

RESOURCES, OPPORTUNITIES AND IMPACTS FOR BIOENERGY DEVELOPMENT

**COMPETE Conference and Policy Debate on Biofuels
Sustainability Schemes, 16th to 18th June 2008
Arusha, Tanzania**

Faith Odongo
Senior Renewable Energy Officer, Ministry of Energy, Kenya

Presentation Outline

- **Bioenergy Resources**
 - **Forests and woodfuel plantations**
 - **Biogas generation from animal manure and plants (anaerobic digestion)**
 - **Municipal waste (electricity and biogas generation)**
 - **By products of Agriculture (Crop residues)**
 - **Plant based liquid fuels**
- **Biomass energy processes**
- **Advantages & difficulties of using biomass as a source of energy**

Presentation Outline

■ Opportunities

- Woodfuel development
- Liquid biofuels
- Crop residues
- Biogas generation
- Biomass for other purpose other than direct combustion
- Addressing environmental concerns

■ Impacts

- Dependency on woodfuel as an energy source
- Large scale production of energy crops
- Air quality
- Water quality
- Waste disposal problems
- Safety
- Relevance of crop residue in land use
- Removal of crop residues from land

Bioenergy Resources (1)

Comprise plant species and animal wastes

■ Forests and woodfuel plantations

- Woodfuel –major form of energy for many developing countries (domestic, institutional, small scale industrial establishments, tea industry etc)
- Wood fuel accounts for up to 68% of National Energy Consumption in Kenya
- Sustainability issues (demand supply imbalances)
- Legal issues surrounding charcoal production

■ Biogas generation from animal manure and plants (anaerobic digestion)

- Confined animals dung (cattle, sheep, pigs, camels, goats etc)
- Waste from abattoirs
- Plant material such as hyacinth

Bioenergy Resources (2)

Municipal waste (electricity and biogas generation)

- Solid waste (paper, yard wastes, food wastes)
- Liquid waste (sewage)

By products of Agriculture (Crop residues)

- Cotton wastes
- Rice husks
- Coffee husks
- Sugarcane bagasse (co-generation)
- Maize stalks

Bioenergy Resources (3)

Plant based liquid fuels

- Biodiesel from Jatropha, Yellow oleander and croton
- Bioethanol from for Sugarcane, sweet sorghum
- Water plants such as algae

2nd Generation biofuels : Cellulosic feedstock (wood, crop residues and grasses, paper – from municipal waste) the technology is yet to reach acceptable levels of economic viability

Biomass energy processes

- Direct combustion
- Pyrolysis (Destructive distillation)
- Anaerobic digestion
- Alcoholic fermentation
- Gasification
- Carbonization (Conversion into charcoal)
- Oil extraction and trans-esterification

Advantages of using biomass as a source of energy

- Low sulphur levels
- Inexpensive source of energy (wood, dry animal manure methane etc)
- Reduces environmental hazards (sewage and processing wastes)

Difficulties

- Low concentration of biomass per unit area of land and water
- Scarcity of land for food crops and energy
- High moisture content that make transportation expensive and energy conversion inefficient

Opportunities(1)

Woodfuel development

- Tree planting and management on privately owned lands (Sustainable woodfuel production)
- Promotion of improved wood stoves for households and institutions (Most of the developing countries still use wood burning stoves)
- Improvement of existing improved stoves to levels that achieve complete combustion and minimize emissions
- Development of sound reforestation programmes
- Testing of new and existing stove designs for their emission characteristics
- Testing of wood burning boilers for efficiency and emission characteristics
- Enterprise development, job creation & income generation

Opportunities(2)

Woodfuel development Contd'

- Dissemination of efficient charcoal kilns for conversion of wood to charcoal
- Development of efficient fireplaces for centralized heating in homes
- Fuelwood for direct combustion of solid biomass for space heating, process steam and electricity generation
- Use of fuelwood fired boilers in tea industries as opposed to oil fired boilers

Opportunities(3)

Liquid biofuels Development

- Energy farming: use of underutilized land, particularly dryland for bioenergy production (Liquid fuel production Biodiesel and bioethanol)- Large and small scale
- Genetic improvement of existing varieties for crops that are found promising
- Development and dissemination of oil extraction and refining methods
- Development and dissemination of equipment and appliances that can utilize these fuels
- Promotion of plants that produce bioethanol and biodiesel
- Rural Enterprise development
- Development of engines that can use biofuels
- Testing of available prototype appliance, development and dissemination

Opportunities(4)

Biogas generation

- Use of animal waste to generate energy (Particularly confined livestock)
- Improvement of crop productivity arising from the use of digested slurry from biodigester processes (soil conditioning)
- Use of the slurry in aquatic plant systems
- Use of effluent as animal feed
- Use of the sanitation process of digesting liquid municipal waste makes It an opportunity for purifying liquid waste before discharge into water bodies

Opportunities(5)

Biogas Generation Contd'

- Development of anaerobic digestion technologies for energy generation and waste management
- Developing the micro biology aspects of biogas production (bacteria involved, optimum conditions, nutrient requirements etc.
- Demonstration of different digester types to optimize safety and reliability,
- Design development and dissemination of low cost digesters
- Development of engine designs that use biogas technology
- Research and development of digested and undigested material from different feed stocks
- Determination of value as fertiliser

Opportunities(6)

Biomass for other purposes other than direct combustion

- Direct combustion of biomass for electricity production
- Conversion of solid biomass into gaseous and liquid fuels for purposes other than direct combustion
- Development and promotion of gasification technology for boiler use or space heating
- Research and development of gasifiers to improve reliability, efficiency and flexibility
- Development of combustion controls that allow efficiency and minimize pollutant emission
- Development of technologies for converting cellulose into alcohol (hydrolysis)
- Use of appropriate techniques of minimizing particulate emissions
- Formulation of performance standards for industrial combustion facilities for ethanol production to address particulate matter levels in the emissions

Opportunities(7)

Crop residues

- Use of crop residues for energy
- Promotion of Biomass densification technologies such as pelletization, and briquetting
- Pelletization has an energy efficiency of about 90%
- Development of improved stoves for crop residues

Cross cutting :

- Capacity building, Research and development, technology development and promotion extension and awareness creation, networking, development of standards, local and foreign investment

Impacts(1)

Dependency on woodfuel as an energy source

- Land degradation arising from charcoal harvesting
- Haphazard wood harvest causes severe environmental damage reduced supply of woodfuel
- Pertinent need to improve the efficiency of wood burning stoves to minimize the concentration of pollutants environmental concerns
- Assessment of health effects of emissions from wood stoves and biomass conversion technologies

Impacts(2)

Large scale production of energy crops

- Competition with other land uses such as food production
- Reduction of natural plant and animal species diversity due to monoculture – less stable ecosystem
- Invasiveness of certain plant species
- Deterioration of soil quality due to continuous use of pesticides and fertilisers
- Increase in the prices of food products

Impacts(3)

Air quality Contd'

- Air pollution from the combustion of woodfuel (Low combustion efficiency and therefore high emissions of Carbon monoxide, particulate matter especially during the cold seasons (high concentration of wood stoves);
- Polycyclic Organic Matter (POM) emissions such as Benzo(a)pyrene which are known carcinogens are the most dangerous components
- CO emission from the equipment used for harvesting, chipping and transport equipment

Impacts(4)

Air quality contd

- Use of wood instead of coal significantly reduces SO₂ emissions from coal fired plants
- Corrosive effect of sulphurous and sulphuric acid from the reaction of H₂S with water.
- Air pollution: fugitive dust from raw material and product handling; organic vapours from the distillation process; volatile organic compounds; odours from fermentation tanks

Impacts(5)

- Safety: Explosiveness of the gas in confined environments (leaks)
- Odour from H₂S in biogas
- Decentralised ethanol production may not be favourable for monitoring environmental conditions and enforcement of environmental standards

Impacts(6)

Water quality

- Impacts on water sources by the leaching of biomass storage pile
- Energy requirements, wastes from the distillation process and hazards associated with the use of toxic chemicals
- Damage of aquatic ecosystems arising from stillage (High biological and chemical oxygen demand)
- Reduction of feedlot pollution arising from run off from cattle feed lots (bacteria, suspended and dissolved solids, chemical and biological oxygen demand) especially for aquatic systems

Impacts (7)

Waste disposal problems

- Effluent from biogas systems contains high concentrations of inorganic salts, H_2S and NH_3 or even heavy metals.
- Elimination of drawbacks of animal manure (disposal problems)

Impacts(8)

Removal of crop residues from land

- Increased erosion and flow of sediments into surface waters
- Decrease in productivity
- Increased flood potential

Conclusion
