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ENVIRONMENTAL POLICY FOR BIOMASS ENERGY PRODUCTION TOWARDS CLIMATE CHANGE MITIGATION IN INDIA

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ABSTRACT

The UN Conference on Human Environment in 1972 marked a significant milestone that changed the course of environment policy forever. High energy demands versus climate change mitigation under environmental policy are two sides of the same coin. Biomass contributes over a third of primary energy in India. Biomass may be used in a number of ways to produce energy and the most common methods are: combustion, gasification, fermentation and anaerobic digestion. Biomass fuels are predominantly used in rural households for cooking and water heating, as well as by traditional and artisan industries. As an energy source, biomass can either be used directly, or converted into other energy products such as biofuel. Biomass can be converted to other usable forms of energy like methane gas or transportation fuels like ethanol and biodiesel. Biomass policies for improving efficiency of the traditional biomass use, improving the supply of biomass and technologies for improving the quality of biomass use must be visualized from the point of sustainable development. The source of policy developments in environment decisively shifted from an elected political executive to an unelected judiciary. International debates on climate change in recent years and commitments to abatement measures appeared only at the fringes of policy discussions.

INTRODUCTION

The Government of India embraced the declaratory principles of the UN Conference whole-heartedly and refashioned environmental policy through a flurry of legislative and administrative activity. The Wildlife (Protection) Act passed by Parliament in September, 19722, was the first in a series of such legislations. The Act was notable in that Parliament exercised its over-riding powers under the Constitution to legislate on a subject assigned to the States. Later other many Acts for protection of environment were made and implemented. Along with development, high demand of energy was major concern before the nation. The scope of environmental friendly and renewable source of energy is certainly need for every nation. Biomass delivers most energy for the domestic use (rural - 90% and urban - 40%) in India [1].

Wood fuels contribute 56 percent of total biomass energy [2]. Consumption of wood has grown annually at 2 percent rate over past two decades [3-6]. Estimates of biomass consumption remain highly variable [7-8] since most biomass is not transacted on the market. Supply-side estimates [7] of biomass energy are reported as: fuel wood 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 [9] estimates demand in India for fuel wood 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 program has added to fuel-wood supply to the tune of 40 million tons annually [7]. Until the middle of 19th century, biomass dominated the global energy supply with a seventy percent share [10].

Among the biomass energy sources, wood fuels are the most prominent. With rapid increase in fossil fuel use, the share of biomass in total energy declined steadily through substitution by coal in the nineteenth century and later by refined oil and gas during the twentieth century. 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. Presently, the biomass sources contribute 14% of global energy and 38% of energy in developing countries [11].

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 liters of oil annually [12]. 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 program 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. A rice husk based co-generation plant of 10.5 MW capacity installed by a private rice processing firm in Punjab and commissioned in 1991 faced problems such as unavailability of critical spares of an imported turbine and uneconomical tariffs from the state utility despite power shortage in the state [7].

Biomass yield of up to 36.8 tons per hectare per year is reported [13] from some promising fuel-wood species. Since the knowledge of these package of practices has remained limited within the research circles, their benefits remains to be realized. The mean productivity of farm forestry nationally is very low at 4.2 tons per hectare per year [7]. The estimates of degraded land vary from 66 million hectares [14] to 130 million hectares [15]. Pollutants cause considerable damage to health, especially of women and children who are exposed to indoor pollution for long duration [16-18]. The modern technologies offer possibilities to convert biomass into synthetic gaseous or liquid fuels (like ethanol and methanol) and electricity [19-20].

CONSTRAINS IN BIOMASS ENRGY

Direct combustion of any carbon based fuel leads to air pollution similar to that from fossil fuels. There is direct competition with land use for food production and water use. In present situation it is not feasible for bio-fuels to replace the demand for petroleum and coal; coal alone meets more than 60 % energy requirement of the nation presently. 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. The twin problems of traditional biomass use are the energy inefficiency and excessive pollution. An additional problem with the traditional biomass use is the social costs associated with excessive pollution.

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.

POLICIES FOR BIOMASS ENERGY

The national biomass policy originated later, in the decade of 1970's, as a component of rural and renewable energy policies as a response to rural energy crisis and oil imports. India has a long history of energy planning and program interventions. Programs for promoting biogas and improved cook-stoves began as early as in 1940's. Afforestation and rural electrification programs are pursued since 1950's. A decade before the oil crisis of 1973, India appointed the Energy Survey Committee. Rural energy crisis in the mid-1970s arose from four factors - i) increased oil price, ii) rising rural household energy demand (following the population growth), iii) trading of wood in rural areas and urban peripheries to meet demand of growing industries like brick making and services like highway restaurants in the wake of sustained shortages of commercial energy, and iv) over exploitation of common property biomass resources. The crisis called for a national policy response to find economically viable and sustainable energy resources to meet growing rural energy needs. A short term response resorted to was of importing kerosene and LPG to meet cooking needs and diesel for irrigation pumping. India's oil imports rose rapidly during 1970's with kerosene and diesel contributing most to the rising oil imports bill.

Biomass, being a local, widely accessible and renewable resource, was potentially the most suitable to alleviate macro and micro concerns raised by the rural energy crisis. Biomass policies followed a multi-pronged strategy: i) improving efficiency of the traditional biomass use (e.g. improved cook-stove program), ii) improving the supply of biomass (e.g. social forestry, wasteland development), iii) technologies for improving the quality of biomass use (e.g. biogas, improved cook-stoves), iv) introduction of biomass based technologies (wood gasifiers for irrigation, biomass electricity generation) to deliver services provided by conventional energy sources, and v) establishing institutional support for program formulation and implementation.

PAST EXPERIENCE IN R & D

The experience with R&D and pilot project suggests the need for considerable technological and institutional improvements to make biomass energy competitive. Four gasifier Action Research Centers (ARCs) located within different national institutions and supported by the MNES have developed twelve gasifier models, ranging from 3.5 to 100 KW. Two co-generation projects (3 MW surplus power capacities) in sugar mills and one rice paddy straw based power project (10 MW) were commissioned. While the co-generation projects are successfully operated, the 10 MW rice straw based power project completed in 1992 ran into technological problems and is closed since last two years due to want of suitable raw material. The rapid escalation in the price of rice husk and low capacity utilization added to the cost making the operation uneconomical.

The focus of modern biomass program is on the cogeneration, especially in sugar industry. The future of modern biomass power program rests on its competitive ability vis-à-vis other centralized electricity generation technologies. Policies for realizing biomass electric power potential through modern technologies under competitive dynamics have a recent origin in India. The biomass electricity program took shape after MNES appointed the task force in 1993 and recommended the thrust on bagasse based co-generation.

Program for biomass combustion based power has even more recent origin. It began in late 1994 as a Pilot Program launched with approval of two 5 MW projects. Interest subsidy programs on the lines of that for the bagasse based co-generation was extended in 1995. The program also initiated a grid connected biomass gasification R&D-cum-Demonstration project of 500 Kilo Watt (KW) capacity. A decentralized electricity generation program initiated in 1995 provided support for total of 10 to 15 MW of small decentralized projects aimed at energy self sufficiency in electricity deficient rural locales. The program aims to utilize some of the 350 million tons of agricultural and agro-industrial residues produced annually in India. The cost of electricity generation from these plants is anticipated to be quite competitive at Rs. 1.8 per KWh.

BIOMASS ENERGY TECHNOLOGIES

Supply of biomass at a competitive cost can be ensured only with a highly efficient biomass production system. Productivity of crops and trees depend critically on agro-climatic factors. With improved biomass productivity and efficient energy conversion, it is feasible to sustain a significant share of biomass in total energy use in India by utilizing a fraction of this degraded land for biomass plantation. Modern biomass supply has to be driven by the dynamics of energy market.

To enhance biomass productivity, the MNES is supporting nine Biomass Research Centers (BRCs) in nine (of the fourteen) different agro-climatic zones in India with an aim to develop packages of practices of fast growing, high yielding and short rotation (5-6 years) fuel-wood tree species for the degraded waste lands in these zones. Some centers have existed for over a decade. Packages of practices for 36 promising species are prepared. Exploitation of bio-energy potential is vitally linked to the adequate land supply. While the use of cultivable crop land for fuel remains controversial under the "food versus fuel" debate, there exists a vast supply of degraded land which is available cheaply for fuel-wood plantations.

BIOMASS ENERGY SCOPE IN INDIA

The source of policy developments in environment decisively shifted from an elected political executive to an unelected judiciary. The establishment of a specialized judicial body, the National Green Tribunal, has brought the reach of judicial determination of environmental policy closer. International debates on climate change in recent years and commitments to abatement measures appeared only at the fringes of policy discussions. Biomass use is growing globally. Despite advancements in biomass energy technologies, most bio-energy consumption in India still remains confined to traditional uses. 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.

Modernization in biomass energy use in Asia has 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. These developments have opened new avenues for biomass energy in several Asian nations, besides India.

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.

CONCLUSION

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. 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. 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. Associated with conventional electric power plants are some negative social and environmental externalities.

Biomass energy offers positive environmental and social benefits. Biomass plantation is often a best way to reclaim degraded lands and to generate sizable employment. Fossil fuel plant operations pose local, regional as well as global hazards. Biomass combustion also emits pollutants; however aggregate damage during the fuel cycle is much less compared to fossil or nuclear fuel cycle. Biomass offers most promising future carbon mitigation options. Policy support for a transition towards a biomass based civilization in India should consider (a) Short-term Policies (1 to 5 years) for enhanced utilization of crop residues and wood waste, information dissemination, niche applications (e.g. remote and biomass rich locations), technology transfer (e.g. high pressure boiler), co-ordination among institutions, demonstration projects, participation of private sector, community and NGOs, waste land development, and subsidy to biomass technologies to balance the implicit subsidies to fossil fuels. Medium Term (5 to 20 years) provisions includes R&D of conversion technologies, species research to Match agro-climatic conditions, biomass Plantation, scale economy based technologies, Local Institutional Developments, and removal of distortions in fossil energy tariffs. Long term (over 20 years) strategies include infrastructure (logistics, T&D), multiple biomass energy products (e.g. gas, liquid, and electricity), institutions and policies for competitive biomass energy service market, and land supply for biomass generation.

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