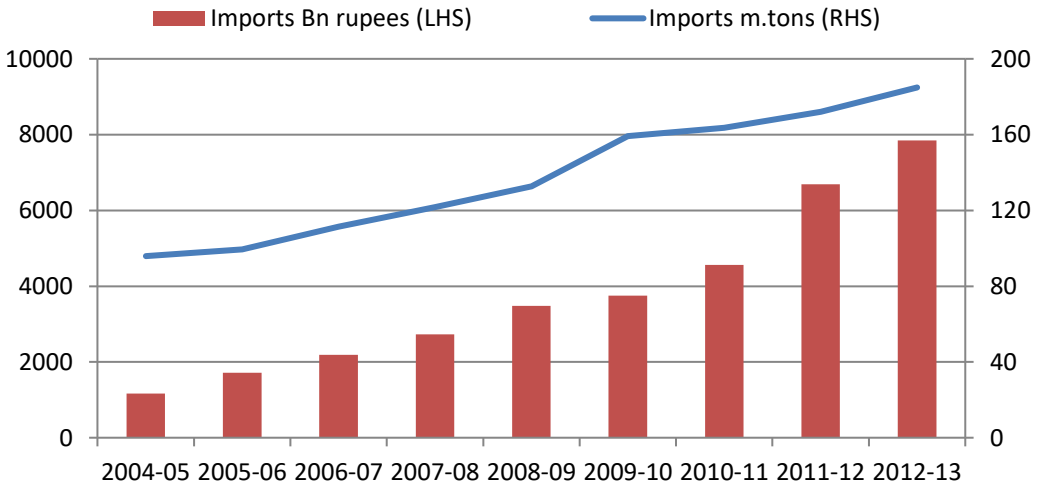
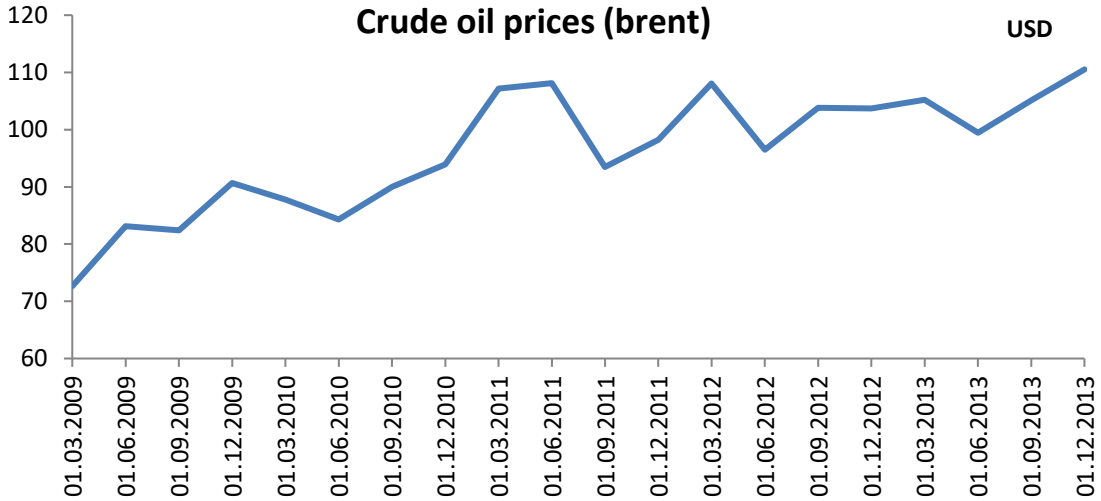
Introduction

- India is one of the fastest growing economies in the world.
- A growing economy naturally means higher energy consumption which is critical to its social as well as economic development.
- According to the Energy Information Administration‘s (EIA) website, India was the fourth-largest consumer of crude oil and petroleum products in the world in 2015, after the United States, China, and Japan.
- Most of India‘s demand for energy is met by the import of crude oil from the Middle East countries. Higher import of petroleum products leads to a strain on the economy by causing a trade deficit.





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- Out of total commercial fuels in India – Coal (57.1%), Oil (31.6%), Natural gas (8.0%) and carbon free hydro, nuclear and other new renewable resource (3.3%). (IAEA, 2010).
- Domestic production can only bridge the gap by 25-30% has serious effect on energy security of country, coupled with import burden.
- 2012-13 India imported 185.0 million tons of crude oil, which is 80% of domestic oil consumption and 30% of country's total imports.
- Of all the sectors, the transport sector is the largest consumer of petroleum with more than fifty percent consumption and is also responsible for the emission of harmful Greenhouse Gases.
- Thus, there is pressure on India to look for alternative and environmentally benign sources that can fulfil its energy requirements in a sustainable manner as well as enhance its energy security.

Key Issues Emerged from the review of existing literature on Bio fuels

- Biofuel is environmentally friendly fuel compared to either gasoline or petroleum diesel, biofuel is also recognized due to its portability, ready availability, renewability, higher combustion efficiency, lower sulfur and aromatic content, and higher biodegradability (Ma F, 1999; Konthe *et al* 2006).
- However, primary concern is that the growth of agricultural crops to produce biofuels may be inherently unsustainable (Peer *et al*., 2008).
- Overall energy required to produce crops that provide energy raises questions about whether the finished product provides more energy than is spent to produce it (Giampietro *et al*, 1997).
- There is also considerable debate questioning whether the end fuel product will truly be better for the environment than fossil fuels when subjected to a Life Cycle Analysis (Heintzman & Solomon, 2009; Puppán, 2003).

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- Francis *et al*, (2005), Kumar et al (2008), Pradip *et al* (2010) say that Jatropha bio diesel can be more economical than petroleum diesel.
- Pradip *et al* (2010), identifies the hurdles to achieve 20% target of blending. Indicates economies of scale is need of the hour. Issue of ownership, yield fluctuations in different climatic zones, technological handicaps, and price fluctuations are the potential risks.
- Sorda *et al* (2010) noted government intervention is needed for profitable production. LCA analysis reveal negative net contribution to reduction in GHG emissions.
- Montobbio and Lele (2010), study on viability of Jatropha in Tamil Nadu assessed the likelihood trade-off on livelihood and latent conflict. Study found yields much lower and determined by water availability. Large scale biofuel has very low energy return on investment compared to fossil fuels while at the same time imposing heavy demand on land, water and labour.
- Findalter and Kandilkar (2011), study in Rajasthan studied impact of Jatropha on both government and private lands. Study questions the concept of waste land.

National Bio Fuel Policy

- National policy on biofuels aims at mainstreaming use of biofuels by 20% blending with petrol and high speed diesel by 2017. (GOI, 2009).
- But, amid reports of unavailability of jatropha seed and overall negative energy balance of biofuel processes the National Biofuel mission and policy recommendations seems to land in jeopardy (Negi *et al.*, 2006; Gonsalves, 2006; Singhal and Gupta 2012).
- Given moisture stress, millets are the best alternatives for extreme weather conditions and are well suited to drought-prone regions of India (Parthasarathy Rao *et al*, 2006).

Present Context

- Renewable energy is considered as one of the most promising alternatives.
- Recognizing this potential, India has been implementing one of the largest renewable energy programmes in the world.
- Among the renewable energy technologies, bioenergy has a large diverse portfolio including efficient biomass stoves, biogas, biomass combustion and gasification
- India has also formulated and implemented a number of innovative policies and programmes to promote bioenergy technologies.
- However, according to some preliminary studies, the success rate is marginal compared to the potential available.
- This limited success is a clear indicator of the need for a serious reassessment of the bioenergy programme.
- Further, a realization of the need for adopting a sustainable energy path to address the above challenges will be the guiding force in this reassessment.

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- A careful analysis of the current energy scenario and future plans suggests India has a long way to go in ensuring energy security to the people.
- Some of the following summarized statistics clearly establishes this fact:
- Per capita energy consumption at 520 kgoe in 2003 is one of the lowest in the world and compares badly with world average of 1688 kgoe and 1090 kgoe for China.
- Though 74% of Indian villages were electrified as of March 2005 only 54.9% of households had access to electricity.
- Still 44.4% of rural households depend on kerosene lamps for lighting. In comparison, about 92% of urban households had access to electricity for lighting in 2005.
- About 42% of people had access to clean LPG for cooking as of January 2005. With respect to the rural–urban divide, in 2005, 9% of rural households had access to LPG whereas about 57% of urban households had access.
- About 75% of rural households still depend on fuel wood (in traditional stoves) for their cooking energy needs with only 3% having access to kerosene for cooking.
- Rural households spend about 10% of total household expenditure on energy for cooking and lighting whereas this is 9% for urban households.
- For this level of energy demand, CO2 emissions are expected to rise from the current level of 1 billion tonnes to 5.9 billion tonnes per year by 2031–2032.

Ethanol Production in India

- In India it is ensured that biofuels are deliberately produced only based on non-food feedstocks.
- Hence bio-ethanol is produced mainly from molasses, a by-product of the sugar industry. It is produced from the fermentation of sugarcane molasses and sugar beet. It is also produced from starch containing crops such as corn and sorghum.
- But the ethanol production in India is mainly sugarcane centric. This is to ensure that a food vs fuel conflict does not arise as a result of growing non-food feedstocks on lands where food crops are grown.
- But there has been criticism that ethanol produces from sugarcane molasses alone will not be sufficient to cater to the present blending levels.
- Restricting ethanol production only to sugarcane molasses is neither sustainable nor economically viable.
- Ethanol production in India continues to face a lot of challenges. There are mainly drivers and barriers in the cultivation of bioethanol crops in India.

Drivers of Biofuels

- **Energy security -** The conventional fuels such as fossil fuels on which the world is majorly dependent are fast depleting. There is hence an immediate need to look for alternative fuels. Hence biofuels, which are derivatives of biomass are not only renewable but also help in decreasing the net import of oils from other countries.
- Second, if a good market for ethanol is developed, growing ethanol crops such as corn or sugarcane more extensively will be profitable and result in higher revenues, making farmers well off, thus contributing to **rural development.**
- Thirdly and finally, **environmental sustainability** is also an important driver in the production of biofuel crops. Biomass fuels such as ethanol are seen as better than fossil fuels for two reasons: i) they are renewable and hence contribute to sustainable development and ii) they are seen as a means of reducing GHG emissions.

Barriers in the Production of Bioethanol in India

- One of the main reasons for the lack of adequate supply of ethanol is due to a deficiency in growing biofuel crops in India. Even though there exist alternative crops such as sugar beet, corn, sorghum etc. for the production of bio ethanol, India cannot fully make use of them. This is because of the unique way in which the biofuel policy in India is formulated.
- Another problem is the term wastelands itself. How can one demarcate between wastelands/marginal lands and lands which are fit for production of food crops? Biofuel crop production, in case of ever increasing demand and prospect of huge profits would no longer be restricted to marginal lands. This would lead to displacement of food crops from the fertile lands and eventually lead to a threat to food security.
- Increasing demand for biofuels also increases the demand for water. With water already being scarce in many parts of the nation, biofuel crops may actually be a bane.
- Other barriers in the non-realization of bioethanol blending in petrol in general include the battle between alcohol sector, medicinal sector and fuel sector for ethanol. Of the total amount of available ethanol, a maximum of 45% goes to the alcohol industry.

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- Rapid growth of liquid biofuel production and consumption has had negative unintended consequences. Questions are being raised about possible competition for land and water resources even in growing energy crops for second-generation biofuels.
- According to the National Policy on Biofuels, substantial research thrust in the development of second- and third-generation feedstock is needed to address the country‘s future energy needs, particularly in regards to future transport fuel needs.
- The need of the hour is thus to look beyond production of ethanol from sugarcane molasses and move to second generation ethanol.
- Biofuels, either conventional or advanced should not be blindly encouraged without a comprehensive outlook on the overall impact the will ultimately have on the society, environment or on the countries‘ energy security. Efforts should be made towards encouragement of research and development in the field as well as in formulating a comprehensive and effective biofuel policy.

BIO ENERGY
An Overview

Bio Mass

INTRODUCTION

- Biomass has always been an important energy source for the country considering the benefits it offers.
- It is renewable, widely available, carbon-neutral and has the potential to provide significant employment in the rural areas.
- Biomass is also capable of providing firm energy.
- About 32% of the total primary energy use in the country is still derived from biomass and more than 70% of the country's population depends upon it for its energy needs.
- Ministry of New and Renewable Energy (MNRE) has realised the potential and role of biomass energy in the Indian context and hence has initiated a number of programmes for promotion of efficient technologies for its use in various sectors of the economy to ensure derivation of maximum benefits.

POTENTIAL

- As per a recent study sponsored by MNRE, the current availability of biomass in India is estimated at about 750 million metric tonnes per year.

- The Study indicated estimated surplus biomass availability at about 230 million metric tonnes per annum covering agricultural residues corresponding to a potential of about **28 GW**.

- This apart, about 14 GW additional power could be generated through bagasse based cogeneration in the country's 550 Sugar mills, if these sugar mills were to adopt technically and economically optimal levels of cogeneration for extracting power from the bagasse produced by them.

DEPLOYMENT

- The Ministry has been implementing biomass power/co-generation programme since mid-nineties.
- Over 800 biomass power and bagasse/Non-bagasse cogeneration projects aggregating to **10205.61 MW** capacity have been installed in the country for feeding power to the grid.
- States which have taken leadership position in implementation of bagasse cogeneration projects are Maharashtra, Karnataka, Uttar Pradesh, Tamil Nadu and Andhra Pradesh.
- The leading States for biomass power projects are Chhattisgarh, Madhya Pradesh, Gujarat, Rajasthan and Tamil Nadu.

Biogas

- There is ample potential of setting up biogas plants considering the livestock population of 512.06 million, which includes about 300 million (299.98 million) total population of bovines (comprising of cattle, buffalo, mithun and yak). The livestock sector contributes about significantly to India's GDP and will continue to increase. The dissemination of biogas technology is a boon for Indian farmers with its direct and collateral benefits.

- The Ministry of New and Renewable Energy promoted installation of biogas plants by implementing 2 Central Sector Schemes under Off-Grid/distributed and decentralized Renewable Power. The following schemes were valid upto 31/03/2021:

  i. New National Biogas and Organic Manure Programme (NNBOMP), for Biogas Plant size ranging from 1 cu.m. to 25 cu.m. per day.

  i. Biogas Power Generation (Off-grid) and Thermal energy application Programme (BPGTP), for setting up biogas plants in the size range of 30 m^3 to 2500 m^3 per day, for corresponding power generation capacity range of 3 kW to 250 kW from biogas or raw biogas for thermal energy /cooling applications.

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- Initially, Biogas Plants were developed for digesting cattle dung.
- However, over a period of time, technology has been developed for the bio-methanation of various types of biomass materials and organic wastes.
- Biogas plant designs are now available from 0.5 M^3 to 1000 M^3 unit size or more and multiples of that can be installed for achieving higher Biogas Plant sizes, depending upon availability of the raw material such as for family/ household, small farmers, dairy farmers and for community, institutional and industrial/ commercial applications.
- The unit size of industrial and municipal wastes based biogas plants may go up to 15000 M^3 to 20000 M^3 biogas production per day.

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- MNRE continues to give high priority for the development and utilization of biogas as energy in its various forms.
- Under the National Biogas and Manure Management Programme (NBMMP), about 50.0 Lakh (5 Million) Family size plants have been installed up to 2017-18.
- The NBMMP scheme has been redesigned, modified and renamed as New National Biogas and Organic Manure Programme (NNBOMP) and continued from 2018-19 with the aim to enhance the biogas production from small Biogas plants of 1 to 25 M^3 capacity.
- The scheme aims to set up about 2.5 Lakh units of Biogas plants of various sizes in the above mentioned capacity range with an overall biogas generation of about 8 lakh Cu. M. per day.
- For encouraging farmers to use nutrient enriched organic bio-manure, the scheme also aims for value addition of the biogas plant slurry by linking it with enrichment units such as vermicomposting, Phosphate Rich Organic Manure (PROM) plants and other organic enrichment facilities as a source of an additional income and saving in chemical fertilizers bills of farmers.

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- Biogas plants are reliable source of decentralized Renewable Energy for heating, cooking as well as generating electricity/ power generation and thermal energy application alternatives in our country.
- In order to promote this Decentralized Renewable Energy Source (DRES) of power generation, specifically in the small capacity range (3 kW to 250 kW) and thermal energy for heating/cooling from the biogas produced from Biogas plants of 30 M^3 to 2500 M^3 size, operated based on the availability of required quantity of biodegradable organic waste(s).
- Biogas plants installed under the scheme meets the electrical or thermal requirements of the beneficiaries and dairy farmers and other organizations.
- It is used for milk chilling applications and other general applications such as pumping, lighting, irrigation as well as cooking.
- The farmers can also sell out surplus biogas/ electricity to his neighbours in off-grid mode.

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- The technical potential of modern BETs (Bio Energy Technologies) in contributing to the energy system is indisputable. Even in terms of economic comparisons, the modern BETs outperform conventional fossil fuel-based technologies.

- The life cycle cost (LCC) of installing and operating various types of BET for cooking and power generation is used for this comparison.

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Life cycle cost estimates of bioenergy technologies for cooking and a comparison with kerosene cooking (Rs GJ_1 of heat output).

	Total life cycle cost (Rs GJ-1 of heat output)	Unit cost of energy (Rs GJ_1 of heat output)
Traditional fuelwood stove	674.27 (16.50)	271.13 (6.63)
Efficient fuelwood stove	713.78 (17.46)	163.89 (4.01)
Dung-based biogas plant/stoves	3572.4 (87.41)	393.56 (9.63)
Leafy biogas plant/stoves	2469.7 (60.43)	272.07 (6.66)
Kerosene stove	1743.1 (42.65)	459.82 (11.25)

- The numbers in bracket are costs in US$ at an average exchange rate of Rs40.87 per US$ in May 2007.

Environmental and climate change benefits

- Biomass has traditionally been used in rural areas, particularly by the poor.
- The poor's dependence on natural resources such as land, water and fuelwood could be further enhanced if biomass systems are holistically implemented.
- Land reclamation, soil conservation, and watershed development are the inherent benefits of biomass energy sources.
- Environmental considerations compel greater use of sustainable technologies.
- One of the major environmental threats is energy induced global warming and associated impacts.
- BETs are uniquely placed in this context as they could mitigate the climate change impacts by preventing emissions and also absorb emissions by sequestering carbon through the photosynthesis process.

BETs' greenhouse gases reduction potential in India.

Biomass technology	Technical potential	Global environmental benefit (million T C year_1)
Biogas	17 million	5
Community biogas	150000 villages	10.8
Improved stove	120 million	4
Biomass	57000MW	89
Cogeneration	3500MW	6
Urban wastes	1700MW	3

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Difficulty in mainstreaming environment into development plans

- Economic and other development priorities precede environmental objectives.
- Even in countries like India, which has an exhaustive regulatory and policy framework for protecting the environment and sustainable development, have difficulty in their enforcement or implementation.
- The institutional set up – multiplicity of institutions, overlapping roles, etc. – further acts as a barrier.

Lack of direction and transparency

- There is reluctance to transfer the technologies by the research institutions.
- The fear of failure and the risks associated with the transfer being high due to low confidence levels, information sharing is limited.

Lack of private sector participation

- In the case of BETs, there have been hardly any partnerships with the private sector in the process of technology development.
- Few private sector companies were involved in production of systems such as biomass gasifiers under a licensing agreement.
- These enterprises were mainly first generation entrepreneurs with very weak financial and technical resource bases and as a result dependent on the research institutions for any major technological breakthrough.

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Institutional and policy framework

- BETs are still considered as the most complex cluster of technologies for transfer or diffusion.
- First of all, BETs are still in an evolving phase, which makes it difficult to decide what exactly should be diffused in terms of knowledge, techniques and hardware.
- Second, it requires a series of difficult technological choices concerning biomass sources, production, transportation, conversion and end-use.
- Finally, there are a multitude of actors who potentially could become crucial players.
- In the above context, policies, institutions and financing play catalytic roles in technology transfer and diffusion of BETs.

Conclusion

- India's energy supply system dominated by traditional biomass, centralized grid electricity and petroleum products has failed to meet the growing energy needs of the nearly 1 Billion rural population and at the same time has contributed significantly to local and global environmental degradation.
- It has been proved time and again that advanced bioenergy technologies have the potential to produce sufficient quantum of modern energy carriers to meet the heating, lighting, shaft power and motive power needs, particularly of the rural population.
- Further, bioenergy technologies are the prime candidates aimed at mitigation of climate change.
- Though India is a pioneer in establishing one of the most comprehensive programmes in bioenergy, the success rates in terms of number of installations, self-sustaining replications and creating access to modern energy carriers in rural regions are marginal.

Thank You