CSIR-INSTITUTE OF INDUSTRIAL RESEARCH &
GHANA ENERGY COMMISSION

China-Ghana South-South Cooperation on Renewable Energy Technology Transfer (RETT)

PRE-FEASIBILITY STUDY ON POTENTIAL LOCATIONS FOR BIOGAS TECHNOLOGY DEMONSTRATION CENTRE IN SOUTHERN GHANA

for

PRODUCTIVE BIOGAS USE IN PIGGERIES, CLUSTERED SMALL SCALE PALM OIL MILLS AND FOOD PROCESSING FACILITIES

PRESENTATION AT GHANA ENERGY
13TH JANUARY 2017

PROJECT SPECS

- **China-Ghana South-South Cooperation on Renewable Energy Technology Transfers**
- **LOCATION:** **SOUTHERN GHANA.**
- **FUNDING ORGANISATION:** **DANISH GOVERNMENT**
- **OTHER SUPPORTING ORGANISATIONS:** **MST-CHINA/UNDP-GHANA/ ENERGY COMMISSION-GHANA**
- **BUDGET:** **USD 15,000**
- **DURATION:** **8 WEEKS**
- **RESEARCH TEAM:** **MAWUENA AGGEY , PAX DAVIES DZAMBOE, DE-GRAFT ADDO, GILBERT SELORMEY, ISMAIL ABDULAI CSIR-IIR Scientists**
- **PROPOSAL DATE** **JUNE 2016**

PROJECT SCOPE/OBJECTIVES

- Phase 1:

  Criteria for Selection of Biogas Technology for Transfer;

  Application of Criteria – Selection of Biogas Technologies for Transfer from China to Ghana
- Phase 2:

  Identification of Biogas Technology Suppliers from China and Elsewhere
- Phase 3:

  pre-feasibility study on proposed Biogas Technology demonstration sites
- Geo-scope:

  South Ghana: Gt Accra; Central; Eastern; Western; Volta.
- Industry scope:
  - Large-scale piggeries,
  - Small-scale cluster palm oil mills,
  - Selected agro-processing facilities
  - Integrated farms

Biogas Technology Selection Criteria

Analytic Hierarchy Process (AHP)
- developing selection criteria
- discriminating shortlisted technologies

- Key Criteria – 5

  technical, economic, environment, socio-cultural and political
- Sub-criteria – 5

  Technical – Ease of design and construction; technical efficiency; maturity & reliability; scalability; flexibility, versatility and life span;

  Economic – Useful by-products; substitute fossil fuels; traditional use biomass; productivity; gross value added; and energy diversity;

  Environmental – Water quality; use & efficiency; soil quality; air pollutants; emissions GHG/non GHG'; land degradation; deforestation;

  Socio-cultural – Land tenure and litigation; change in income & employment skills; cultural attitudes/practices and acceptability; urban migration, human settlement; occupational injury & risk;

  Political - Political will; political stability; policy framework; legal framework; institutional linkages , networking.

Biogas Technology Selection Criteria

Preference Ranking of Biogas technology selection criteria:

Out of a whole number 1.0000:

- Economic considerations weigh highest - 0.3181;
- Socio-cultural - 0.2720;
- Environmental 0.1903;
- Political was 0.1459;
- Technical came last with 0.0738

Selected Biogas Technologies

- Datum - prevalent digester designs available in Ghana 2016
  Mainly Low rate
  - Fixed Dome , Combined Fixed & Floating Dome (Puxin)
  - ABR
  - CSTR (One?)

- Digester Technologies above DATUM identified for review
  - High Rate

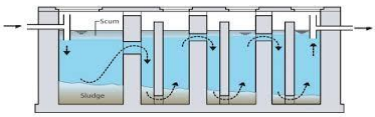
- Five (5) digester types shortlisted in each assigned industry (AHP technique)

Selected Biogas Technologies

Preference ranking - top five bio-digesters	
PREFERENCE RANKING ON BENEFITS (BEFORE COSTS)	**BIO-DIGESTER TYPE**
1	Reversible Anaerobic Baffled Reactor (RABR)
2	Contact Stabilization or Anaerobic Contact Digester - Continuous Stirred Tank Reactor (CSD-CSTR)
3	Contact Stabilization or Anaerobic Contact Digester - Plugflow (CSD-plugflow)
4	Dry Anaerobic Digester (DrAD) (Dranco)
5	Fixed dome insulated with internal heating

Selected Biogas Technologies - Reversible Anaerobic Baffled Reactor (RABR)

ABR basic design

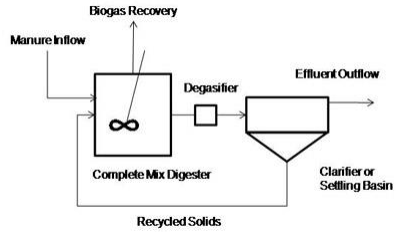


RABR – 1

RABR - 2

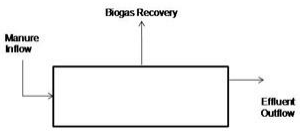
Selected Biogas Technologies - Contact Stabilization or Anaerobic Contact Digester - Continuous Stirred Tank Reactor (CSD-CSTR)

CSD-CSTR basic design & structure



Selected Biogas Technologies - Contact Stabilization or Anaerobic Contact Digester - Plugflow (CSD-plugflow)

CSD-plugflow basic design & structure

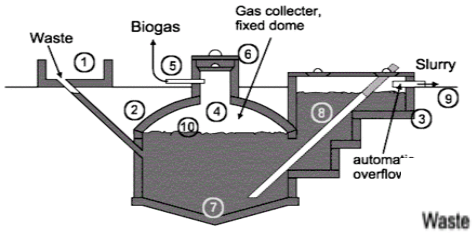


Selected Biogas Technologies - Dry Anaerobic Digester (DrAD, Dranco)

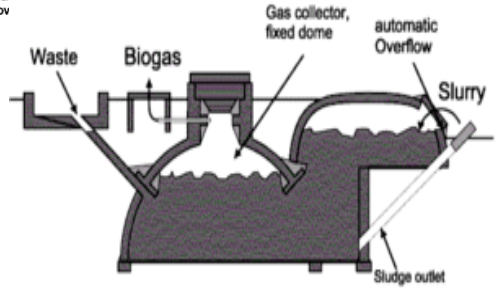
(Dranco) structure

Selected Biogas Technologies - Fixed dome insulated with internal heating

Basic structure



Carmatech Fixed Dome



Selected Biogas Technology Suppliers (13 + 3)

Selected Wet Anaerobic Digestion Technology Suppliers	
Supplier	Province & Region
Along Environ Tech Limited	Dongguan, Guangdong, China
Hebei Shengwei Jiye Frp Group Co., Ltd.	Hengshui, Hebei, China
Henan Hi-Tech Kingdo Industrial Co., Ltd.	Zhengzhou, Henan, China
Shenzhen Hannover Tech Co., Ltd	Shenzhen, Guangdong, China
Shengdong New Energy Group Corporation Ltd	Dongguan, Guangdong, China
Shenzhen Puxin Technology Co.,Ltd.	Shenzhen, Guangdong, China
Shandong Mingshuo New Energy Technology Co., Ltd.	Weifang, Shandong, China
Sichuan Motet New Energy Technology Co., Ltd.	Chengdu, Sichuan, China
Wuxi Youbor Chemical Equipment Co., Ltd.	Plot E15, Phase 5, Shuofang Industrial Concentration Zone, New Dist., Wuxi, Jiangsu, China (Mainland)
Shijiazhuang Zhengzhong Technology Co., Ltd. http://www.zztank.com	No. 81, Huaan East Road, Zhengding County, Shijiazhuang, Hebei, China (Mainland)
Chengdu AMOCO Architecture Engineering Company www.amoco.com.cn	Shandong, China (Main
Jinhaosanyang Environmental Protection Machine Co., Ltd.	Guangdong, China (Mainland)
Shandong Huaneng Jinhao Environmental Engineering Co., Ltd.	Shandong, China (Main
Selected Dry Anaerobic Digestion Teechnology Suppliers	
DRANCO technology – UG	Gent, Belgium
BIOFerm™ Energy Systems	USA
Hitachi Zosen Group.	Zurich, Switzerland

PRE-FEASIBILITY ON POTENTIAL LOCATIONS - Objective

- find & assess demonstration centre locations in southern Ghana
- shortlist potential demonstration centre locations

biogas for productive use in

- pig farms, integrated farms, food processing industry, small & micro scale cluster palm oil mills

demonstration centre

- use, spread information, promote, advertise, commercialize, research, develop, train & consult on biogas technology
- Includes complementary technology

  feedstock pre-treatment, digestion, biogas cleaning, storage & distribution, treatment & use of biogas & digestate

Geo scope

- Volta, Greater Accra, Central, Eastern and Western regions

- Also focus on institutional framework & capacity required for local absorption of RETs effective & sustainable

PRE-FEASIBILITY ON POTENTIAL LOCATIONS – Shortlisting Criteria

CRITERIA EMBEDDED IN METHODOLOGY SELECTED PARAMETERS:

- Literature
- MoFA & MoT & Ind staff
- Purposive Sample by region
- Accessibility & availability
- Introduction to Management of enterprises, appointments
- Structured interviews & walk-through observations/ photography
- final sample by multi-stage-wise considerations
  - initial regional selection of target sub-sectors
  - Oil mills - Eastern & Central
  - Pigs – western
  - Pig research – Gt Accra
  - Food processing Gt Accra & all regions
  - Food cassava purposely selected so Volta and central
  - Food – Livestock processing – Gt accra
  - Integrated farms – Gt Accra, Central & Western

PRE-FEASIBILITY ON POTENTIAL LOCATIONS – Shortlisting Criteria

- largest, most popular, most organized enterprises in each region;
  - Two/one enterprises selected for each subsector for each region

SHORTLISTING PARAMETERS

- Potential electricity generation from waste
- Generation potential to use ratio
- Digestate to capacity to use ratio

Regional Analysis of Initial List of Potential Hosts

Region	Sub-Sector			
	Integrated Farm	Piggery	Food Processing	Artisanal Palm Oil
Gt Accra	8	4	19	0
Volta	4	5	4	2
Eastern	2	8	4	200
Central	4	4	4	40
Western	4	27	4	30
Totals	22	48	35	272

Sample of Potential Hosts Shortlisted for Pre-feasibility Study

Category of Industry	Enterprise/Organization	Region
Integrated farm	CSIR-Animal Research Institut	Greater Accra
	Livestock and Poultry Research Centre, University of Ghana	Greater Accra
	B-Bovid Limited	Western
	Attah Mills Farms Limited	Central
Large scale piggery	Premier Western Pig Farm Ltd	Western
Food processing	Caltech Ventures Limited	Volta
	Ayensu Starch Company Ltd	Central
	Jonny's Food & Meat Complex Limited	Greater Accra
Artisanal cluster palm oil mill	P. K. Adzibolo Palm Oil Enterprise	Eastern
	Honest Farm Enterprise	Central

Shortlisting Criteria

Potential Host	Comparative Parameter		
	Generation Potential (kWh) pa	Generation to Consumption ratio	Digestate to Land (m3/acre)
Ayensu	1,876,186	16.69	8
B-Bovid	485,317	1.44	13.2
UG-Farms	179,632	1.37	4.6
P. K.	67,414	5.05	250.5

Summary of Financial Analysis

	Potential Host			
Parameter	Ayensu	B-Bovid	P. K.	UG-farms
Investment (USD)	4,000,000	400,000	190,000	145,000
Operations (USD)	400,000	40,000	19,000	14,500
Revenue (USD)	904,152	227,846	31,645	38,997
Benefit/Cost	0.21	0.52	0.15	0.24
Gross Profit (USD)	504,152	187,846	12,645	24,497
Pay back (yrs)	7.9	2.1	15.0	5.9
Established Market (USD)	54,220	162,487	6,435	63,189
Excess Market (USD)	849,932	65,359	25,211	(24,193)

Additional Economic Benefits

- Bio-fertilizer revenue
- Carbon credits
- Subsidies and Grants

Business Model 1: Subsidiary

- Independent new company/subsidiary
  - Use organic waste from parent company

  Produce at competitive prices
  - Produce combined heat & power (CHP)
  - digestate/fertizer

  Sales to Parent company & others

  parent company maintains control of subsidiary by electing board and enforcing by-laws. The parent has the legal right to demand subsidiary meets financial objectives, conducts business in acceptable manner. Parent company can examine subsidiary's financial reports and business plans to ensure it is in right direction. Although the parent company retains control, subsidiary is liable for its debts or any obligations. Properly regulated public intrusion for demonstration and training purposes will be accommodated

  ASCo model

Business Model 2 Joint Venture

- Host company agrees with one or more parties to pool their resources f
  - Includes subsidies and incentives.
  - Joint venture (JV),

  Each participant in JV responsible for profits, losses and costs associated with it. But the JV independent entity, from participants' other business interests.

  JV acquires feedstock from its host company, process it and generate heat & electricity which is sold back to the host company and and Others.

  Digestate liquid fertilizer is also sold to the host company as well as any additional clients.
- This model will be suitable for B-Bovid Limited and probably Livestock and Poultry Research Centre in that order.

Business Model 3 & 4:
- Technology Promotion Non-Commercial Productive Use
- Research, Development & Technology Promotion

- BM3

BM2 with host equity strictly limited to provision of land and post-Project operation and maintenance responsibility.

B-Bovid Limited and Adzibolo Palm Oil Mill Enterprise could be suitable for this business model in that order.

- BM4

BM2 with very strong emphasis on Technological Research and Development as well as public training components in the model.

B-Bovid Limited and Livestock and Poultry Research Centre in that order could be suitable for this business model.

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THANK YOU