



European Union



FINAL PROJECT REPORT; SWITCH AFRICA GREEN PROMOTING BIOGAS TECHNOLOGIES IN GHANA



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ACRONYMS

AGI	Association of Ghana Industries
ARSCP	Africa Roundtable for Sustainable Consumption and Production
BTAL	Biogas Technologies Africa Limited
BAG	Biogas Association of Ghana
COTVET	Council for Technical Vocational Education and Training
CH ₄	Methane gas
EC	Energy Commission
ECOWAS	Economic Community of West African States
EPA	Environmental Protection Agency
EU	European Union
DCE	District Chief Executive
GBEP	Global Bioenergy Partnership
GEMOD	Ghana E-Waste Model
GES	Ghana Education Service
GNCPC	Ghana National Cleaner Production Centre
GAMA	Greater Accra Metropolitan Area
HND	Higher National Diploma
IES	Institute of Environmental Studies
IBAN	Inclusive Business Action Network
KVIPs	Kumasi Ventilated Improved Pits
LPG	Liquified Petroleum Gas
MESTI	Ministry of Environment Science Technology and Innovation
MMDA	Municipal Metropolitan District Assemblies
MoU	Memorandum of Understanding
MSMEs	Micro Small Medium Enterprises
NTCC	National Technical Coordination Committee
NVTI	National Vocational Training Institute
SCP	Sustainable Consumption and Production
SHS	Senior High School
STEPRI	Science and Technology Policy Research Institute
SEA4ALL	Sustainable Energy for All
SME	Small & Medium Enterprise
SAG	SWITCH Africa Green
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNEA	United Nations Environment Assembly
UNOPS	United Nations Office for Project Services

Table of Contents

Executive Summary	1
1. Introduction	2
2. Project output	3
3.0 Implementation and activities carried out	3
3.1 Activities carried out over the period of implementation	3
2.1.1 Summary on baseline survey in institutional biogas and allied services in the GAMA.....	8
2.1.2 Summary on types of biogas technologies and development of training materials	9
2.1.3 Summary on training of artisans/engineers	10
2.1.4 Summary on development of biogas estimator/Calculator software	13
2.1.5 Formation of the Biogas Association of Ghana.....	14
2.2 List of Contracts Awarded	15
2.3 Visibility captured in the project	15
3. Difficulties encountered and measures taken to overcome problems	16
4. Changes introduced in the implementation	16
5. Achievements/results by using the indicators included in this agreement	17
6. Integration /Complementarity with other SWITCH actions	19
7. Cross cutting issues	19
8. Involvement/partnership with other key stakeholders	19
9. Sustainability measures and recommendations	20
10. Financial report	21
12. Appendixes	22

List of Tables

Table 1: Tables of activities carried out	7
Table 2: Type of biogas plant constructed and location	11
Table 3: Contracts awarded by the Ghana National Cleaner Production Centre	15
Table 4: Measures taken on difficult challenges encountered in project	16
Table 5: Results of project activities based on the logical framework	17
Table 6: Stakeholders and their role in the project	19

Figures

Fig 1: Map of GAMA showing the 16 MMDAs	2
Fig 2: Schematic drawing of the horizontal balloon/Carmatech type biodigester	9
Fig 3: Team of experts developing standards and training materials	10
Fig 4: Validation of training materials by key experts and stakeholders	10
Fig. 5: Construction of septic tank type biogas plant: St. John's School with balloon & generator	11
Fig 6: First batch of biogas trainees at GNCPC site.....	12
Fig 7: Second batch of trainees at the IES of EPA site.....	12
Fig 8: Third batch of biogas trainees at Maritime Hospital Site	12
Fig 9: Fourth batch of trainees at Ashaiman SHS site.....	12
Fig 10: Mr. Ambrose Tsekpo (Left) and Edem (Right) biogas plants.....	13
Fig 11: Interface of biogas estimator software	14
Fig 12: Biogas Association of Ghana meeting at GNCPC & Elected National Executives of BAG	14
Fig 13: Exhibition in Uganda & Burkina Faso during SWITCH Africa Green Networking Forums.....	16

Executive Summary

The Promotion of Biogas Technologies Project was implemented over a period of 33 months with the commencement in June 2015. The project was funded by the European Union through a grant disbursed by UNEP, UNOPS and the UNDP also providing technical support. The Environmental Protection Agency as part of its contribution to the project provided funding for the construction of 10 biogas plants in 7 Senior High Schools (SHS) within the Greater Accra Metropolitan Area. The Ghana National Cleaner Production Centre was implementing Agency while contributing in-kind to the successful implementation of the project.

The project was aimed at providing an opportunity to manage liquid waste generated on-site and provide capacity building in collaboration with other stakeholders for artisans. This will increase their sources of income generation and also improve their standard of living. The project was implemented within the Greater Accra Metropolitan Area (GAMA). The project commenced with a survey being conducted to solicit the interest and key stakeholders interest in the promotion of the biogas technologies.

During the implementation of the project, there was a technical assembled who developed a training manual that was used for the training of artisans. The training manuals entails the development of a curriculum, learning materials, assessment tools and marking tools. The manuals were then approved and validated by key stakeholders who made their contribution to enhance the training manuals. The project implementers was granted a temporary accreditation by the NVTI for the training of artisans (National Proficiency II). A total of 101 artisans have been trained of who have commenced constructing biogas plants while others have future plans to setup their own enterprises to become experts in the construction of biogas plants. The training programme have been tailored to engage trainees in the theoretical aspects of biogas technology, field visits to some existing biogas plants and the practical construction of biogas plants. As a result of the training, artisans have constructed 3 biogas plants (made up of 2 fixed dome biogas plants and converted an existing septic tank into a biogas plant).

The project also consulted with the development of a software for the calculation of the cost of a biogas plant which includes the bill of quantities. It was initially developed with a Microsoft excel which developed the calculations and was finally converted into a software which will automatically generate a final report. The GNCPC in collaboration with the Energy Commission was able to register a total of 12 biogas companies existing in the GAMA. This laid the grounds for the establishment of the Biogas Association of Ghana which has been officially registered as a not-for-profit making organization aimed at promoting biogas technology in Ghana and Africa. The Association was officially outdoored in 2017 and has been able to register more than 19 corporate organization and 34 individuals. The Association has currently received grant from the BUSAC Fund to be involved in advocacy activities promoting biogas technology.

The GNCPC was also engaged in awareness promotion activities which include the printing of t-shirts, note pads which trainees used, printing of training materials, participating in networking forums and exhibitions at various locations aimed at promoting biogas technologies. The GNCPC through the project has been involved in advocacy with a major input made into the National Building Code which has made it a requirement for applicants who require building permit for their buildings to include the construction of a biogas plant for the on-site treatment of liquid waste instead of dislodging. The Vice President has officially launched the National Building Codes.

The project also encountered various challenges which include industry experts protecting trade secrets of which the project have had to engage them further to ensure that their interest are protected. There was also a lack of MMDAs interest in the project for which the team had to follow-up several times after giving invitation letters and organization of workshops to engage them. The GNCPC has successfully signed MoU with the NVTI and the BTAL to work together to integrate the curriculum into the NVTI training programmes to train artisans in the construction of biogas plant. After the completion of the project, the GNCPC will continue to organize more training for artisans at a fee to cover overhead expenses.

The overall total cost of the project was five hundred and sixty nine thousand seven hundred and forty eight United States Dollars (\$569,748). The total expenditure from UNOPS/UNEP was two hundred and fifty thousand United States Dollars (\$250,000). Total amount of funds received from UNEP/UNOPS is two hundred thousand United States Dollars. Outstanding amount to be reimbursed by UNEP/UNOPS is fifty thousand United States Dollars. The funding from EPA/GNCPC was three hundred and fourteen thousand one hundred and thirty one United States Dollars (\$314,131).

1. Introduction

The SWITCH Africa Green project builds on past and ongoing capacity building activities by UNEP, its partners and others in addressing Sustainable Consumption and Production (SCP) challenges and promoting sustainable business ventures as well as green economy policies. These include activities which increase access to sustainable energy sources and services, conserving ecosystems and the services they deliver and advancing green economy transition through macroeconomic analysis in the African region. The European Union (EU) through the United Nations Environment (UN Environment) awarded a grant to the Ghana National Cleaner Production Centre (GNCPC) for the implementation of the Promotion of Biogas Technologies Project which began in July 2015.

The Promoting Biogas Technologies Project created opportunity to develop capacity within the Greater Accra Metropolitan Area (GAMA) for the adoption in planning and use of biogas technology to manage domestic faecal sludge while creating the opportunity for income generation, move towards clean and sufficient domestic energy. In addition, the project provided the opportunity for the demonstration of biogas plant construction in schools as examples to eliminate physical handling of faecal sludge and consequently provide for environmentally sound faecal sludge management for other sixteen (16) Metropolitan, Municipal and District Assemblies (MMDAs) in the GAMA.

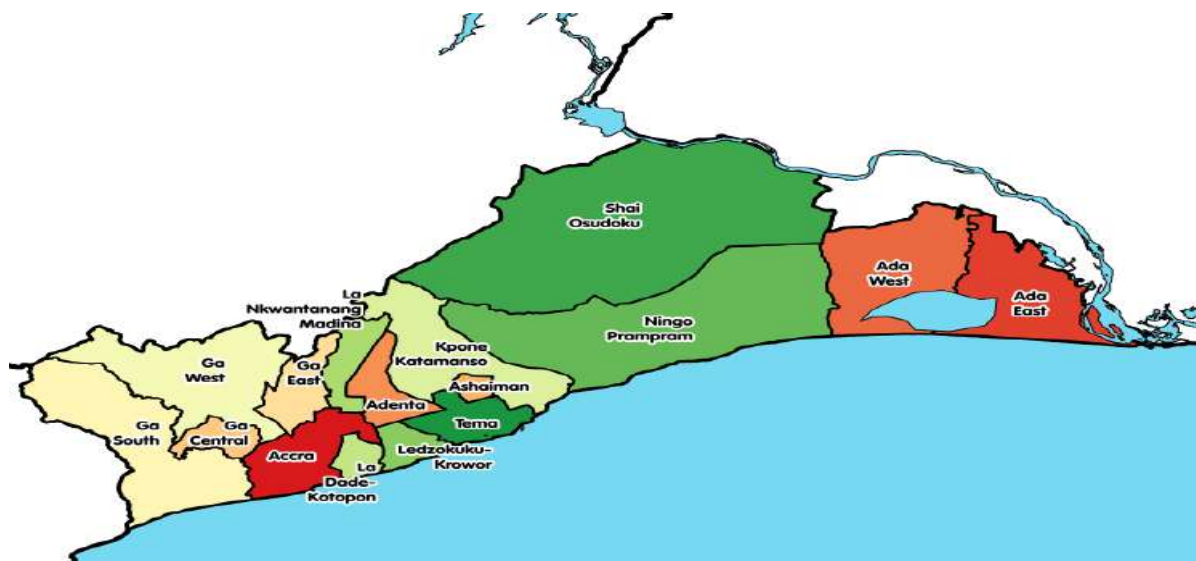


Fig 1: Map of GAMA showing the 16 MMDAs

The project has trained a total of 101 artisans/engineers from different areas in the GAMA including 3 from other parts of the country. The trainees have also constructed two (2) demonstration biogas plants located at the GNCPC and the Institute of Environmental Studies (IES) hostel and converted one (1) septic tank into a biogas digester at the Ashaiman Senior High School with support from their facilitators.

A software which helps to determine an estimate of the cost of constructing a biogas plant including the measured quantities of materials required and methane gas production potential has also been developed and is in use.

The project was funded with a total of \$319,748.10 from various funding partners. The UN Environment contributed about eighty percent (78.12%) while GNCPC provided the remaining twenty percent (21.81%) in-kind contribution. As part of the Ghana's support to the project, the Environmental Protection Agency (EPA) provided an amount of two hundred and sixty two thousand four hundred and sixty seven United States Dollars and twenty cents (\$262,467.20¹) for the construction of ten (10) bio-digesters in seven (7) Senior High Schools in GAMA (St. John's Grammar School (1), St. Mary's Girls' SHS (2), Accra Girls SHS (2), Presbyterian Boys SHS (1), Odogonno SHS (2), Wesley Grammar School (1) and Christian Methodist SHS (1).

¹ Exchange rate used was \$1 = GH¢3.81)

2. Project output

The project realized the following outputs;

- i. Trained 101 artisans/engineers in the construction of biodigesters.
- ii. Constructed two (2) demonstration biodigesters at IES of EPA, GNCPC office and converted one (1) septic tank to a biodigester - all have been completed by trainee artisans/engineers as practicals.
- iii. Developed a biogas estimator/calculator as marketing tool as well as a tool for determining land space requirement, feed requirements, gas generation potential, building materials - bill of quantities as well total cost estimation
- iv. Constructed 10 biodigesters in seven Senior High Schools in the GAMA.
- v. Developed skills and competency training manuals with support from Energy Commission (EC) and Council for Technical, Vocational Education and Training (COTVET) for Proficiency level II.
- vi. Secured accreditation from the National Vocational Training Institute (NVTI) has been obtained for training, skills and competency test assessment and certification for Proficiency Level 2
- vii. Signed a memorandum of Understanding with NVTI to train instructors/facilitators and students in the thirty-six (36) NVTI schools in the construction of biodigesters.
- viii. Registered 34 individuals and 19 companies in the construction of biogas plants.
- ix. Facilitated the formation of Biogas Association of Ghana (BAG) as an umbrella advocacy and not-for-profit making organization to champion the promotion of the technology in Ghana.
- x. Publicity and visibility - printed 100 T-shirts, 100 overalls, developed 2-minute documentary, 500 note pads and 100 bags.
- xi. Provided input into the development of the draft national biogas strategy
- xii. Facilitated and provided technical (green buildings - EDGE) input into the development of the Ghana Building Codes

3.0 Implementation and activities carried out

The project was implemented over a period of 33 months which includes the period of extension.

3.1 Activities carried out over the period of implementation

The project was carried out through the following activities;

The table below gives the detailed activities carried out over the period of the implementation;

Activity workplan	What has been done so far	Where	When	How	Remarks/Comments
Desktop study and field visit	Gathering primary data on household and public schools census and waste management systems	In the GAMA	July 2015	Consultancy to cover summary of 2014 household census by Ghana Statistical Service and second cycle institutions via Ghana Education Service (GES)	Part of Consultant's draft report.
	Review of legal framework on renewable energy, waste to energy and reports on biogas projects	GNCPC, Tema	Aug. 2015	Review of past reports & academic journals on promotion & potential biogas technology Renewable Energy Act, Strategic Energy Plan and Ghana Shared Growth & Development Agenda II SEA4ALL project, Waste Management Policy; Green Economy documents	Recommendations from review to be incorporated into <ul style="list-style-type: none"> • The ongoing building codes for uptake and upscaling of technology in the country. • The Draft National Biogas Strategy produced
	Development of a draft National Biogas Strategy (Policy initiative)	STEPRI	Jun-Aug 2015	Multi-stakeholder national steering committee comprising Departments and Institutions under the Ministry of Environment, Science, Technology and Innovation (MESTI) to draft the Strategy.	GNCPC Project team represented in the committee & ensured the project objectives were reflected in the draft National Strategy produced.
	Site visit to a privately owned public toilet with a bio-digester	Ashaiman	Sept. 2015	Request by Municipal Assembly and transport conveying the team to site.	The facility unable to generate biogas despite redesigning by two different contractors. Willingness by the owner to have a fully functional biogas plant due to competition from other facilities.
Baseline assessment of existing biogas plants;	Consultant has submitted report (Attached)	In the GAMA	July 2015	Consultancy services - developed survey tools, pre-testing tools, administer tools on biogas construction firms, individuals, institutions, energy experts and site visits	Report completed and submitted with one of the key findings being that of the high initial cost of the construction of the biogas plant.
Develop biogas construction calculator	Development of an excel template for bio-digester calculator (capacities, feed, LPG equivalence and bill of quantities).	GNCPC, Tema	Sept. 2015 Apr 2016	Using design equations for bio-digester and rescue chamber capacities, space, feed, amount CH ₄ generated and cost of construction	As identified in the baseline survey regarding the high cost of construction as not encouraging to the public, the Centre has developed a calculator as an innovative approach to demystify the construction of biogas plant and help reduce the cost of construction of a biogas plant. BTAL, Vulpec Company Ltd & Green EnergyTech Ltd made inputs.
	Completed cost build up and LPG equivalence calculator	GNCPC office	Dec. 2015	Used software to develop the calculation. Liaise with experts to validate the software.	This was done by the Staff of GNCPC and a consultants. It has also been used during the training programme
Organized stakeholder workshop	Formal discussions with MMDAs in the GAMA	GAR Regional Administration	Oct.,2015	Discussions with GAR Minister who invited all DCEs to a briefing meeting.	Invitation Letters and briefing notes on biogas Technology and application in the MMDAs sent out to DCEs
	Registration of biogas company's operating in Ghana	Collaborating with GNCPC, EPA & EC	Jan-Mar, 2016	An advert was placed in the newspapers for companies to register with the EC, GNCPC and EPA.	Before the advert were placed only 2 companies were known (BTAL and Vulpec Ghana Ltd) but currently a total of 18 has been registered and steps will be taken to help them obtain license from Energy Commission (EC) to operate.

Activity workplan	What has been done so far	Where	When	How	Remarks/Comments
Construction of Biogas plants in Senior High schools	Completion of the construction of 10 demonstration plant in schools and procurement of generator sets	MESTI/EPA GNCPC	Jan. - Apr 2015	GNCPC counterpart funding in project and biogas is used to power generator sets for schools lighting	Activity should have coincided with April 2016 artisans training but the MESTI fast-tracked the civil works contracts in Oct 2015 to solve power crisis in some 2 nd cycle schools in the project area. No accessories connected to harvest gas
Training	Capacity building for one staff	Weitz Centre - Sustainable Dev't, Israel	Nov.-Dec. 2015	Course and project work on community bio-digester projects	Improved GNCPC bio-digester design skills and construction capacity.
	Stakeholder workshop for the development of certification of participants of the training programme	Series of meetings held at EC and GNCPC.	Feb, 2016	Consultative discussion held between Energy Commission, GNCPC and Council for Technical and Vocation Education Training (COTVET) on certification of participants in training programme	Series of meetings leading to the setup of a technical committee to work with the consultant to develop training materials. (Various levels were identified after series of discussions to develop proficiency-based training for artisans, technicians, operation and maintenance and designers). COTVET & NVTI to accredit & certify graduates whiles GNCPC runs the training program.
	Stakeholder capacity building, needs assessment and development of training materials (This was awarded on contracts)	GNCPC office	Nov. to Dec. 2015	<ul style="list-style-type: none"> ToR developed for limited tendering Shortlisted of experts written to with tender documents to complete (Limited tender consultancy) Select consultant, negotiate consultancy fees and award contract. 	<p>The contracts with the consultants (2 No.) have been signed and</p> <ul style="list-style-type: none"> Inception reports received for both. Draft report received for 1No. Final report submitted
	Recruit artisans for training	GNCPC office	Dec. 2015	<p>Developed and advertised in 2 most circulated newspapers for individual & company artisans in the GAMA area.</p> <p>Profiled, selected & registered candidates for capacity building workshop</p>	<p>Adverts were developed and published in the Daily Graphic and Ghanaian Times newspapers (copies attached) in Jan 2016. (Daily graphic & Ghanaian Times)</p> <p>A selection committee assessed the 35 applications & five (5) disqualified for lack of knowledge in block-work, plumbing, carpentry or steel bending.</p>
	Training materials developed	EPA- IES	Mar, 2016	A committee comprising of experts from GNCPC, Industry players, COTVET & EC camped at the IES hostel for 4 weeks to develop training materials	Development of training materials took longer than expected. (Competency-based proficiency Level II for artisans was developed which is attached to the appendices). A total of 8 modules were developed
	Stakeholder validation workshop reports from consultants and training tools	Ange Hill Hotel		<ul style="list-style-type: none"> By invitation (list & pictures attached) Electronic copies of consultant's report sent out for review prior to workshop. Consultants made presentations on work and received comments 	There was considerable turnout for the workshop especially the MMDAs and industry players. (Recommendations from the validation workshop)
	Skills training of artisans (Course Structure)	GNCPC	11-15 Apr, 2016 3-7 Oct 2016	<ul style="list-style-type: none"> Training organized with industry experts facilitating the course. Classroom theory and practical construction work 	<ul style="list-style-type: none"> 1st Batch - total of 30 artisans trained and a 3M³ bio-digester demonstration plant was constructed at the GNCPC translating and testing the calculator and testing the skills of participants 2nd Batch - a total of 19 artisans trained 15M³ bio-digester constructed

Activity workplan	What has been done so far	Where	When	How	Remarks/Comments
			24 Nov-3 Dec 2016 Feb. 19-23, 2018	<ul style="list-style-type: none"> NVTI carried out skills assessment during the practical construction stage Field Trips to operating biogas plants. 	<ul style="list-style-type: none"> 3rd Batch - A total of 22 artisans trained. 15M³ bio-digester constructed at the EPA IES, Amasaman 4th Batch - 30 artisans trained & septic tank conversion into a 46.41m³ bio-digester at Ashaiman Senior High School Training reports were prepared and reported in biannual and annual report.
	Accreditation for GNCPC and Training Program	NVTI, COTVET	Apr, 2016	Completed applications and secured accreditation for GNCPC as an institution & staff as technical biogas technology - Inspection of GNCPC infrastructure	The training materials validated & approval given for course curriculum content (See Syllabus attached) Assessment and Accreditation for the GNCPC as a Centre Assessment of qualification and skills of staff to conduct skills training by NVTI accomplished Accreditation application evaluation ongoing for skills-based training for tertiary level (HND) with COTVET
Develop biogas calculator	Development of an excel template for bio-digester calculator (capacities, feed types, LPG equivalence and bill of quantities). Completed the development biogas of cost build up and LPG equivalence calculator	GNCPC, Tema	Sept. 2015 Apr 2016 Sept. 2018	Using design equations for bio-digester and rescue chamber capacities, space, feed, amount CH ₄ generated and cost of construction Used a software to develop the calculator. The software to be launched at an SAG policy dialogue.	Baseline survey identified high installation cost as a dis-incentive to the public adopting the technology & the GNCPC decided to develop simple calculator as an innovative approach to demystify biogas plant cost estimation and help market biogas technology. Inputs from BTAL, Vulpec Company Ltd, Green EnergyTech Ltd supported the consultant & GNCPC Team to complete the calculator development to support all the training
Stakeholder workshop	Formal discussions with MMDAs in the GAMA	GAR Regional Administration	Oct.,2015	Discussions with GAR Minister who invited all the District Chief Executives (DCEs) to a briefing meeting.	Invitation Letters sent out to DCEs and briefing notes on biogas Technology and application in the MMDAs
	Registration of biogas companies operating in Ghana	Collaborating with GNCPC, EC and EPA	Jan. 2016 - Mar, 2018	An advert was placed in the newspapers for companies to register with the EC, GNCPC and EPA.	Before the advert were placed only 2 companies were known (BTAL and Vulpec Ghana Ltd) but currently a total of 19 SMEs have been registered and obtain registration license from the registrar of companies as well as EC to operate.
Construction of Biogas plant in Senior High Schools (SHS)	construction of demonstration plant (10) in 7 SHS and procurement of power generator sets	MESTI/EPA GNCPC	Jan. 2015	GNCPC counterpart funding in project and will use biogas to power generator sets for schools lighting using contractors procured through MESTI	Activity should have coincided with April 2016 artisans training but the Minister of Environment fast-tracked the civil works contracts in Oct 2015 to solve power crisis in some 2 nd cycle schools in the project area
Networking	Attend SWITCH Africa Green Networking Forum and ARSCP-9 Conference	Kampala, Uganda	May 26- June 2, 2016	Participate in seminars and workshops. Exhibition on biogas project activities implemented	The biogas technologies in all programmes was well presented and feedback was good. Many expressed the desire the contact the Centre or its consultants to enable them construct biogas plants at various locations.
	EU-Day Celebrations	Accra, Ghana		GNCPC exhibit SAG biogas project	
	World Environment Day	Accra, Ghana	Jun 6 2017	GNCPC & SAG SMEs exhibition on biogas technology	

Activity workplan	What has been done so far	Where	When	How	Remarks/Comments
	Regional Policy dialogue on Switch Africa Green	Accra City Hotel, Accra	Mar, 2017.	Presentations on the implementation of the Promotion of Biogas Technologies Project. Exhibition on biogas technology	
	Commissioning of Safi Sana Waste Treatment Plant	Ashaiman, Ghana		Invited as a key stakeholder in the biogas technology advocate and promoter	
	Energy Commission's ECOWAS GBEP Bioenergy Week	Accra, Ghana			
	Participated in the SEED West Africa Symposium	Accra City Hotel, Accra	June 2017	GNCPC & SAG SMEs exhibition on biogas technology	
	Affordable renewable energy sector dialogue by Inclusive Business Action Network (IBAN)	Accra, Ghana		Presentation on -biogas calculator as a marketing tool - biogas technology and renewable energy balance	
	UNEA - 3	Nairobi, Kenya	Dec. 2017	Participate in sessions & exhibition	

Table 1: Tables of activities carried out

2.1.1 Summary on baseline survey in institutional biogas and allied services in the Greater Accra Metropolitan Area

The main purpose of the study was to assess the Biogas situation in the Greater Accra Metropolitan Area (GAMA) and the willingness of landlords, educational institutions, health facilities, hostels and hotels to adopt the use of biogas as a source of (renewable) energy. It was also to assess public knowledge about biogas technology and the willingness of MMDAs to legislate to ensure the uptake of the technology as source energy and a waste management strategy.

The primary data collection used interviews, questionnaires, and physical observation of facilities, while secondary data was collected through review of reports, relevant policy documents and data lists. A random sample sizes of 1,589 was used to gauge public awareness; 631 landlords and institutional stakeholders to assess willingness to adopt biogas technology and a questionnaire administered to 64 duty bearers of MMDAs on biogas bye-laws.

The survey results also show 794 public toilets comprising water closets, Kumasi Ventilated Improved Pits (KVIPs) and septic tank/latrines in private and public ownership. The daily average patronage per toilet was estimated to be a minimum of 85 people. The GAMA has the right profile of toilets to support the implementation and adoption of biogas technology. There is strong incentive base for public toilet owners and the MMDAs, to adopt biogas technology as it is critical in helping solving the organic waste management challenge facing them. For the private owners, the lure of additional income from the biogas business was seen as a huge incentive.

The MMDAs have acknowledged the importance of waste management as one of their key mandates and they were aware of the availability of waste-to-energy technologies such as Biogas that could help manage waste as well as produce much needed energy for domestic use. The lack of legislation on such technologies was also acknowledged and as a result the majority (92.2%) of duty bearers at the MMDAs were willing to legislate the adoption of biogas in the physical development process by having applicants for building permits make provision for biogas facilities in their building projects. This should be based on rigorous sensitization on the implementation of such bye-laws, making the technology affordable and backing it with logistical support to ensure compliance.

Among landlords, educational institutions, health facilities and hotels, the majority (63.0%) of them used Liquefied Petroleum Gas (LPG) for cooking, while 94.2% depended on electricity from the national grid for lighting. The dependence on the two hydrocarbon-base fuel/energy was attributed to availability and convenience. While 67% were satisfied with LPG for cooking, only 35.5% were satisfied with the electricity from the National Grid for lighting as a result of frequent power outages. As a result, 97% of landlords and toilet operators as well as 100% of educational institutions, health facilities and estate developers affirmed their willingness to adopt biogas provided it was available and affordable, even if it is supplementary.

With regard to the general public, the majority (70.7%) used LPG as the main source of energy for cooking, 98.6% used electricity from the national grid as their main source of power for lighting. These were followed by charcoal (7.6%) and 0.3% used Biogas. The reasons for the choice of LPG and electricity for the National Grid were their availability and convenience. Charcoal was mainly patronized by the low income areas in the cities and the rural areas.

The majority (94%) of the public had knowledge about other sources of energy, including biogas. The more rural the district the lesser the number of people with knowledge on the biogas technology. Thus more people in Accra and its immediate vicinity tend to have more information about biogas than the less urban communities/districts such as Ada East, Ada West etc. The media, especially radio was cited by 82% as the main source of information about biogas (Methane - CH₄).

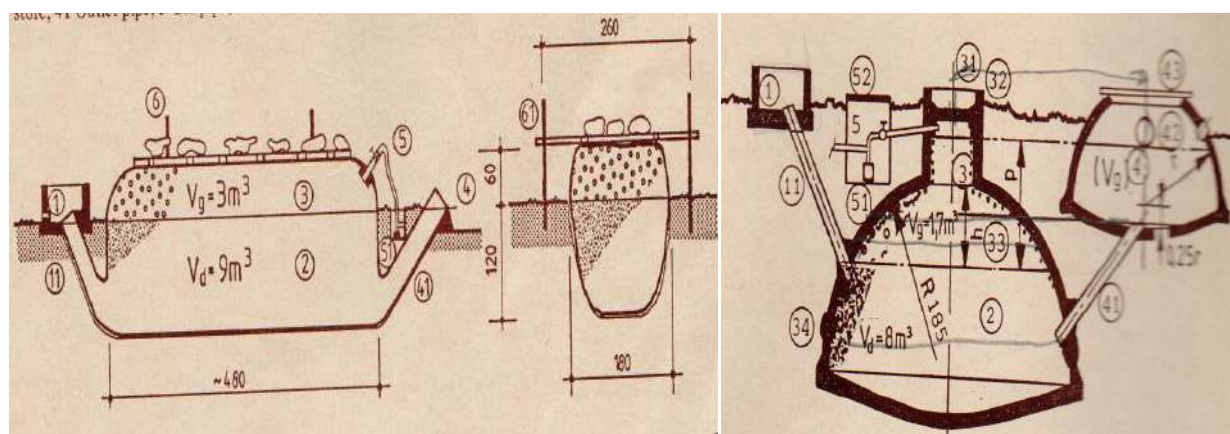
An overwhelming majority (98.8%) were willing to use biogas depending on its availability, cost, and convenience in relation to other sources of energy currently being used.

The study recommended further analysis in relation to functional design of the human excreta-fed bio-digesters in order to determine the suitability and ability of the toilets to provide sustained feedstock for the bio-digesters and also ensure suitable retention time in the bio-digesters. It also recommended the development of a viable public-private partnership business model as a way of encouraging use of the technology at reasonable cost; development and promotion of standardized bio-digesters and quality control standards for the sector; and implementation of biogas technology programme as an integrated solution for waste management, energy and agricultural production (crops and fish) since the technology is capable of supporting sustainable and eco-friendly development. The study also suggested that Biogas technology should be made more convenient and affordable than current sources in order to encourage its adoption and uptake.

2.1.2 Summary on types of biogas technologies and development of training materials

The technology survey unearthed the existence of five (5) different types biogas plants constructed across Ghana in both commercial and residential buildings (Wasasa, Carmatech fixed-dome, Indian floating drum, Converted septic tank, covered lagoon and plastic drum & balloons) and the most common is the fixed dome. The digester is the main component of the primary on-site waste management system that optimizes naturally occurring anaerobic bacteria to decompose and treat the organic manure while producing biogas. The choice of which digester to use is usually driven by the existing (or planned) feedstock handling system at the facility.

Fig 2: Schematic drawing of the horizontal balloon/Carmatech type biodigester



1-Mixing pit, 2-Digester, 3-Gasholder, 4-Slurry store/displacement pit, 5-Gas pipe, 6-Burden, 11-Fill pipe, 31-Entry hatch, 32-Gas cover, 33-Seal coating, 34-Rated break ring, 41-Outlet pipe, 42-Overflow, 43-Cover, 51-Water trap, 52-Cover, 61-Guide frame

There are three main types of feedstocks which are human waste, animal waste and plant waste. The average gas yield potential for each of the various types of waste based on research conducted by scientist affects the quantity of gas generated which averages 60%-80% methane, 20%-40% carbon dioxide, traces of ammonia, hydrogen sulphide, nitrogen, hydrogen, oxygen and water vapor. Pig/Swine/Hog manure has the highest gas potential followed by cow, poultry, horse, sheep, stable manures, sewage sludge etc. The environmental factors that affect the digester type in the African terrain include the soil type, nature of feedstock and climatic conditions.

The development of training materials came about as a result of the need to train 100 artisans as one of the major outputs of the project and to be done in accordance with the scheme of getting the training materials approved by a body and the NVTI and COTVET were selected.

The GNCPC contracted John Afari Idan to lead the effort to do an assessment of the biogas types available in Ghana, identify appropriate biogas design type to be promoted, develop the occupational standards (curriculum), learning materials and assessment tools. The effort led to the engagement of key industry stakeholders coming together to develop the training materials since this is the first of its kind in Ghana. Prominent amongst the key stakeholders engaged included EC, COTVET, GNCPC, and an expert in entrepreneurship expert. COTVET, technical education awarding institution then accredited the training materials. The Centre also engaged the NVTI which is also an accreditation body to supervise the skills practical training, administered tests and awarded proficiency certificates to students. NVTI modified the course to meet the needs of the industry and also issued accreditation for the course and the GNCPC to ran the course.

The outline is prepared for Proficiency Level II level under the NVTI Trade Testing qualification and the duration is six (6) months under European Union (EU) funded Switch Africa Green project is administered by the GNCPC and Biogas Technologies Africa Limited in Ghana. The usual Proficiency programme is 2 years and so attempts have been made to ensure that the training will still meet the standard without compromising quality by introducing intermittent assessment to consolidate acquisition of skills.



Fig 3: Team of experts developing standards and training materials



Fig 4: Validation of training materials by key experts and stakeholders

2.1.3 Summary on training of artisans/engineers

Training has been successfully carried out for 101 artisans/engineers while modifications were made to the training materials to afford a train-the-trainers course to be organized for 25 lecturers and instructors of the Koforidua Technical University to train HND students in the design, construction and maintenance of biogas plants as well as six (6) instructors from NVTI schools also to train students. Two (2) persons were also trained from the St. John’s Grammar School to ensure they maintain the biogas-to-electricity project there.

The entire training was conducted in four (4) phases with an average class number of 25. The training for artisans/engineers entailed three areas which are;

- ✓ Theory of biogas and biogas technology including entrepreneurship.
- ✓ Visits to existing biogas plants at different locations within Accra.
- ✓ Practical training which involves the construction of a biogas plant by trainees.

Table 2: Type of biogas plant constructed and location

Location	No. of Trainees	Biogas type constructed	Digester Size
GNCPC	30	Fixed dome biogas plant	8 m ³
IES of EPA/Maritime Hospital	41	Fixed dome biogas plant	8 m ³
Ashaiman Senior High School	30	Conversion of an existing septic tank to biodigester	46.41 m ³
Total	101		

The MESTI also awarded counterpart funding contracts for the construction of 10 biodigesters in 7 Senior High Schools as part of the project implementation which has been completed. Out of this, the project supported the St. John’s Grammar School with biogas accessories such as a 10m³ balloon for storage of biogas, a 5kVA generator set, pipes, connectors, meters and a de-sulphurizer to enable the school make use of the biogas produced from the biogas plant to generate electricity for lighting at the girls dormitory.



Fig. 5: Construction of septic tank type biogas plant for St. John’s School with balloon & 5KVA generator (counterpart funding)



Fig 6: First batch of biogas trainees at GNCP site



Fig 7: Second batch of trainees at the IES of EPA site



Fig 8: Third batch of biogas trainees at Maritime Hospital Site



Fig 9: Fourth batch of trainees at Ashaiman SHS site

Since the training has been completed, some artisans registered companies and take biodigester construction as their main jobs or as part of their main job as masons and plumbers. A total of six (6) artisans have made good strides in the construction of biogas plants. Mr. Ambrose Tsekpo, Edem Dovi Komivi, Joshua Bright Amenorfe, Enoch Boadu, Suleman Kassim Ekyem and Chris Senyaglo have constructed biogas plants either for clients or for themselves.

The pictures below show Mr. Ambrose Tsekpo (A first batch trainee), a mason has constructed about ten (10) biogas plants in collaboration with a partner Mr. Charles of Charmass Biogas Engineering Ltd also a member of the Biogas Association of Ghana. The project provided training for Mr. Ambrose Tsekpo who did not know anything about biogas plants. Currently, Mr. Teskpo has constructed about seven (7) biogas plants after the training he acquired through the project. It has also created alternative source of income generation and improved his finances. He has currently added it to his masonry work.

A member of the second batch by name Edem, a mason has been able to construct a biogas plant with technical support from the biogas project team as can be seen below in the picture in his house which he currently uses at the kitchen for cooking.



Fig 10: Mr. Ambrose Tsekpo (Left) and Edem (Right) biogas plants

2.1.4 Summary on development of biogas estimator/Calculator software

The rationale behind the development of the biogas estimator is as a result of the complaint by several clients about the high cost of the biogas plant. GNCPC saw the need to develop a tool that can be used by the biodigester contractors to generate the bill of quantities and cost breakdown to make to the client.

The development of the software started initially in a excel format and eventually upgraded into a software. The basic principles and attributes in the function of the software are as follows;

- **Volume of digester:** this is the independent variable needed for the calculation of the other variables.
- **Total influent:** this variable refers to the amount of faecal matter and water
- **Amount of faecal (organic) matter**
- **Quantity of gas generated:** this is based obtained for the quantity of gas likely to be generated for a given feedstock.
- **Gas generation potential in LPG equivalent cylinders:** this variable represents the amount LPG cylinders that the amount of gas generated will fill up.
- **Cost Savings per cylinder:** this variable the likely savings one is going to make from the biogas generated as compared to consuming LPG.
- **Bill of quantity:** Quantity and cost of materials for construction.
- **Land area required:** the area for excavation and area required for construction.
- **Construction details:** design parameters and measurements for the construction of the biogas plant.

The calculator will eventually be uploaded on a website which will be made accessible to all. The calculator will be updated regularly at agreed periods depending on the current demands. The software will require the user to pay a token or fee before the user can use it. The software also comes with an operational manual (see attachment in appendixes).

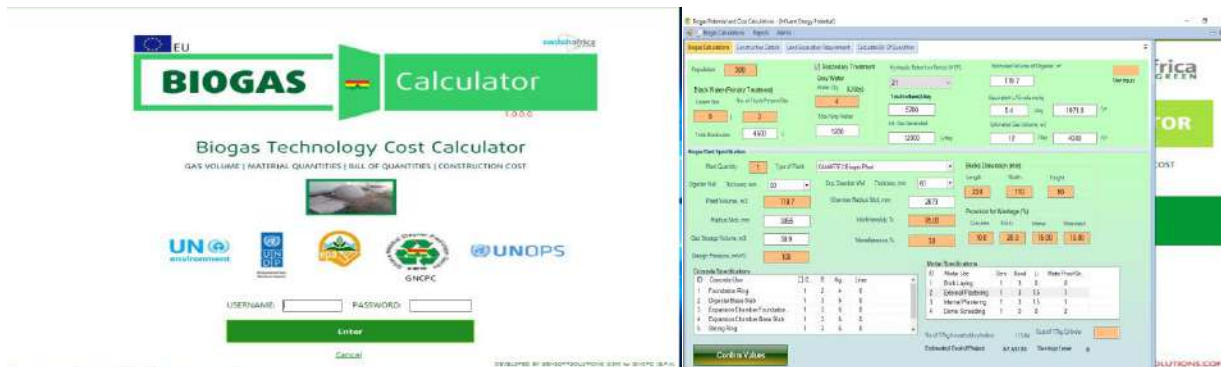


Fig 11: Interface of biogas estimator software

2.1.5 Formation of the Biogas Association of Ghana

In collaboration with the Energy Commission a key stakeholder in this sector, was able to register a total of twelve (12) biogas companies. There was a stakeholder meeting organized afterwards to discuss how to bring together all key stakeholders together under one umbrella organization to promote biogas technologies in Ghana and Africa.

An interim technical committee was established after a series of meetings to discuss and choose a name and develop a constitution for the umbrella organization. This led to the formation of the Biogas Association of Ghana (BAG) which has been registered at the Registrar General’s Dept as a not-for-profit making organization with the aim of promoting biogas technologies in Ghana. Elections were held and an eleven (11) member executive team was established to control the affairs of the Association over a period of two (2) years after which fresh elections would be held to elect new Executives.

Since the election of Executives the Association has made good strides with the opening of a bank account, working at the interest of its members to bid for contracts and various projects relating to biogas plant advertised by various Government sector Ministries, Departments and Agencies including private companies and institutions. The Association has embarked on a registration drive to register new members. The Association has been able to register nineteen (19) corporate organizations involved in the construction and promotion of biogas technology while thirty four (34) individual members have been registered. The Association has also created a website where further information can be gathered concerning its activities.

The Association has currently been able to apply for and signed agreement for advocacy to promote biogas technologies through funding from the BUSAC fund. The Association will receive an amount of one hundred and ninety eight thousand Ghana Cedis (GH¢ 198,000.00) to promote biogas technology and also create awareness and educate the general public on the benefits of the biogas technology.



Fig 12: General meeting of the Biogas Association of Ghana at GNPC & Elected National Executives of BAG

2.2 List of Contracts Awarded

A total of three contracts were awarded to three separate individuals to implement various aspects of the project. The Centre used a limited tender process and the national procurement standard contract template in procuring and contract award in this case. The local experts in this specialized technology field required are limited and the advert assisted us to locate them and those with proven record knowledge and practical experience were requested to submit both technical and financial proposals for the assignments. The table below gives the details of contracts awarded.

Table 3: Contracts awarded by the Ghana National Cleaner Production Centre

Consultant	Type of contract	Amount (US\$)
Moses Pumpuni of Vulpec Company Ltd	Consultancy service to carry out baseline survey on biogas plant usage in the Greater Accra Metropolitan Area	29,343.00
John Afari Idan of BTAL	Consultancy service on the development of training materials for artisans and engineers	11,839.47
Senyo Anipa of Sensoft	Consultancy service for the development of software for calculating the biogas estimates on the quantity of gas and the bill of quantity for the construction of a biogas plant.	10,000.00

2.3 Visibility captured in the project

Visibility was captured during the implementation of the project. This is a requirement in the implementation of the project.

The following visibility materials have been developed;

- Banners for training of artisans have been printed.
- Writing notepads for the project has been printed.
- T-shirts have also be prepared to be printed.
- Bags and overalls were made for the trainees.
- Roll-up stands for exhibition purposes were also made and used during participation in various exhibitions.
- For each of these visibility materials, project and project sponsors, implementers and other partners' logos have been embossed on each of the materials.
- News video covering the validation workshop for the validation of the baseline survey and training materials was telecasted on the Ghana National Television station.
- Participated in exhibition at the EU displaying visibility materials developed for the project.
- Participated in exhibition at the SWITCH Africa Green Networking Forum and the ARSCP-9 Conference in Kampala Uganda. The exhibition displayed visible materials like project T-shirts, bags with a new cookstove which uses wood pellets/briquette. There was also a demonstration of the use of cookstove for cooking and lighting at the same time using wood pellets/briquette as source of firewood.
- Participated in an exhibition of the Regional Policy dialogue on Switch Africa Green held in Accra. Digesters made from plastic barrels, T-shirts, banners of the project were displayed during the workshop.
- Produced a 2-minute cartoon animation of organic waste management using biogas technology



Fig 13: Exhibition in Uganda & Burkina Faso during SWITCH Africa Green Networking Forums

3. Difficulties encountered and measures taken to overcome problems

There were a few challenges which the project encountered during implementation. The table 3 below provides details on how the challenges were resolved.

Table 4: Measures taken on difficult challenges encountered in project

Difficulties/Challenges	Measures to overcome issues
Lack of support from relevant public institutions.	Adequate notification to relevant public institutions is critical. Ensure an officer from the relevant institution has been appointed to work with the GNCPC or appointed consultant(s).
Data and relevant information is not readily available in the form that can be used.	Ensure that the required data and relevant information are sorted for project use.
One of the major challenges was getting to meet the heads of the MMDAs for discussions on the project.	However we intend to overcome this by making a presentation at the Regional Coordinating Council meeting for the MMDAs.
Collecting data from the Ghana Statistical Service was extremely difficult and too bureaucratic just have to deal with it that way.	Work closely with the Ghana Statistical Service to ensure the relevant data is provided.
Demonstration plants financing envisaged 4 biogas plants but the Minister increased to 10 No making financing all 10 very difficult	The EPA had to be consulted to provide the additional funds for the 6 No.
Development of training materials took longer than expected.	The technical team together with consultant had to stay longer than expected to complete the development of the training materials which affected the budget.
Industry experts protecting key trade secrets in the development & construction of the biogas plant. GNCPC has been able to device calculator to provide information on the design of the biogas plant.	The Centre managed to collect data from the key industry experts required for the development of the biogas digester design. It's a key result to demystifying the cost of construction of a biogas plant.

4. Changes introduced in the implementation

There have been changes introduced to the project as a result of observations the project implementers made after consulting with other stakeholders. During one of such a stakeholder meeting, a committee was established to outline the development of the training materials. The technical committee identified that there are various levels for which materials would have to be developed. The team identified and distinguished the following levels required for training;

- Artisans
- Technicians
- Operation and maintenance
- Designers

In addition to the identification of the various levels, the project team due to the high cost of construction of the biogas plant realized that there is the need to design and develop a software that will generate design parameters for the biogas plant. The software also could generate the bill of quantities which can be used for both the contractor and the client to determine the nature of agreement for the construction of the biogas plant. During meetings held with UNEP, UNDP and UNOPS during a monitoring and evaluation visit, it was agreed that instead of training students in the design and construction of biogas plant, the lecturers should be trained and who intend will train the artisans.

5. Achievements/results by using the indicators included in this agreement

The table 4 below provides information on the results or achievements based on the indicators given in the logical framework.

Table 5: Results of project activities based on the logical framework

Intervention	Indicators of achievement	Sources or means of verification	Assumption
Overall objectives			
Sustainable management of faecal sludge & creating income for artisans	10 biodigesters constructed at 7 Senior High Schools	Sites visited	
Improve sanitation situation of 95% of Ghanaian population	Capacities of artisans/engineers developed to adapt biogas technologies to residential, commercial and public toilets	Reports prepared on training programme. List of participants	
	District planning permitting regulations and guidelines revised to integrate the use of biogas technology in faecal sludge management.	National Building Code revised and launched for use by all Town and Country Planning Dept Offices of the District Assemblies	
Specific objectives			
101 local artisans/engineers trained in the Construction of biogas plant	3 demonstration plants constructed by trainees	Reports submitted on biogas plants. Visits to biogas plants constructed.	
Public-private partnerships between MMDAs and private sector	MoU signed between GNCPC, BTAL and NVTI	Signed documents between 3 parties	
Information on biogas technologies widely disseminated and stakeholders well informed on success stories from the project	Key stakeholders appreciated the benefits of biogas technologies	Implementation progress reports submitted. Cartoon video developed. Brochures of flyers printed. T-shirts note pads printed. Participated in various stakeholders forums to disseminate information on the biogas technologies.	
Expected results			
101 craftsmen trained in design and construction of biogas facility integrated and public toilet management systems	Training materials developed and validated. Signed attendance sheets by the trainees. Construction of 3 pilot biogas plants. Equipped 1 of the schools biogas plant with balloon and generator set	Reports on training programs. Report on 3 biogas plants construction Videos on harvesting, testing and bottling of biogas. Trainees constructed 3 biogas plants	Participant attendance to training program. Acceptability of gas from faecal sludge.
Biogas technologies and its benefits demonstrated and extensively	Signed attendance list. Workshop reports submitted	Technology buy-in.	Cost of technology to beneficiaries.
Activities			
Consultation with identified key stakeholders, assessment of capacity building needs of the key stakeholders, development of training programmes and development of training materials.	Technical officers, stationery and printing,	Refer to budget	Timely disbursement of funds
Participated in the stakeholder consultation workshops on the draft revised building regulations and	Workshops: transport, facilitators	Signed attendance list	Invitation sent to project team/GNCPC.

	planning guidelines to incorporate the use biogas technologies in new building.			
	Awareness creation through video documentaries on success stories on TVs, publishing of flyers and posters on the benefits of biogas. Participated in interviews on local television and radio to discuss the benefits of biogas projects.	100 bags printed, 500 note books, 100 t-shirts printed, 50 overalls, 1000 brochures, 2 minutes cartoon,	Refer to budget	Funds disbursed on a timely manner
	Trained craftsmen and polytechnic students on design and construction of biogas plants. Capacity building of MMDAs and Trained craftsmen on business development and marketing of biogas technologies.	Facilitators, stationery, transport, facility for training, venue.	Please refer to budget	Timely delivery of training materials

Income generation and job creation contribution of the project

Artisans who have been involved in the construction of biogas plants have seen improvement in their incomes as a result of the construction of biogas plants.

Policy contribution of the project

The project team provided technical input into the newly launched Ghana Building Code which was launched by the Vice President of Ghana on October 31, 2018 in Accra at the Alisa Hotel.

As a result, all building permits to be granted by the town and country planning departments should have as part of the requirement a design of a biogas plant to meet permit requirements.

Project has made contributions into the development of draft National Biogas Strategy and 8th national Clean Cooking policy review - *'Making Clean Cooking Technologies A National Priority'* the GNCPC made a presentation on the topic *'State of Cooking in Ghana – Realities, Prospects and Challenges'* to kick-start the policy dialogue

Feedback from users

Most users of biogas plants have expressed satisfaction over its use. The benefits have been immense which include;

- Non-dislodging of the biogas plant as pertains with the septic tanks in homes and schools.
- The use of space for other purposes where the biogas plant has been constructed for gardening, car park or sitting area.
- Good sanitation as there is no leakage from the biogas plant.
- It prevents diseases such as typhoid, cholera and other communicable diseases.
- Low or no maintenance cost on the biogas plant.
- Use of by-products such as clean water for gardening and sludge for farming apart from the gas for cooking or lighting.

Public Private Partnerships

There has been to establish partnerships during the implementation period. The project obtained accreditation from NVTI in collaboration with Biogas Technologies Africa Ltd to provide training in biogas under the competency based training programme national proficiency II for artisans. The NVTI is a national accreditation and training institution for technical and vocational training. The NVTI also has thirty-two (32) Institute across Ghana which provide various training programmes.

The NVTI, BTAL and GNCPC towards the end of the project has signed an agreement to adopt the training manuals in the NVTI training institutions to train students in the construction of biogas plants. As a result, memorandum of understanding has been adopted and signed among all the three parties involved. The process has started with the training of eleven (11) Teachers/Facilitators who participated in the last batch of training. Further training will be required to enhance their ability to train students in this field.

6. Integration /Complementarity with other SWITCH actions

This project was selected based on the integrated waste management which is one of Ghana's focal area out of the three focal areas which includes tourism and manufacturing. This complements the Ghana E-waste Model (GEMOD) project being implemented by the Environmental Protection Agency which recycles e-waste into other forms. The construction of biogas plant has the potential to be constructed using plastic materials. This can be done in the manufacturing sector. A test sample has been done by L & G Ltd after engaging them in discussions on the production of biodigesters.

The project team engaged Pioneer Food Cannery Ltd, a manufacturing company that produces various types of canned fish and generates fish waste with the potential to generate large quantities of biogas to convert their waste treatment plant into a biogas plant. Biogas plant can also be integrated in the tourism sector where biogas plant are constructed in hotels which generate a lot of biodegradable waste is generated.

7. Cross cutting issues

The cross cutting issues can be related to the benefits the biogas plant brings to its users. It provides multiple solutions which this reason it is being promoted by the GNCPC. The promoting biogas technologies project solves the organic waste management problem by treatment of the waste and wastewater resulting in biogas and compost production and income generation for artisans/craftsmen.

The project also supports SMEs with the technical knowledge in this area. Industrial uptake with Accra Breweries Ltd using the technology for their wastewater treatment. Support to the Association of Ghana Industries (AGI) project where they are promoting biomass clean cookstoves and also the Industrial Symbiosis support for the industries with waste generated becoming a raw material for other industries. This promotes the SAG programmes ideals in promoting SCP patterns and green economic activities in Ghana.

8. Involvement/partnership with other key stakeholders

Various stakeholders were engaged and helped in the implementation of the project. The table 5 below gives the name of the stakeholder and their role in the project.

Table 6: Stakeholders and their role in the project

Stakeholder	Role in the project
Environmental Protection Agency	<ul style="list-style-type: none"> ▪ Member of NTCC
Ministry of Environment, Science, Technology & Innovation	<ul style="list-style-type: none"> ▪ Chair of NTCC
Ministry of Trade & Industry	<ul style="list-style-type: none"> ▪ Member of NTCC
Ministry of Health	<ul style="list-style-type: none"> ▪ Member of NTCC
Ministry of Energy	<ul style="list-style-type: none"> ▪ Policy direction in Renewable Energy
Ministry of Education	<ul style="list-style-type: none"> ▪ Provide policy direction and guidelines for health, energy usage, hygiene and waste management in schools
Energy Commission	<ul style="list-style-type: none"> ▪ To setup a procedure to ensure that all biogas projects in the country are streamlined to avoid any repetition. ▪ Working relationship has been established for possible collaboration in the offing. ▪ Provide technical advice on the development of training materials. ▪ Provide technical advice on training of artisans.
MMDAs through the Regional Coordinating Councils	<ul style="list-style-type: none"> • To ensure their cooperation during the implementation of the project and also to ensure the sustainability of the project as they absorb the artisans that are going to be trained. • Liaise with GNCPC for the training of artisans.

Ministry of Local Government & Rural Development	<ul style="list-style-type: none"> ▪ Provides policy direction in municipal waste management in Ghana
Engineering Council of Ghana	<ul style="list-style-type: none"> ▪ To help with the awareness creation activities.
NVTI/COTVET	<ul style="list-style-type: none"> ▪ Provide accreditation for training courses and certification for trainees
Private Sector Biogas Companies & individual experts	<ul style="list-style-type: none"> ▪ Provide input to the formation of the biogas association. ▪ Provide technical input to the development of training materials and the software for estimating biogas plant construction.

9. Sustainability measures installed beyond the project, lessons learned, and recommendations

- 9.1 The Project implementing partners in collaboration with the GNCPC has put in place the necessary steps required for the sustainability of the project after its implementation period.
- 9.2 The signing of MoU between NVTI and GNCPC/BTAL will ensure that biogas training of students in the Vocational and Technical Schools will continue to be done to ensure adequate human resource for the construction of biogas plants.
- 9.3 The GNCPC/BTAL will also continue to roll out training programmes annually to train artisans each year at a fee to ensure that artisans can acquire the skills required for the construction of the biogas plants. The launch of the National Building Code will require more artisans who will be engaged to construct biogas plants or convert existing septic tanks into biogas plants.
- 9.4 The GNCPC with in-house expertise, will also construct small to large biogas plants for potential clients at a reasonable cost. This will be done based on the agreements signed with clients.
- 9.5 The GNCPC will continue to work with its partners to provide consultancy and other services in relation to the promotion of biogas technologies.
- 9.6 The establishment of the Biogas Association of Ghana through the GNCPC will ensure that the Association will continue to promote biogas technologies with its partners.
- 9.7 The development of the biogas calculator software will make it easier for biogas contractors to provide building estimates to clients at their request.

10. Financial report

The project was expected to cost a total of three hundred and nineteen thousand seven hundred and forty eight United States Dollars (\$319,748). The European Union contribution to the project was two hundred and fifty thousand United States Dollars (\$250,000.00) making a seventy eight percent (78%) of the total cost of the project while GNCPC in-kind contribution to the project was sixty four thousand one hundred and thirty one United States Dollars (\$64,131). Biogas Technologies Africa Ltd an associate to the project made an in-kind contribution to the project of thirty two thousand five hundred United States Dollars (\$32,500) for the supervision and construction 2 biogas plants. The Environmental Protection Agency also made a contribution of two hundred and fifty thousand United States Dollars (\$250,000) as part of its contribution to the construction of ten (10) biogas plants which have been constructed in seven (7) Senior High Schools with one of the schools which has been supplied with accessories.

Hence the overall total cost of the project is five hundred and sixty nine thousand seven hundred and forty eight United States Dollars (\$569,748).

There is an outstanding amount of fifty thousand United States Dollars (\$50,000) to be refunded to the GNCPC.

The table below gives a breakdown of the expenditure made on the project.

Table 7; Project Expenditure

	All Year	UNOPS	GNCPC	EPA**
Total Amount for All Years/Total amount to be contributed by partners	569,748.10	249,999.99	69,749.00	250,000.00
Amount Spent to Date (July 2015 - March, 2018)	569,731.33	569,731.33	319,749.00	
Amount Contributed (Received)		200,000.00	69,749.00	250,000.00
Actual Spending		249,999.99	69,731.34	250,000.00
Percentage of Amount spent to Amount Contributed (Received)		125.00%	100.0%	100%
Percentage of Amount spent to total budget for all the years	100%	44%	12%	44%
Percentage of Amount Contributed to total amount to be contributed by each partner for all years		80%	100%	100%
Balance from Contributions		- 49,999.99	17.66	-
NOTE: J=Disbursement of UNOPS first tranche				
UNOPS contribution budget balance	(49,999.99)			
**In completing the annual financial report template, the US\$250,000.00 EPA contribution used for the construction of the 10 schools biodigesters was not included.				

See attachments

11. Appendixes

- i. Baseline survey report
- ii. Biogas calculator manual
- iii. Complete list of all trainees
- iv. Contracts awarded
- v. Development of training manuals report
- vi. List of biogas installers
- vii. Training manuals on biogas construction
- viii. Validation attendance sheet signed by participants