ENVIRONMENTAL EFFECTS OF ENERGY FROM BIOMASS AND MUNICIPAL WASTES

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Contents

Summary

The environmental effects of traditional and modern technologies of using biomass and municipal wastes for energy are presented in this chapter.

- The traditional biomass use as energy is leading to forest degradation, deforestation, decline in biodiversity, soil degradation, indoor air pollution and GHG emission.
- The environmental effects of traditional modes of disposal of municipal wastes in rivers, ponds, ocean and on land are; anaerobic decomposition of solid wastes in land fills and open dumps leading to methane (a greenhouse gas) emission, leaching leads to pollution of water bodies, incineration of waste leads to emission of dust, metals, organic compounds, acids, dioxins and other pollutants.
- Biomass production for energy in degraded lands, with appropriate guidelines, could lead to land reclamation, watershed protection, promotion of biodiversity and carbon sequestration.
- Biomass conversion technologies, such as biogas production, liquid fuels (ethanol and methanol), and gasification for electricity could lead to reduction in air pollution, greenhouse gas emission reduction, reduction in land degradation and land reclamation.
- Incineration of municipal wastes under controlled conditions could be used to produce heat and power. Similarly the biomethanation process could be used to generate methane as gas from municipal wastes for cooking or for power generation. The environmental effects include reduction in air pollution, greenhouse gas emission reduction and waste disposal.

Energy generated from biomass and municipal waste is renewable in nature. The environmental effects of the use of biomass and municipal wastes for energy through modern technologies are, reduction in air and water pollution, land reclamation, and greenhouse gas emission reduction.

1. Introduction

Global environmental problems such as deforestation and climate change caused by non-sustainable extraction of wood from forests and fossil fuel combustion, has led to the realization of the need to explore efficient and alternative environmentally sound energy options. Local environmental problems such as air, water, soil pollution, and land degradation have also contributed to the need for assessing environmentally sound energy options. In this chapter, the environmental effects of energy from biomass and municipal waste are discussed. Firstly, the environmental effects of current patterns of biomass use for energy and municipal waste management are presented. This is followed by a discussion on some of the environmentally sound technological alternatives for energy from biomass and municipal waste and their environmental effects.

Biomass contributes to about 15% (930 MtOE) of the global energy supply, contributing a higher amount than that of coal (816 MtOE) (IEA 1998). In the majority of the developing countries, biomass is the dominant source of energy particularly in the rural sector, with adverse environmental and social implications. Biomass use for energy is largely for domestic activities (such as cooking), where it is less efficiently used. Human activities similarly generate enormous wastes (domestic and industrial solid waste and to an extent sludge), which are dumped in open land or in land excavated for minerals and other resources. The biodegradable fraction of municipal wastes offers a potential source of energy. The extraction, conversion, and utilization of various forms of these energy sources based on biomass and municipal wastes have however, environmental implications—both positive and negative—depending upon the nature of the energy source and the extent of its use and the type of technology implemented for conversion. Biomass as well as municipal waste management technologies provides the opportunity for mitigating local and environmental problems (see *Environmental Impacts of Current Use of Biomass and Municipal Wastes*.)

2. Environmental Impacts of Current Uses of Biomass and Municipal Wastes

2.1. Traditional Biomass Use as Energy

The current extraction and consumption pattern of biomass has led to forest degradation and deforestation, loss of biodiversity, soil degradation, atmospheric pollution from emissions of greenhouse gases (GHG) during the combustion of wood (with its implications for climate change), and indoor air pollution leading to domestic health hazards (particularly for women during cooking); and loss of nutrients due to combustion of cattle dung and crop residues.

2.2. Deforestation and Land Degradation

Biomass comprising traditional fuels constitutes about 50% of energy consumption in developing countries. In the case of some countries like Bangladesh, Ethiopia, Burkina Faso, Malawi, Tanzania, and Uganda (Kaale, 1990), it is estimated to be as high as 90%. Deforestation leading to soil erosion, risks of floods, desertification on account of clearing of forests and woodlands for agriculture and livestock, and so on, are the common concerns of environmentalists at macro levels. At a microlevel, the concerns range from non-suitability of forest soils for agricultural purposes, health problems due to smoke caused by burning of fuelwood, loss in soil fertility due to use of agricultural residues and so on. Even a shift towards non-wood biomass fuels creates direct competition with animals that rely upon crop residue and the shrubs for fodder (Kaale, 1990).

The global fuelwood consumption is estimated to be about 1.3 X 10^9 m^3 (during 1990) and is further projected to treble by 2020 (FAO, 1993). The main sources of fuelwood are forests, village trees, and forest residues. Fuelwood is largely used as domestic fuel in developing countries and in some countries (such as Brazil) it is used as a source of heat in industries (steel industry). There are divergent views on the contribution of fuelwood extraction to deforestation ranging from a marginal (such as in India) to a significant factor (for charcoal production in Africa for domestic use and as industrial fuel in Brazil). Studies (Ravindranath and Hall, 1995) have concluded that fuelwood extraction contributes at varying degrees to loss of trees (in villages and forests), forest degradation and ultimately to deforestation.

Imbalance between the demand and production of fuelwood is reported to be one of the primary factors responsible for forest depletion (Ravindranath and Hall, 1995). The increasing use of fuelwood for meeting the domestic and industrial needs of both rural and urban areas has contributed to forest decline.

The environmental impacts of urban fuelwood consumption have been severe due to commercial exploitation of fuelwood for charcoal production. The demand for charcoal in urban areas has spread deforestation, which begins at the surrounding areas of urban centres and moving outwards.

2.2.1. Loss of Soil Nutrients

Agricultural residues constitute an important source of energy in rural areas of developing countries when left on fields improves the fertility of the soil. The use of agricultural residues for energy would thus be an issue if it reduces the fertility of the soil. It is important to note that all residues do not have the same effect on the soil. Some residues such as corncobs, rice husk, jute sticks, cotton stock, coffee prunings, and coconut shells do not decompose easily and have potential as energy sources. The choice of agricultural residues thus has an impact on the environment. Cattle dung, similarly, though it is a fertilizer, loses its value as fertilizer if burnt or left under the sun for a few days. Fuel shortages, if experienced, generally force the use of all available energy sources irrespective of their environmental values and thus cause environmental damages.

The two categories of residues from agriculture sector are crop residue and cattle dung. The large-scale use of agriculture residue as fuel is peculiar to South Asia, probably due to high population density and lower area under forests. Currently crop residue of cereals is largely used as fodder and ligneous (woody) residues are used as fuel. Burning of woody crop residue may not lead to any significant loss of nutrients to soil. Burning of cattle dung as fuel leads to loss of organic mater and other nutrients affecting crop production. In India the loss of Nitrogen due to use of dung as fuel is estimated to be about 3kg/ha/year (Ravindranath and Hall 1995). Thus the environmental impact of loss of nutrient value due to burning of crop residue and dung is marginal.

2.2.2. GHG Emissions

Combustion of fuelwood and other biomass fuels leads to CO_2 emissions, as nearly 50% of wood is carbon. If fuelwood is coming from sustainable modes of extraction, its combustion will lead to no net C emission. However, it is difficult to estimate what percentage of fuelwood use is from non-sustainable source. At a global level, about 2.8% of CO_2 emission is attributed to fuelwood combustion (Ahuja, 1990). In addition to CO_2 emissions, combustion of fuelwood and agro-residues leads to emission of products of incomplete combustion. These products are even more powerful GHGs per gram in carbon emitted than CO_2 (IPCC 1992). An estimate of the global warming potential of non CO_2 GHGs, such as CO, CH_4 and non methane hydro-carbons, could be in the range of 20-110% as much as that of CO_2 itself, depending on the timeframe (Smith, 1991).

2.2.3. Health Hazards

Smoke from use of biomass fuels in rural kitchens, wood fires, and the associated pollution are a common phenomena in most developing countries. Cooking in smoke filled kitchen is inconvenient and leads to drudgery among women. According to the World Health Organization (WHO), smoke from low quality biofuels such as farm residues and animal wastes can cause acute bronchitis and pneumonia among infants and women.

2.3. Environmental Effects of Municipal Wastes

A large quantity of wastes—both solid and liquid—are generated by urban, municipal, and industrial sectors. These wastes are generally disposed in rivers, ponds, land, and so on, causing environmental impacts. The two major categories of wastes are the commercial and industrial wastes and the municipal solid wastes from the domestic sector.

Commercial and industrial wastes generally undergo processes in the waste treatment plants before they are disposed; while the municipal solid wastes constitutes of various kinds varying from plastics to organics wastes, thus making its management a complex issue.

Waste disposal is becoming an environmental issue. Reduced land availability and methane emissions from solid waste disposal sites are major problems being faced in waste disposal. The practice of waste disposal to landfill sites has been generally favored because of cost advantage. However, there is a realization of the possible environmental impacts and concerns on ground water, air quality, disease transmission, operational safety, and so on.

The approaches currently practiced to tackle the waste disposal problem are: (a) recycling; (b) composting; (c) incineration; and (d) waste reduction. Recycling and waste reduction addresses the need to reduce the quantum of wastes whereas composting and incineration are the processes used for reducing emissions and meeting energy requirements.

The digested slurry from municipal and wastewater is believed to contain harmful elements. For example, an increase in heavy metal content was found in soils where sewage sludge had been applied, in grass grown on such soils, and in the tissues of animals feeding on that grass (Ellegars, 1990) and would thus require appropriate treatment plants, sewage networks and monitoring of the composition of the sludge.

The environmental impacts of current methods of processing and disposal of municipal solid wastes are as follows.

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Biographical Sketches

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