BIOFUELS TECHNOLOGIES IN GHANA : CURRENT STATUS

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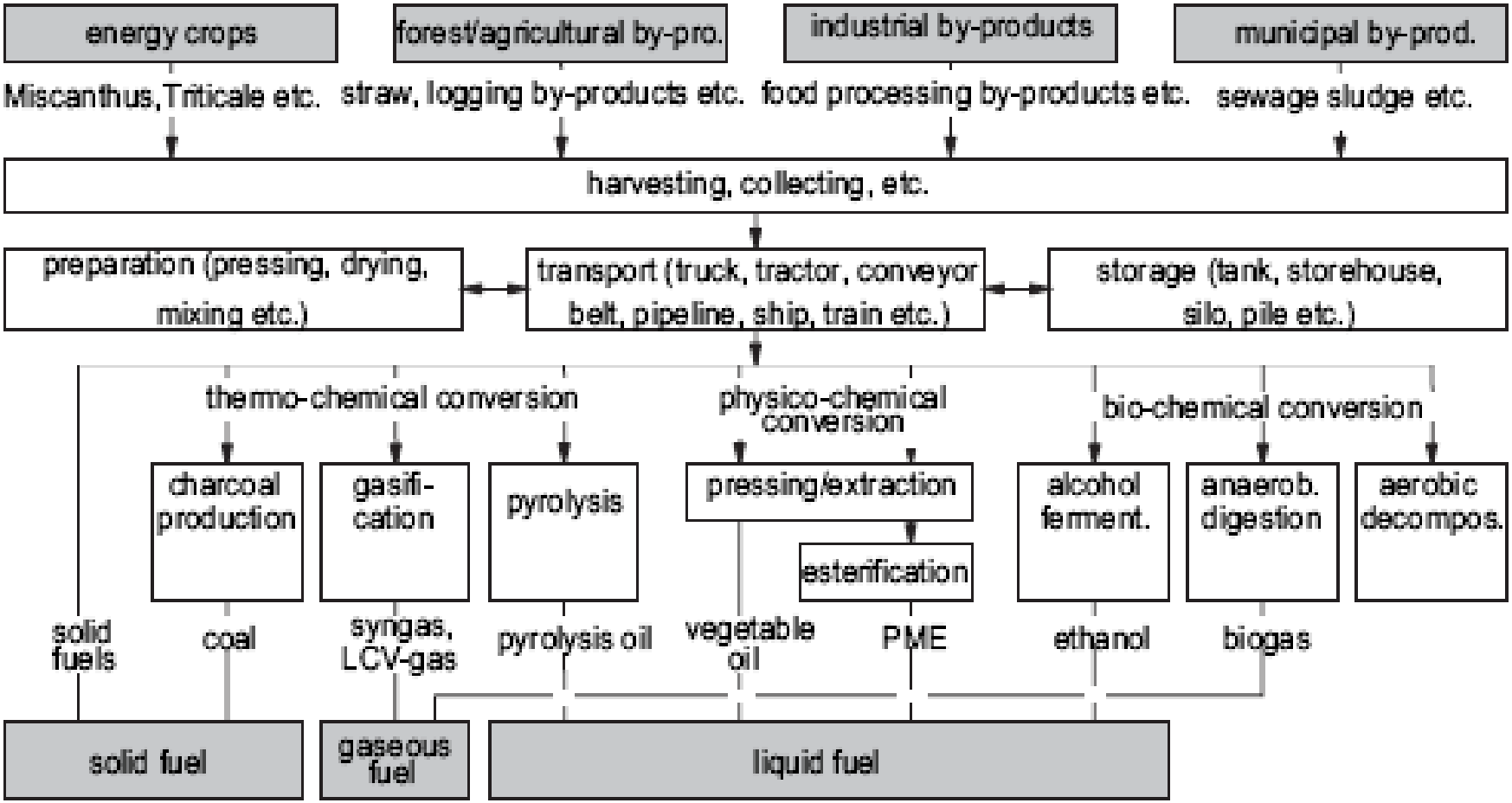
BIOENERGY TECHNOLOGIES OVERVIEW

- Variety of Feedstock – Usually Solid State
- Variety of Products & Forms – Gas, Liquid & Solids



Source: Biofuels Production Routes (FAO, 2004)

TESTED BIOENERGY TECHNOLOGIES

1. Improved Cookstoves (Firewood & Charcoal)
2. Improved Charcoal Production Technologies
3. Briquetting – Potential for export due to local competition with Charcoal & Woodfuel
4. Biomass Co-generation (Sawmill / Oil Palm residues)
5. Biogas (Institutional, Municipal Waste & Farm waste)
6. Gasification (Feasibility study/research)
7. Biodiesel –

a) First Generation Feedstocks: Jathropha, Castor oil, Palm Oil, Palm Kernel Oil, Soya bean oil, Coconut oil, Sunflower, etc.

b) Second Generation Feedstocks: Agricultural & Municipal Wastes – Cellulosic Materials

RE Application Biomass

Photos: Rural Energy, Ghana

Improved Wood Stoves in Selected Basic Schools in the Northern & Upper East Regions of Ghana

Traditional 3 stone stoves

Courtesy: Ahiataku-Togobo, 2009

BIOMASS CO-GENERATION

- Over 6MW capacity installed based on sawmill residue and oil palm waste.
- It has been the source of electric power for the industries and surrounding communities without grid electricity.
- High potential but hindered by the following factors:
  - cheaper power supply from grid electricity.
  - no financial or fiscal incentives
  - neither are there regulatory requirements that would encourage industry to generate and sell electricity to the grid (i.e. No grid-connected tariffs).

BIOMASS CO-GENERATION

Snapshot of Some Installed Units

Plant location	Installed capacity	Average annual production
Kwai Oil Mills	420 kW	1.50 GWh
Benso oil mills	500 kW	1.90 GWh
Twifo Oil mills	610 kW	2.10 GWh
Juaben Oil mills	424 kW	1.50 GWh

- SNEP, 2006

Some Palm Kernel Shell Generation Data

Factory	Location	Annual Shell Generation (tonnes)
Benso Oil Plantation	Benso (Western Region)	4,000 – 5, 000
Ghana Oil Palm Plantation Corporation (GOPDC)	Kade (Eastern Region)	5,000 – 6, 000
Ghana Oil Palm Plantation Corporation (GOPDC)	Kwae (Eastern Region)	3,000
National Oil Palm Plantation	Ayiem (Western Region)	1,600

Adapted from Lartey, Acquah & Nketia , 1999

IMPROVED CHARCOAL PRODUCTION TECHNOLOGIES

Technology uptake failed in due to:

- operations of the producers are not regulated
- yields no significantly superior to the traditional method contrary those reported in literature.
- improved method requires some level of initial capital investments in addition to the cost of the wood.
- management of the carbonisation process requires continuous surveillance.

BIOGAS

- Potential not fully exploited since 1960s
- Over 240 digesters with total capacity of about 3,680 m^3 installed
- Size range = 4 – 800 m^3 ***(Biggest @ GGBL, Kumasi using UASB)***
- Current implementations by private companies
- Areas of Applications include:

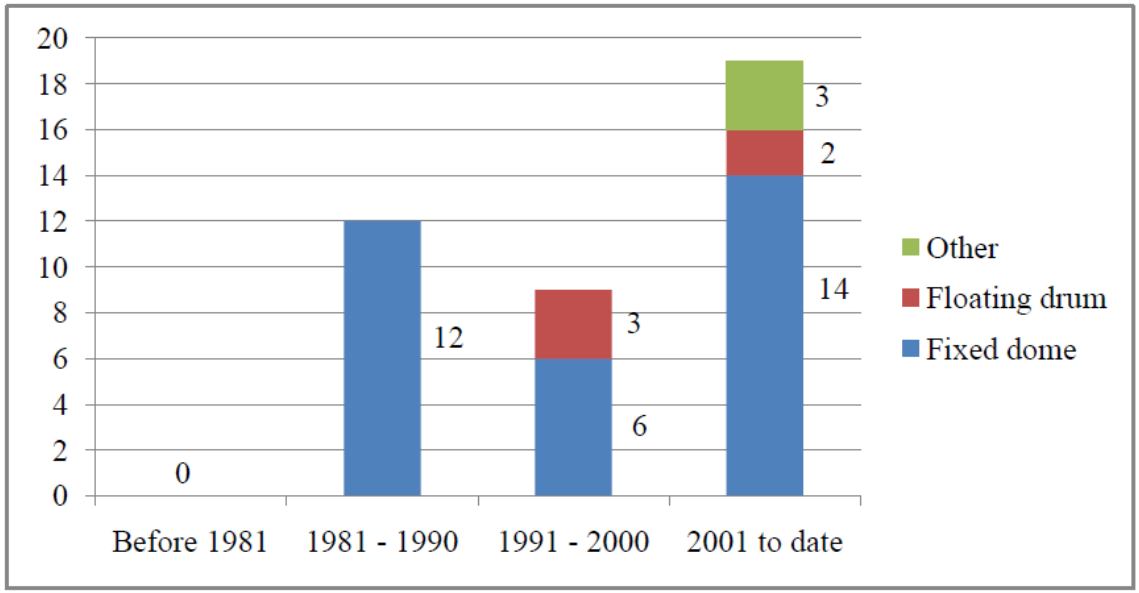
1. Bio-sanitation (Domestic & Institutional)
2. Households cooking,
3. Direct lighting and
4. Small power generation (e.g. 12.5 kVa genset @ Appolonia)

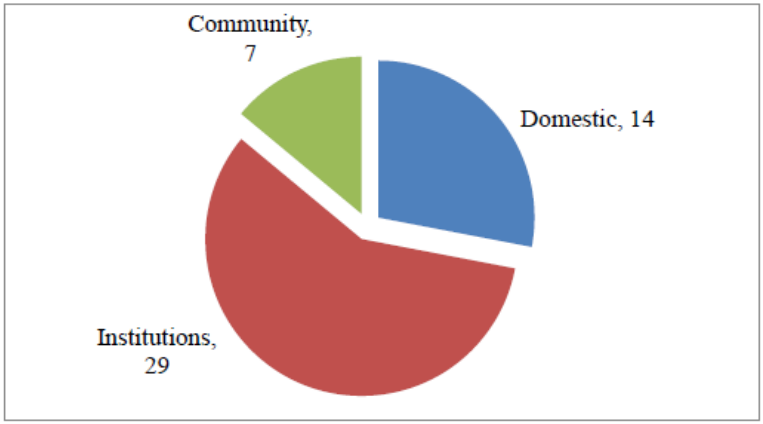
Feedstock have been:

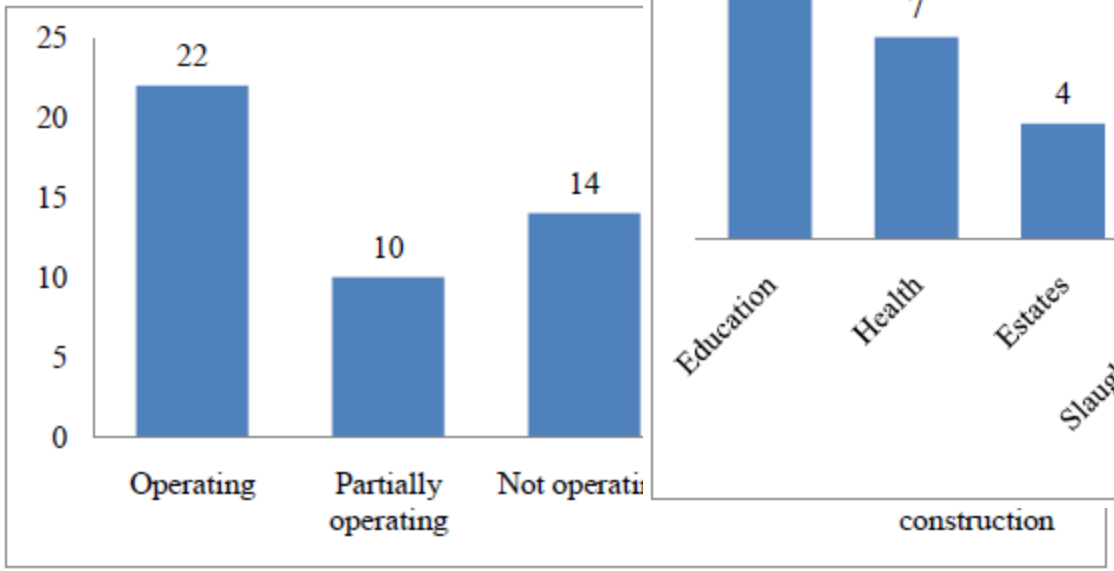
a) animal dung,
b) human excreta and
c) industrial organic waste.

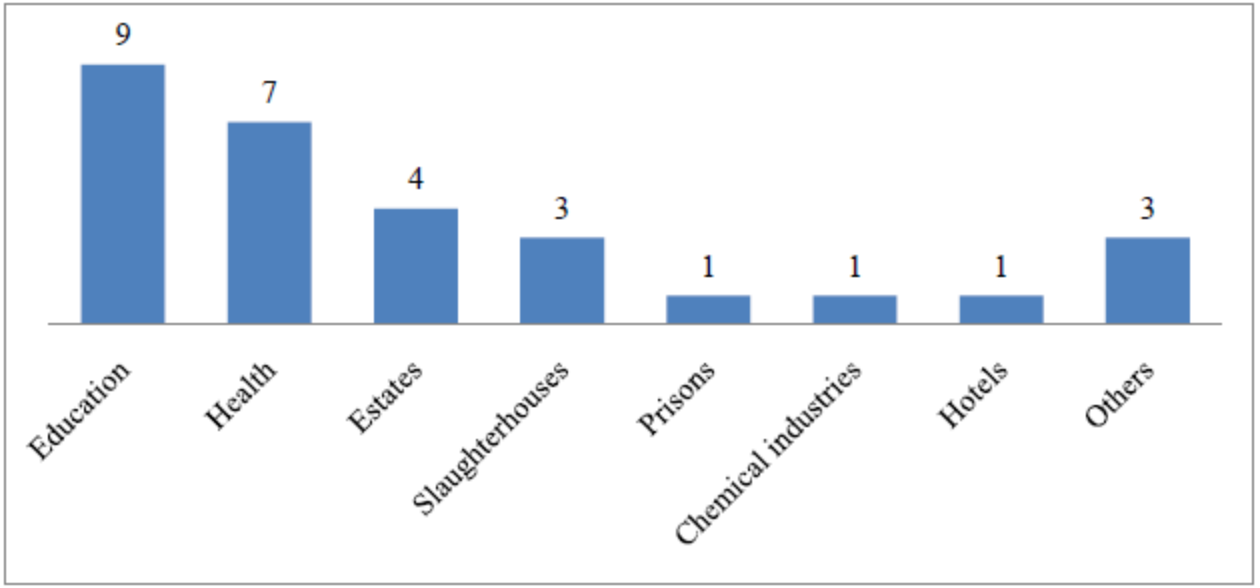
CASE STUDY - BIOGAS SURVEY

Total Population = 50 (50% of known plants in Ghana)





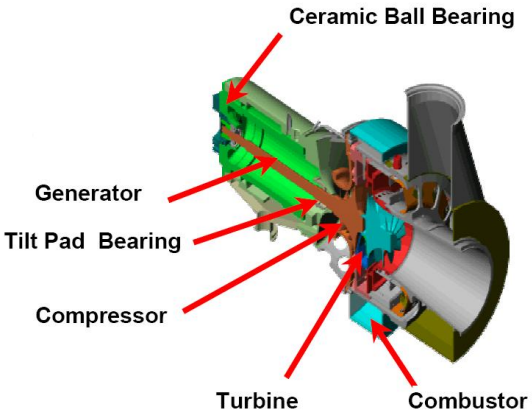


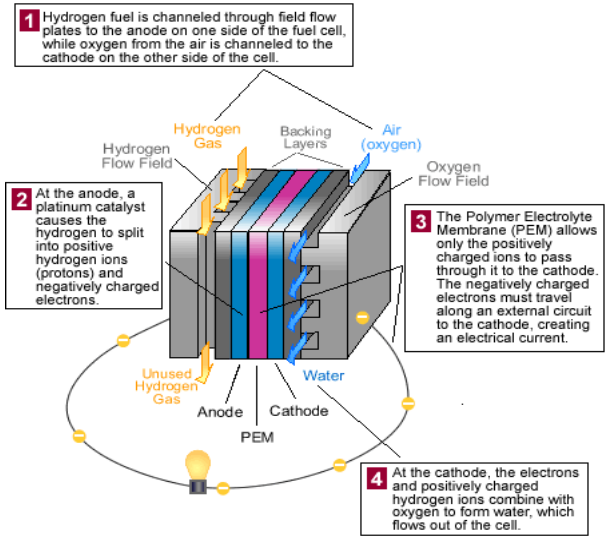


Courtesy: Bensah, 2009

KNUST BIOGAS PROJECT STATUS

- **System Characteristics**
  - Fraction of Campus Student Population ~ 7,000
  - 200 m^3/day of biogas
  - Power Output ~100kW
- **Power Generation Options**
  - Microturbine (~US$3,000/kW)
  - Fuel Cell (US$ 10 – 12,000/kW)
- **Pre-Feasibility Studies (Completed)**
  - MSc Student Mini-Project
  - MSc Thesis Research
  - National Servicemen/TA's Project
- **More Feasibility Studies (On-Going)**
  - Project Implementation Partner Search





TEC

LANDFILL GAS

- Feedstock : Municipal Solid Waste
- Environment: Engineered Landfill
- Interests: At least German delegations for Dompoase site near Kumasi
- Technology transfer is needed to back the known principles
- Potential : 1 MW energy per site
- Sites : Four more other sites in Ghana

BIODIESEL FEEDSTOCKS & PRODUCTION

- STRAIGHT VEGETABLE OIL (SVO) / PURE PLANT OIL (PPO):
  - Jatropha Oil
  - Castor Oil
  - Allan Blackia

- (TRANS)ESTERIFICATION:
  - Sunflower oil
  - Soyabean Oil
  - Jatropha Oil
  - Other Vegetable Oils (Palm, Palm Kernel & Copra Oils)
  - Waste Vegetable Oils

LOCALLY AVAILABLE BIODIESEL FEEDSTOCK

A. Virgin Oils:

α) Plant Sources:

1. Palm Fruit

2. Palm Kernel

3. Copra/Coconut Oil

4. Soyabean – Caltech Ventures, Accra (450 l/day processor)

5. Sunflower

6. Jatropha

BIODIESEL FEEDSTOCK – CONTINUED

β) Animal Sources:

No capacity in Ghana yet

B. Waste Vegetable Oils (WVO)

- Hotels, Restaurants & Fast food joints (Steers, Mr. Biggs, Ebusua Restaurants, etc.)
- Institutions (Boarding Houses, Hospitals, Prisons, etc.)
- **Potential Assessment – Energy Commission Sponsored & TEC Fellows – KNUST**

1. Survey - Completed
2. Transesterification of Samples – Completed
3. Biodiesel Tested
4. Engine Testing – On-going for Performance & Emissions

Independent Private Company at the Implementation Stage in Accra

BIO-ETHANOL PRODUCTION

- Competition for end-usage: Beverage vrs Fuel???
- Feedstocks:
- Sugar Crops:
  - Sugarcane - Proposals for Asutuare & Komenda Sugar Factories Revamping
  - Sweet sorghum – Potential yet to be tested fully
- Starch Crops:

  - Corn and

  - **Cassava**: 1. Laboratory tests – Completed & Ongoing
    - KNUST
    - Notre Dame Industries near Kumasi
- Laboratory Pilot Plant – Yet to proceed

  2. Caltech Ventures – Target = 30% Ethanol local market;

  Currently, 1, 250 acres plantation for gari; flour & dough awaiting plant construction

BIO-ETHANOL PRODUCTION

Ethanol Production Steps by Feedstock and Conversion Techniques

Feedstock type	Feedstock	Harvest technique	Feedstock conversion to sugar	Process heat	Sugar conversion to alcohol	Co-products
Sugar crops	**Sugarcane and sweet sorghum**	Cane stalk cut, mostly taken from field	Sugars extracted through bagasse crushing, soaking, chemical treatment	Primarily bagasse	Fermentation and distillation of alcohol	Heat, electricity and molasses
Starch crops	**Corn**	Starchy parts of plants harvested, stalks mostly left on the field	Starch separation, milling, conversion to sugars via enzyme application	Typically from fossil fuel	Fermentation and distillation of alcohol	Animal feed and sweetener
	cassava	Starchy root tuber harvested. Sticks serve as planting material	Peeling, drying, milling, conversion of sugars via enzyme application	Typically from fossil fuel	Fermentation and distillation of alcohol	Animal feed, manure or raw material for biogas plant

Adapted and modified from Rutz and Janssen, 2008

BIODIESEL PRODUCTION

- Anuanom Ventures -

- Should be credited with popularizing Jatropha and Biodiesel in Ghana .

- Worked on Biodiesel ≥ 5 years
- Jatropha seeds from outgrower farmers

1. TRAGRIMACS : 200 l/day batch process unit
   - Imported System
   - Feedstock: Sunflower Seeds

2. DUMPONG Farms (near Aburi) : 190 l/day biodiesel process unit.

- Locally Assembled System
  - Feedstock: Crude Palm Kernel Oil
  - End Usage: Electricity generation &
  - Transportation (Sales)

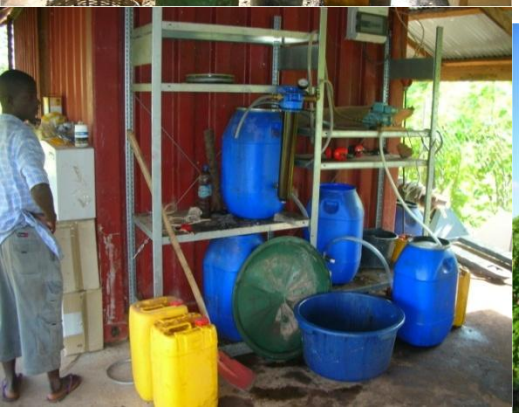
INTEGRATED RENEWABLE CASE STUDY

Busunu Project:

150 houses are connected to the electricity supply system
Each house is entitled to 2 CFL lamps at 11W each.

Generator can run on 5 gallons of jatropha oil for up to 5 hours.

Catholic chaplaincy in Busunu enjoys 24 hour electricity
Villagers to enjoy 4 hour (6 – 10 pm) access each day.



RESEARCH SUPPORT

- KNUST through Departments & Research Institutes such as TCC and TEC offers high quality research, support services & consultancies in agricultural and energy research at National, Regional & Continental levels
- UG – Similar Role as KNUST
- Other Research organizations on biodiesel feedstocks (including Jatropha) to biogas plants include but not restricted to:

  - Biotechnology and Nuclear Agricultural Research Institute (BINARI) under Ghana Atomic Energy Commission (GAEC)

  - IIR, FORIG, Soil & Crop Research instiutes under the Council for Scientific and Industrial Research (CSRI).

OTHER SUPPORT SYSTEMS

Engineering Firms:

Many firms have been meeting the energy project machinery requirements, namely:

- Machinery designs: TCC and Mechanical & Agricultural Engineering Departments(KNUST)

- Fabrication: GRATIS and various engineering firms like FATECO in Accra, RP Engineering in Cape Coast & SIS Engineering in Kumasi

CONCLUSION

- Woodfuel – Still Vital and important energy resource.
  - Main source of cooking fuel for many households
  - Contributes significantly to process heat delivery for commercial and medium scale industrial activities.
- Other bioenergy forms - High potential for heat and electricity on large scale or demonstration plants.
- Biogas development focusing on sanitation improvement with energy as a by-product is gaining grounds.
- Biofuel development as substitute for diesel, kerosene and gasoline is a recent phenomenon in Ghana.
- Biomass gasification and waste to energy - Yet to be demonstrated.
- Second generation biofuels technologies at R,D&D stage
- Research & Support Systems are available but needs to be utilised and strengthened via partnerships & collaborations.

THANK YOU