Workshop on
“Biomass Technology for Sustainable Energy in Western Africa”

Rural Energy Service Needs and the Role of Bio-Energy in Africa

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ENERGY COMMISSION

OUTLINE

- What are rural energy needs?
- How can bio-energy meet these needs?
- What are the socio-economic challenges of Bio-energy technology deployment
- Some lessons from other countries
- Policy related issues

Rural Energy Needs

- Households/commercial/Service
  - Food processing - Cooking, Baking, smoking, etc
  - Lighting, refrigeration, ICT – TV, radio, phone etc
  - Water supply
- Agriculture
  - Ploughing, tilling, irrigation, thrashing etc
- Transport
  - Human & Goods

Rural Industry

- Agric products processing: Grinding, milling,
- Palm, shea-butter, coconut oil extraction, soap making, Pito brewing, Akpeteshi distillation etc
- Storage: Refrigeration, drying
- Wood processing: Saw milling, carpentry etc,
- Others: weaving, sewing, tanning, etc

Current Energy Options

- Man-power
  - Water supply, grinding
  - Ploughing, tilling, trashing, transport
  - Carpentry, sewing, weaving
- Fossil Fuel
  - Shaft power: Milling, transport
  - Lighting
- Bio-energy
  - Direct combustion: Food processing, oil extraction process, brewing and distillation.

BioEnergy - Woodfuel

- Single most important energy resource in Ghana. 67%
- Obtainable anytime anywhere even at the remotest part of the country
- Has been a sustainable cheaper option for providing heat energy for household, commercial, service and rural industry.

Bio-energy

- Key energy resources of the future.
- Wide range of sources including natural forests, short-rotation plantations, energy crops, wood processing, agricultural residues and Municipal and industrial organic waste.
- Can be converted to liquid or gaseous fuel as a sustainable substitute to petroleum fuels.
  - Liquid - (alcohol or vegetable oil) replace gasoline, diesel and kerosene
  - Gaseous fuels (biogas or producer gas) to replace or LPG and natural gas.

Modern bio-energy

- Modern bio-energy can fuel internal combustion engines for shaft power and electricity generation
- Potential to create job and cash for the poor majority.
- Production cost could be low and not influence by the World market to control its price

Modern Bio-energy Technologies

- Biogas
- Gasification
- Liquid Bio-fuels

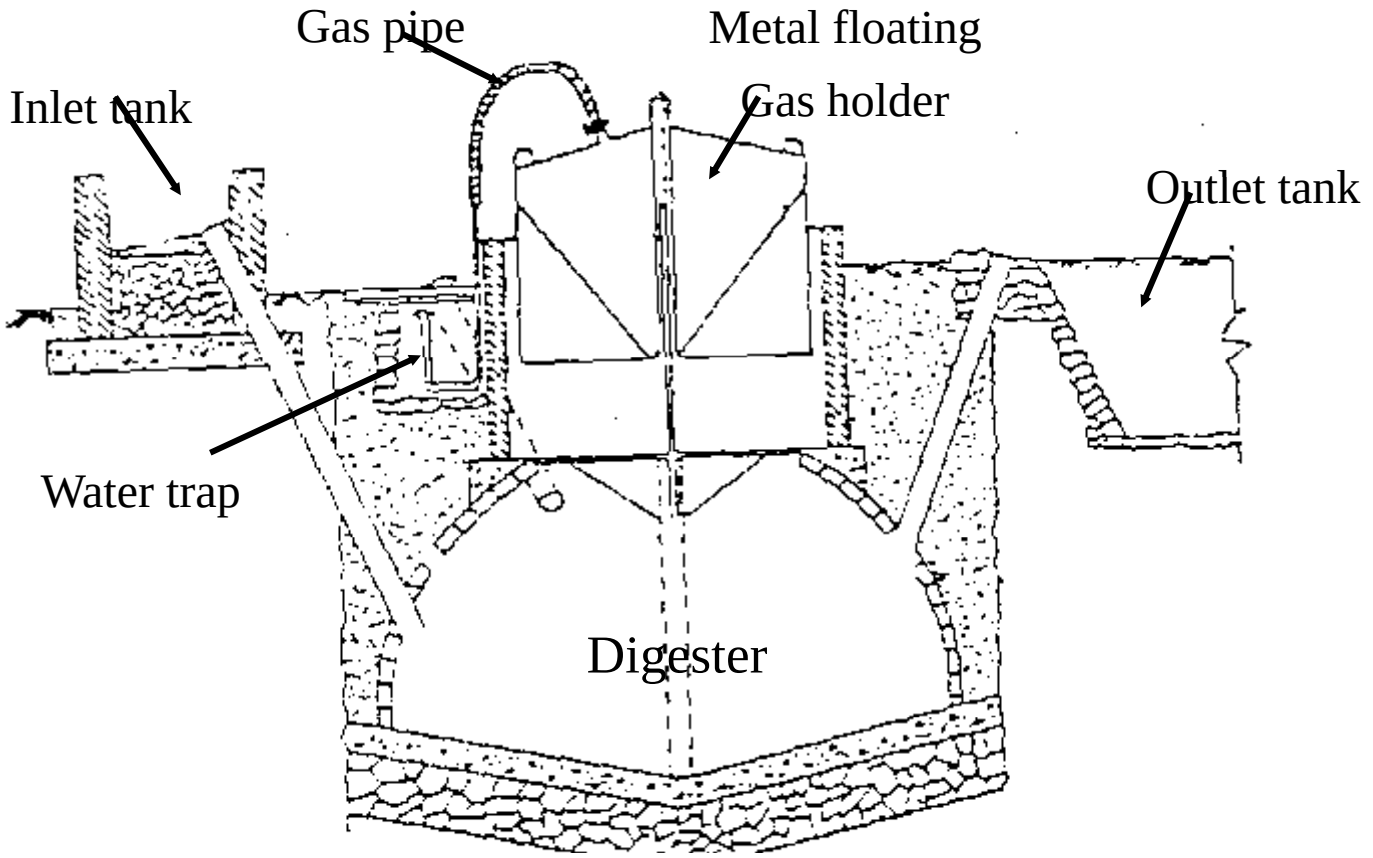
Biogas Technology - What is it?

- Biogas - gas produced from anaerobic digestion of organic matter (agric, industrial and animal waste).
- Gas is inflammable, CH_4 and CO_2, is used
  - directly for cooking or lighting;
  - to fuel engines for motive power or electricity generation

BIOGAS

- Technology is valuable for organic waste treatment (excreta of pig, cattle, chicken, human) or industrial organic waste.
- Effluent or by product
  - Rich organic manure with higher nitrogen content for farming.

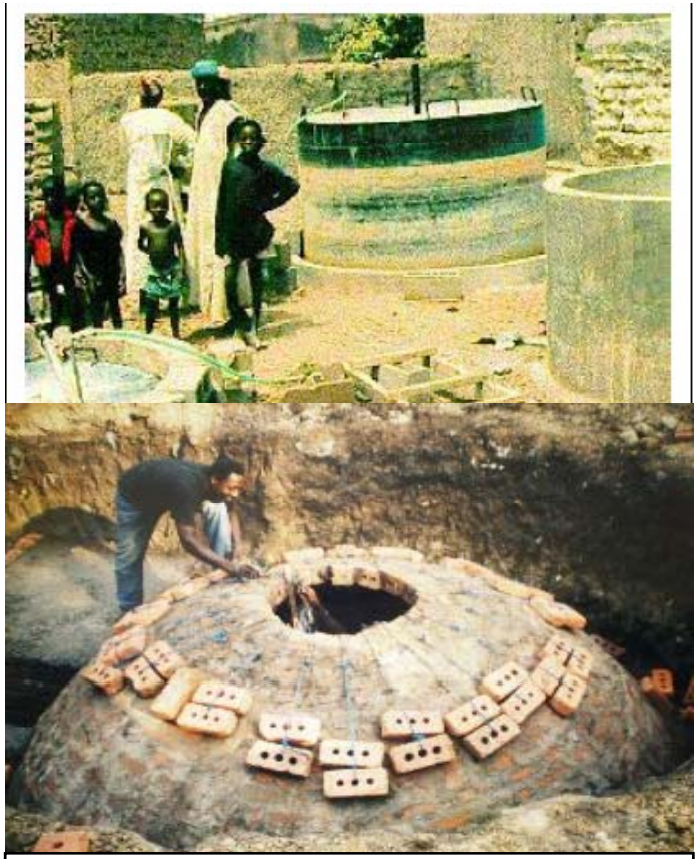
TYPES A BIOGAS PLANT



Floating Drum Plant

Household / farm Biogas Digesters

- Construction materials locally available.
  - Cements, bricks, blocks etc. Floating drum,
- Human capacity for construction exist locally
  - Masons, Carpenters, Metal workers
- Potential to create jobs and employments



Above: Floating drum Biogas plant, Burkina Faso
Below: Fixed Dome Plant under construction in Ghana. Photo: GTZ/REES

Construction of a biogas plant

BIOGAS RESOURCES

- Animal waste – Cowdung, Pigdung etc
- Human excreta
- Industrial organic waste – Brewery, fish/meat processing, food processing, plant oil etc.
- Agricultural – cereals, vegetables, grass etc,

Types of Feedstock, water content

Animal	Dung/day (kg)	Moisture content (%)	C/N ratio	Gas yield per kg (lit)	Gas yield / animal/day (lit)
Cattle	10	78-84	25-30	36	360
Pig (50)	2.5	72-77	14-18	78	175.5
Chicken (2kg)	0.18	52-55	8-10	62	11.16
Human (Adult)	0.4	80-85	8-10	70	28
Straw		20-60	81-140	5-20	

- Regular supply of water is essential for operation of biogas plants. Water/dung ratio (1-2:1)

Gas Consumption for Basic Appliances

Item	Gas Requirement
Biogas requirement for cooking	250-300 litres/head/day
Consumption of standard biogas stoves	425 litres/hr
Consumption of Standard biogas lamp	150 litres/hr
Dual fuel (diesel & biogas) engine	425 litres/hr/hp

Biogas Energy Needs for typical Rural household

- Household of six (6) will require about 1.5-2.0 cum biogas/day (6-10cum digester):
  - 2 buckets cowdung (40-50kg)
  - 2 buckets water (40-50kg)
  - Removal of about 4 buckets slurry (80-100kg) for disposal or as manure
  - Digester investment cost about $1,500-$2,600

Social issues

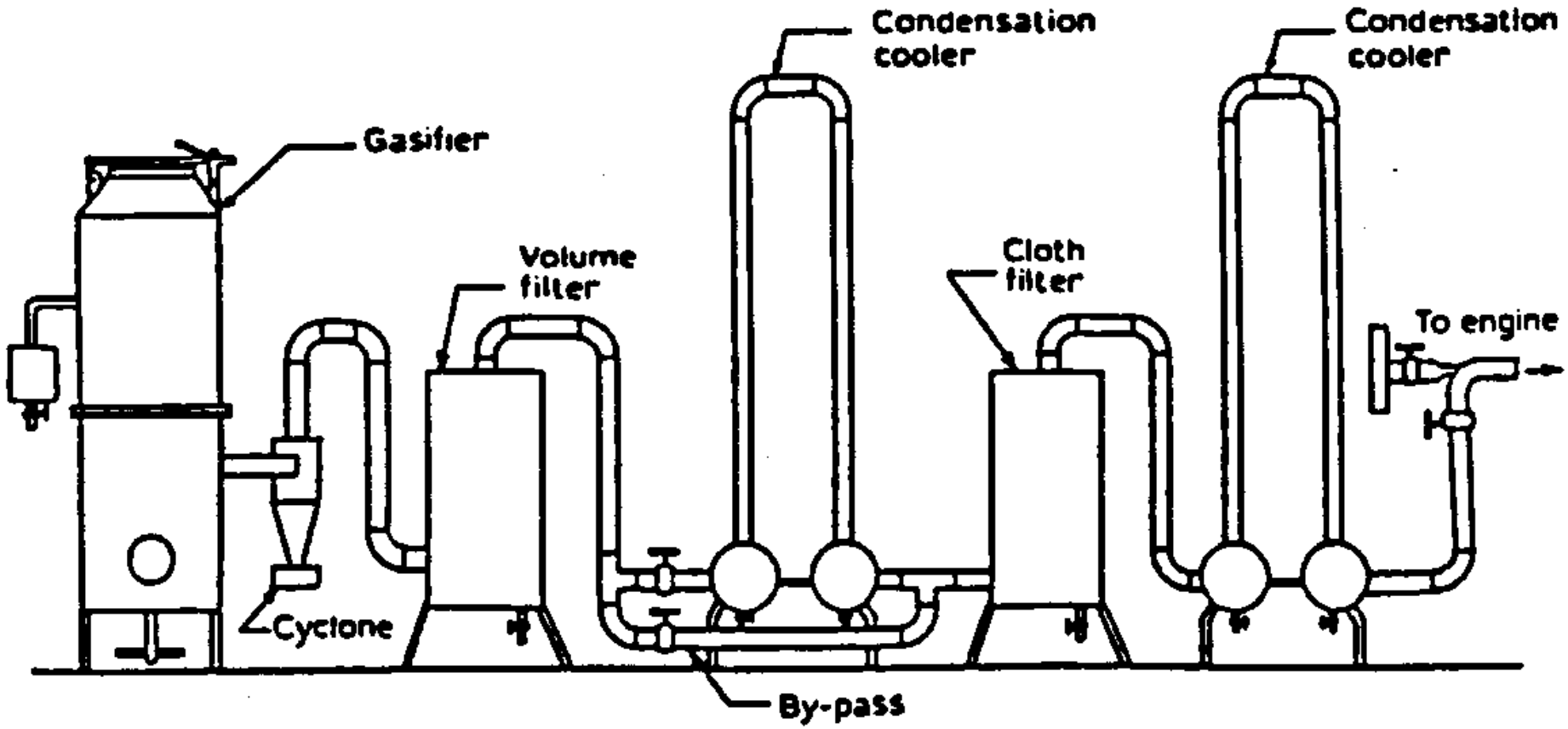
- Women responsible for water & fuel collection
- Biogas usage - potential to increase daily workload of women to fetch dung & water.
  - Kraals location - ½ km away due to flies.
  - Women discriminated from entering kraal to fetch dung when cattle is pregnant
- Biogas for cooking is of little interest where fuelwood is available.
- Where fuelwood is scares, and there is dung (Bawku East), water is a major problem

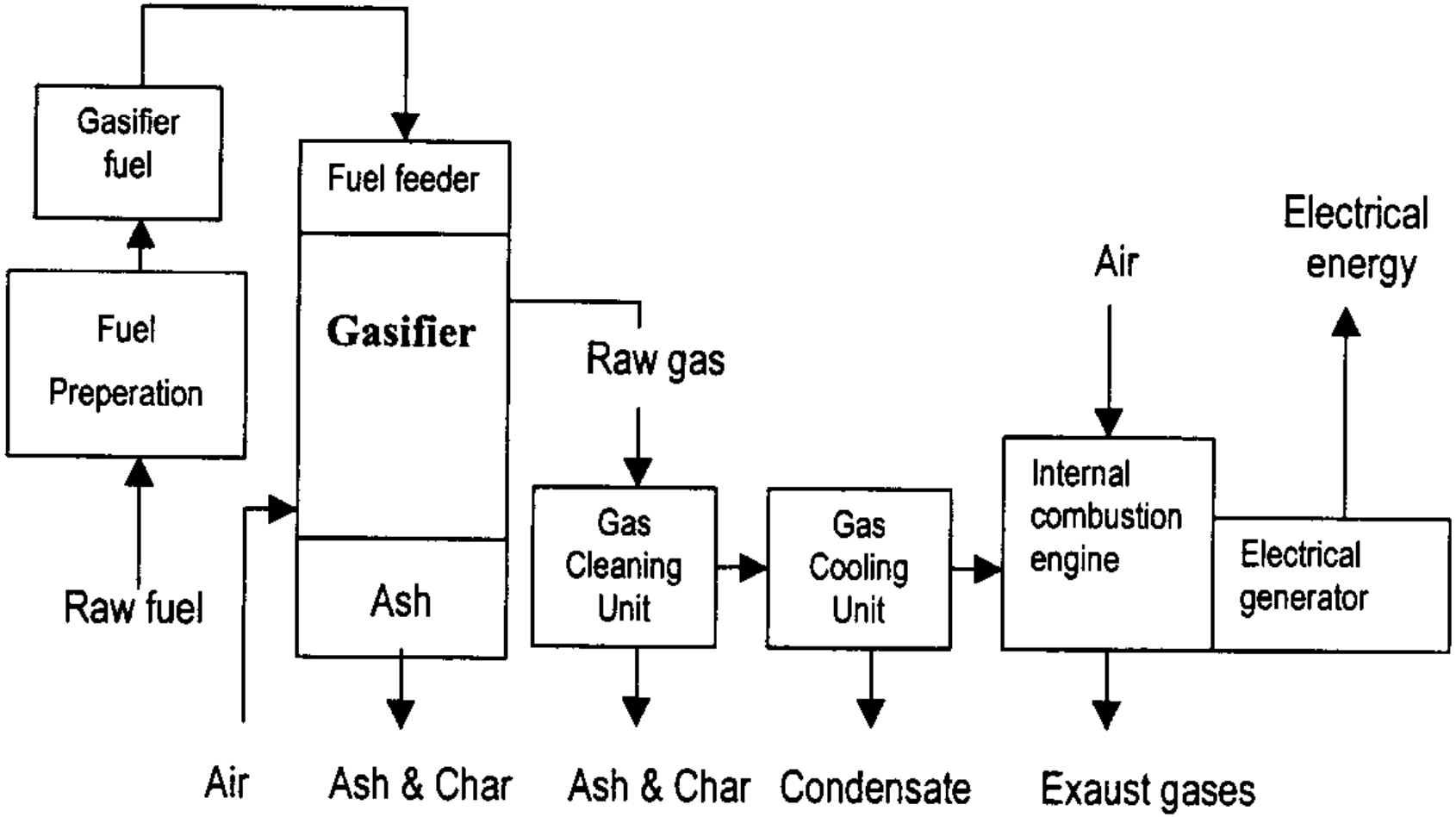
Successful Biogas Plants

- No cost is involved in the supply of biogas feedstock
  - Dairy farm with zero grazing
  - Slaughterhouses
  - Industries producing organic waste and had to pay for proper disposal
    - Breweries
    - Vegetable oil producing industries
    - Food processing industries etc
- Strict implementation of environmental laws for waste disposal

BIOMASS GASIFICATION

- Solid biomass fuel broken down by means of thermo-chemical decomposition in a restricted supply of air - Gasifier
- Product
  - Combustible gas - H_2, CO, CH_4
  - Volatiles & Ash
- Use
  - Fuel for internal combustion engine for shaft power & electricity.


Condensation cooler
Condensation cooler
Gasifier
Volume filter
Cloth filter
To engine
Cyclone
By-pass


Gasifier fuel
Fuel feeder
Fuel Preperation
Gasifier
Raw gas
Air
Electrical energy
Raw fuel
Ash
Gas Cleaning Unit
Gas Cooling Unit
Internal combustion engine
Electrical generator
Air
Ash & Char
Ash & Char
Condensate
Exaust gases


KARA


KARA

Feedstock

- Gasifier is very sensitive to moisture content of feedstock
- Feedstock has to be properly dried before use.
- Size of feedstock need to be uniform to ensure easy flow rate.
- Chopping wood pieces into uniform sizes is a challenge.

- Operates best with charcoal or briquettes.
  - The economic cost of producing charcoal or briquette before introducing into a gasifier to produce electricity could be high.

Gasifier operation.

- Requires technical skills and experience
  - The labour for gasification is different from that for diesel engine.
  - Time and effort for fuel preparation and fuel quality control,
  - frequently check of temperature and pressure meters to react adequately on input parameters - adding fuel, shaking the grate, deblocking filters and adjusting valves etc.
  - Regular cleaning of reactor and filters of ash and dust.

Environmental Pollution and Hazards

- Biomass gasification produce solid, liquid, and gaseous wastes, which, if not adequately controlled, harm the environment.
- Solid wastes => residue ashes. (1-20%)
  - In some cases, the ash may have value for use by steel or cement industries.
- Liquid waste => Tar and condensate
  - Pollute water bodies
- Gaseous emissions => (CO) leakage
  - Could be hazardous to workers. Exposure to high concentrations of CO leads to headache, unconsciousness or death.

- Compared with alternatives, especially fossil-fuel-based systems,
- biomass gasifiers are relatively benign in their environmental emissions,
- produces no sulphur oxides and only low levels of particulates.

DEV. Country Experiences

- High oil prices in the early 1980s led developing countries initiated biomass gasification programmes as substitute to petroleum fuels for power generation.
- Subsidies from government and donor agencies
- Large number of gasifiers based on charcoal, wood and agricultural residue were installed
- A survey carried out by the UNDP/World Bank Biomass Gasification Monitoring Programme (BGMP) in 1989/1990 observed that most systems installed were abandoned due to technical and operational difficulties. [Stassen, 1991].

DEV. Country Experiences

WB evaluation 1991

Country	Programme	Status	Remarks
Philippines	550 gasifier plants installed in the 80s	95% abandoned within 10 yrs	Inadequate operator training No technical backup from plant manufactures
Thailand	Planned for 4000 plants but stopped after installing 143	Installed systems abandoned	Technical problems High moisture content of feedstock Higher operational cost
Indonesia	40 plants installed in the 80s	25% operational after 5 years	High operation cost
Briazil	1000 gasifiers	90% abandoned within 10 yrs	High service and operational cost

Country	Programme	Status	Remarks
Tanzania	5 Gasifiers installed	Abandoned	Design deficiencies High operational cost
Mali	1 plant installed by Chinese	Operational as at 1990	Manufacture on site for 1yr to address initial problems and train operators
Seychelles	3 plants imported from different countries installed	All plants abandoned	Problem with feedstock. Could not work with available coconut husk
Burundi	1 plant in the 80s	Abandoned	Technical problems with fuel preparation
India	500 plants in the 80s	60% not in use	Technical, organizational and financial problems
Vanuatu	1 plant	System operational after 10 yrs of installation.	Expatriate engineer with knowledge in gasifier responsible for operation. Lower operational cost

- biomass gasification is likely to have initial technical problems regarding the fuel specifications and other operating process parameters in the first year of operation.
- Such problems are best solved through careful monitoring of the plant over a period of **at least one year** by qualified personnel.

Liquid Biofuel

- Alcohol has better value if used as an alcoholic beverages rather than as fuel substitute to gasoline.
  - Imported sugar is distilled for alcoholic beverage production
- Land for Food
  - Unlike developed countries that have all their agric land under cultivation, In Ghana less than 50% of agric land is under cultivation.
    - Bio-diesel production has the potential to increase crop production rather than reduce it.

Economic issues

- Electricity requirement in the household sector is only limited to lighting, radio, TV and ironing and therefore cannot yield much revenue. (subsidised tariff <50KWh/month)
- Bio-energy for electrification can best be achieved only when electricity demand is high over a longer period.
  - i.e when the power is utilised for some economic or small-scale industrial activity.
- This is the only way electricity production can be sustained

- Electricity is required for social services such as schools, health clinics, street lighting and telecommunication
- Who pays for the electricity supply if these services are to function satisfactory?
- Rural poor who could hardly afford the full cost of the electric power
- **Need for government intervention in the form of subsidies either directly or indirectly.**

Barriers

- Current energy markets mostly ignore the social and environmental costs and risks associated with fossil fuel use.
- Harmful energy sources e.g. High sulphur oil are given unfair market advantage over relatively benign sources such as biomass.

The "bottom line" question for policy makers and planners:

- How expensive or competitive is bioenergy for compared to other decentralised energy options such as the diesel?
- How much will it cost to make electricity available by bioenergy?
- With appropriate policies and incentives bioenergy could be competitive and effectively deployed in Ghana.

Policy and Regulatory Issues

- There is no policy incentive for the promotion of modern bioenergy in Ghana.
- Penalties
  - No penalty for improper disposal of organic waste including human excreta (no treatment)
  - In, Amelo Holland, suppliers of saw dust and plastic combustibles are compelled by law to pay us for receiving their waste for power generation.
- Drainage systems has been the channel for waste disposal.
  - Leading to flood and causing financial loss to the state

- Green tariff
  - In Europe, Utility companies are compelled by law to buy energy produced from renewable including bioenergy
  - Per kilowatt hour of energy produced from bioenergy is purchased at a higher price, about twice the consumer price for grid electricity.
  - India, state government provides up to 40% subsidy for investment into biogas and gasifiers.
- Need for Tax, Import duty and VAT Exemptions

CONCLUSION

- Bio-energy => technically feasible, economically competitive to fossil fuel under conditions where there is real demand for electrical power and biomass fuel is readily available.
- Development of appropriate regulatory and legislative framework is necessary to create favourable conditions for the private sector to be directly involved.
- Strengthening institutional mechanisms for biomass technology transfer.
  - support entrepreneurs,
  - sponsoring research,
  - development and demonstration projects

Renewable Energy Law under preparation for enactment is hoped to address some of these issues.

THANK YOU
FOR YOUR ATTENTION

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