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Biomass Energy Modern Transitions

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ABSTRACT

The looming threat of climate change and the invaluable role of energy in development have complicated the global transition to sustainable energy while also increasing the urgency of the transition. Bioenergy has a key role in this transition due to its unique characteristics among renewable energy sources, the concentration of bioenergy potential in major developing country regions, and the close relationship between biomass resources and carbon management strategies. This paper offers a review and a conceptual model for bioenergy's role in the transition, outlining its key elements and their significance with respect to environment and development. The transition from traditional uses of biomass for energy to more efficient and higher quality bioenergy, often referred to as modernbioenergy, is important for many reasons, but foremost among them the following: Modern bioenergy provides higher quality energy services that are more versatile and more efficient than traditional bioenergy.

1. Introduction

Bioenergy consists of solid, liquid, or gaseous fuels. Liquid fuels can be used directly in the existing road, railroad, and aviation transportation network stock, as well as in engine and turbine electrical power generators.Biomass materials are used since millennia for meeting myriad human needs including energy. Until the middle of 19th century, biomass dominated the global energy supply with a seventy percent share. Solid and gaseous fuels can be used for the production of electrical power from purpose-designed direct or indirect turbine-equipped power plants. Chemical products can also be obtained from all organic matter produced. Additionally power and chemicals can come from the use of plant-derived industrial, commercial, or urban wastes, or agricultural or forestry residues. Despite its declining share in energy, global consumption of wood energy has continued to grow. During 1974 to 1994, global wood consumption for energy grew annually by over 2 percent rate. The biomass sources contribute 14% of global energy and 38% of energy in developing countries. Globally, the energy content of biomass residues in agriculture based industries annually is estimated at 56 exajoules, nearly a quarter of global primary energy use of 230 exajoules.

2. Biomass Energy In India

Biomass contributes over a third of primary energy in India. Biomass fuels are predominantly used in rural households for cooking and water heating, as well as by traditional and artisan industries. Biomass delivers most energy for the domestic use (rural - 90% and urban - 40%) in India. Wood fuels contribute 56 percent of total biomass energy[1]. Consumption of wood has grown annually at 2 percent rate over past two decades[2]. Estimates of biomass consumption remain highly variable[3] since most biomass is not transacted on the market. Supply-side estimates of biomass energy are reported as: fuelwood for domestic sector- 218.5 million tons (dry), crop residue- 96 million tons (estimate for 1985), and cattle dung cake- 37 million tons. A recent study[4]estimates demand in India for fuelwood at 201 million tons. Supply of biomass is primarily from fuels that are home grown or collected by households for own needs. The Government sponsored social forestry programme has added to fuel-wood supply to the tune of 40 million tons annually.

3. Problems of Traditional Biomass Energy Use

Most biomass energy in India is derived from owned sources like farm trees or cattle, or is collected by households from common property lands. The biomass energy consumption is primarily limited to meet cooking needs of households and traditional industries and services in rural areas. In absence of a developed energy market in rural areas, most biomass fuels are not traded nor do they compete with commercial energy resources. In developing countries, due to excess labour, biomass acquires no resource value so long as it is not scarce. In the absence of an energy market, the traditional biomass fails to acquire exchange value in substitution. Absence of market thus acts as a barrier to the penetration of efficient and clean energy resources and technologies. An additional problem with the traditional biomass use is the social costs associated with excessive pollution. The incomplete combustion of biomass in traditional stoves releases pollutants like carbon monoxide, methane, nitrogen oxides, benzene, formaldehyde, benzo(a)pyrene, aromatics and respirable particulate matter. These pollutants cause considerable damage to health, especially of women and children who are exposed to indoorpollution for long duration[5]. The twin problems of traditional biomass use are the energy inefficiency and excessive pollution

4. Modern Biomass Technology

A decade of experience with modern biomass technologies for thermal, motive power and electricity generation applications exists in India. Gasifier technology has penetrated the applications such as village electrification,

captive power generation and process heat generation in industries producing biomass waste. Over 1600 gasifier systems, having 16 MW total capacity, have generated 42 million Kilo Watt hour (KWh) of electricity, replacing 8.8 million litres of oil annually (CMIE, 1996). An important aspect of small gasifier technology in India is the development of local manufacturing base. The large sized gasifier based power technologies are at R&D and pilot demonstration stage. The thrust of the biomass power programme is now on the grid connected megawatt scale power generation with multiple biomass materials such as rice straw, rice husk, bagasse, wood waste, wood, wild bushes and paper mill waste. Nearly 55 MW of grid connected biomass power capacity is commissioned and another 90 MW capacity is under construction. Enhanced scale has improved economics as well as the technology of biomass power generation. Technology improvement is also derived from joint ventures of Indian firms with leading international manufacturers of turbines and electronic governors.

Modernization in biomass energy happened in the last two decades along three routes - i) improvement of technologies in traditional biomass applications such as for cooking and rural industries, ii) process development for conversion of raw biomass to superior fuels (such as liquid fuels, gas and briquettes), and iii) penetration of biomass based electricity generation technologies. Biomass use is growing globally. Despite advancements in biomass energy technologies, most bioenergy consumption in India still remains confined to traditional uses. The modern technologies offer possibilities to convert biomass into synthetic gaseous or liquid fuels (like ethanol and methanol) and electricity. Lack of biomass energy market has been the primary barrier to the penetration of modern biomass technologies. Growing experience with modern biomass technologies in India suggests that technology push policies need to be substituted or augmented by market pull policies. A primary policy lacuna hampering the growth of modern biomass energy is the implicit environmental subsidy allowed to fossil fuels. Increasing realization among policy makers about positive externalities of biomass has now created conditions for biomass to make inroads into the energy market. Modern biomass has potential to penetrate in four segments - i) process heat applications in industries generating biomass waste, ii) cooking energy in domestic and commercial sectors (through charcoal and briquettes), iii) electricity generation and iv) transportation sector with liquid fuels. Economic reforms have opened the doors for competition in energy and electricity sectors in India. Future of biomass energy lies in its use with modern technologies.

Future of biomass energy depends on providing reliable energy services at competitive cost. In India, this will happen only if biomass energy services can compete on a fair market. Policy priorities should be to orient biomass energy services towards market and to reform the market towards fair competition by internalizing the externalities of competing energy resources. Most economical option is utilization of waste materials. Potential availability of agro residues and wood processing waste in India can sustain 10,000 MW power. Biomass waste however shall be inadequate to support the growing demands for biomass resources. Sustained supply of biomass shall require production of energy crops (e.g. wood fuel plantations, sugar cane as feedstock for ethanol) and wood plantations for meeting growing non-energy needs. Land supply, enhanced biomass productivity, economic operations of plantations and logistics infrastructure are critical areas which shall determine future of biomass in India. Policy support for a transition towards a biomass based civilization in India should consider the following.

5. Conclusion

Is modern bioenergy a local resource or a global commodity? It will have to be both in order to achieve a successful sustainability transition. The knowledge required to harness bioenergy efficiently and sustainably is inherently local; the provision of modern infrastructure, conversion technologies, and the best utilisation of the resource base is inherently global. The global economy and the bio-physical interdependencies have linked the evolution of energy systems more and more to overall social development patterns. Assuming that environmental impacts are appropriately incorporated into overall system designs, modern bioenergy is much more likely to be sustainable in the long-term compared to traditional uses, due to savings in land, water, and other resources as a result of higher efficiency and greater precision in matching the mode of implementation to the differing needs of energy users in particular applications

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