ACP Science
and Technology II Programme

WABEF — Western Africa bio-wastes for energy and fertiliser

Songhaï green rural city model: a sustainable socio-economic settlement for the millennium. Sign displayed at Songhaï Regional Centre in Porto-Novo, Benin (July 2017). © M. Kamaté

SUMMARY OF RESULTS

Anaerobic digestion has been promoted to decision makers and practitioners interested in installing a biogas plant in West Africa as a way to recycle bio-wastes for energy and fertiliser use, and thus closing the organic matter loop. An operational tool has been developed for each step of the biogas value chain: availability of bio-wastes; supply needs for different anaerobic digestion systems; use of biogas and agronomic management of bioslurries; viability for the whole value chain business; and ready-to-use knowledge (theoretical and practical) for decision makers and practitioners. A policy brief has been published on the integrated development of the biogas sector in West Africa describing and illustrating why the usage of bio-wastes for the production of biogas should be promoted, how it should be produced, and what policy and financial incentives are needed to promote a wider use of biogas.

BACKGROUND

Population growth and urbanisation, along with changes in lifestyle and consumption, lead to large quantities of solid and liquid organic waste from agricultural, agro-industrial and urban activities. In the absence of an adequate waste management system, these can affect human health and the environment. Biogas technologies are unique among renewable energy forms in that they address environmental, health, agricultural and energy issues in sub-Saharan Africa in an integrated manner.

Within the framework of a (decentralised) mix of renewable energy, the production of biogas contributes to a reduction in (negative impacts of) the use of wood and fossil fuels. Better management of organic waste sources and pollution, as well as the implementation of clean cooking methods, contribute to improved sanitation, hygiene and health. In addition, the recycling of bioslurries or digestates contributes to improved agricultural performance, and biogas production creates new businesses along the service value chain, contributing to increased employment and improved livelihoods.

The adoption of renewable energies in developing economies is growing rapidly. In 2005, the Biogas Africa initiative was launched and since then, many actors have participated in various initiatives to support the development of anaerobic digestion. However, the dissemination of biogas in sub-Saharan Africa encounters obstacles, such as constraints to mobilise organic residues, high initial investment (construction) costs, incomplete national biogas programmes, and technical, institutional and socio-cultural barriers. Innovative approaches to disseminate information and build capacities are needed to support the private sector, governments and civil society to enable wider adoption and use of biogas as part of a further increase in the proportion of renewable energy in Africa.

To develop a critical mass of specialists in biogas and related topics for biogas development and dissemination, the target groups from the WABEF project were: public decision makers, researchers and lecturers, non-governmental organisations (NGOs), and technical staff from municipalities and agro-industries. The final beneficiaries were: communities, students and young entrepreneurs, industrial parks and agro-industries' managers, and farmers.

PROJECT IMPLEMENTATION PERIOD
February 2014 - July 2017

CONSORTIUM
- CIRAD - Centre de coopération Internationale en Recherche Agronomique pour le Développement, France
- Université Cheikh Anta Diop (UCAD), Senegal
- Institut Africain de Gestion Urbaine (IAGU), Senegal
- Association d'Entraide pour le Développement Rural – Teriya Bugu (AEDR), Mali
- Songhaï Regional Centre, Benin
- International Network of Resource Centres on Urban Agriculture and Food Security (RUAF Foundation), The Netherlands

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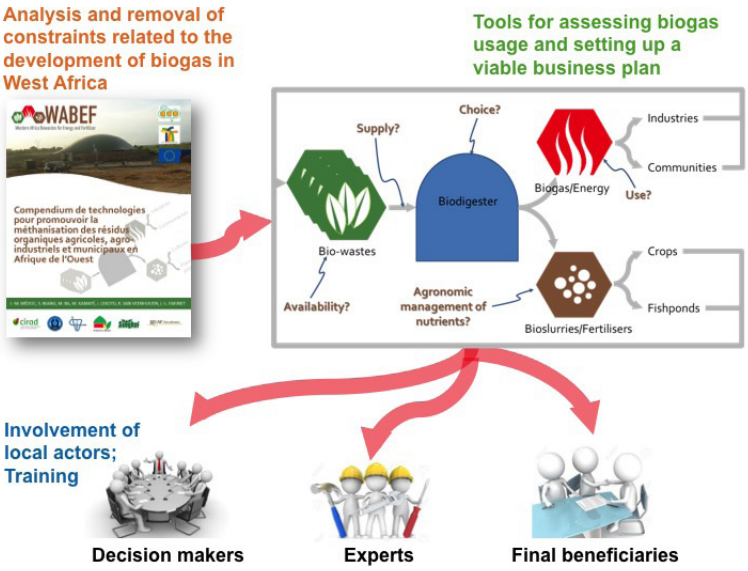
WABEF
Western Africa Biowastes for Energy and Fertilizer

METHODOLOGY



Analysis of biogas experiences in Europe and Africa

To remove the constraints related to the development of anaerobic digestion in West Africa, relevant and viable anaerobic digestion technologies in the Sudano-Sahelian context were identified. 14 visits to anaerobic digestion sites in Europe and 20 in Africa showed technological and managerial successes and failures, but also political and regulatory incentives and disincentives. The technical indicator relating to the nature of the bio-waste intake and the annual quantity processed in the biogas unit and the electric power generated were used as key indicators. Challenges to overcome for the development and appropriation of biogas as a solution for the management of bio-wastes in West Africa require a favourable political climate and strong government support that includes proper financial support for businesses and households investment. An integrated approach must also enable appropriate management of the information, the adapted technology chain, the bio-waste resources (where, when, how much, with which energy and agronomic potential, competition, etc.) and the recycling of bioslurries. The results of the analysis were presented in a compendium that guides practitioners (contractors, biogas plant operators, entrepreneurs, farmers) interested in implementing a biogas plant, project promoters and policy makers into these constraints and challenges and towards the appropriate assessment tool which has been designed or adapted for each step of the biogas value chain.

Interview of the operator of an industrial biogas plant treating palm oil mill effluent in Kwae, Ghana (February 2016). © J.-M. Médoc

WABEF, a toolkit to support the design of biogas value chains

Tools (database, dynamic simulation and calculator) were developed allowing the provision of answers to the following questions: What is the availability of bio-wastes? Which biogas system can be opted for? What possibilities are there for biogas use? When to use bioslurry or digestate? Is the whole biogas value chain feasible? What knowledge and know-how are needed for decision makers and practitioners? Most of these tools are designed with the MS Excel® spreadsheet.

Two existing demonstration plants (in Mali and Benin) were upgraded with extra materials (biogas engine, tarpaulin and monitoring devices) to complete the biogas value chain in order to show operational and sustainable biogas and bioslurry production technologies in local context. These were very useful to define the conditions for a feasible business model and to promote the integrated development of biogas.

Dissemination of knowledge in West Africa

Several multi-stakeholder events were held to ensure that the main results of WABEF were communicated to the relevant target groups and to engage them in the development of biogas in West Africa. A regional summer school was organised at Songhaï (Benin) to train high-level actors from international organisations, ministries, national agencies of renewable energy, NGOs, research institutions and universities from Benin, Cape Verde, Mali and Senegal in the use of the WABEF toolkit and further uptake and dissemination. A policy brief on integrated development of biogas in Africa for advocacy to policy makers, national and local institutional executives and financers has also been produced. A lesson plan for courses on the WABEF approach and tools was developed to be included, among others, in a graduate curriculum in Senegal for students, technicians, engineers, practitioners and decision makers from the agriculture, agro-industry and urban sectors.

Bio-wastes sample collection (here: cattle manure) in Kaffrine, Senegal, to assess their agronomic and energetic values (February 2016). © J. A. Sambou

Wabef Songhaï Energy 'Nenuphar' tarpaulin for biogas production at Songhaï Regional Center in Porto Novo, Benin (July 2017). © M. Kamaté

Outputs

Capacity building

- 1 regional summer school with high-level actors (bioenergy senior officer from the ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE), programme officer from the West and Central African Council for Agricultural Research and Development (WECARD), directors of energy departments from ministries, researchers, technical advisors of national agencies of renewable energy, programme officers from NGOs, and university staff) from Benin, Cape Verde, Mali, Senegal and Niger (3 female, 20 male) trained in the use and dissemination of the WABEF assessment approach and toolkit.
- 4 multi-stakeholder events in Benin (1), Mali (2) and Senegal (1) for engagement and outreach to entrepreneurs and operational directors, project officers and coordinators from NGOs and public programmes, technicians from local institutions and NGOs, and university staff.
- 1 lesson plan for courses in specific masters' programmes in West Africa to train students, technicians, engineers, practitioners and decision makers from the agriculture, agro-industry and urban sectors on 'Integrated biogas development to contribute to the agro-ecological transition in sub-Saharan Africa' *(Méthanisation intégrée pour contribuer au développement de l'agro-écologie en Afrique Subsaharienne)*.
- >1,000 high school and university students informed on the biogas value chain during educational visits to the demonstration sites in Teriya Bugu (Mali) and Songhaï (Benin).
- 150 MSc students trained on the environmental and agronomic impacts of bio-waste use and on integrated biogas development to contribute to the agro-ecological transition in sub-Saharan Africa.

Tools

For each step of the biogas value chain, WABEF adapted or designed an operational toolkit with 7 decision-making support tools:

- A methodology to identify, quantify and evaluate the potential availability of bio-wastes in terms of biogas production and fertiliser use of digestates, making use of 3 databases (MS Excel®) to estimate the wastes from agricultural (crops and livestock), municipal (bio-waste, faecal sludge and sewage sludge) and agro-industrial activities.
- 2 simulation models (Approzut and UPUTUC) adaptable to the West African context for the evaluation of bio-waste supply strategies for a collective biogas unit.

Automatic Methane Potential Test System to assess the biochemical methane potential of bio-wastes, located at the ISRA/IRD research centre of Dakar, Senegal (September 2015). © J.-M. Médoc

- Adapted technical economic model 'Methasim©', a web software to simulate on-farm biogas production.
- A MS Excel® spreadsheet to help local fertiliser providers, farming communities and farmers implementing an appropriate soil fertility system with organic residues based on bioslurry applications.
- A MS Excel® spreadsheet to assess the use of biogas for direct use (heating, cooking) or electricity generation.
- A set of 3 business model templates to assess the feasibility of a new biogas value chain (implementation of new biogas plant) and the viability of an existing biogas plant.

Manuals

- Biogas handbook (French, English) on the establishment and operation of a biogas production unit at domestic or small rural community scale.
- 1 compendium of technologies to promote the anaerobic digestion of agricultural, agro-industrial and municipal organic residues in West Africa.

Infrastructure

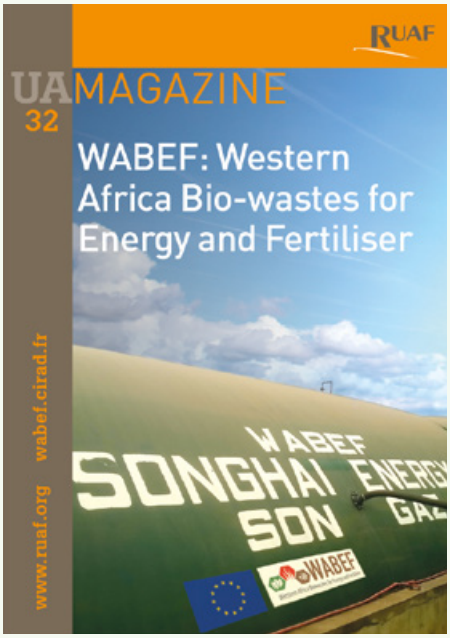
- Laboratory, biogas measurement and safety equipment at AEDR-Teriya Bugu (Mali) and Songhaï Regional Centre (Benin).
- A Nenuphar (i.e. water lily) tarpaulin and a biogas engine of 25 kW at Songhaï Regional Center (Benin).

Visibility

- Project website.
- >700 flyers, >200 posters, 5 banners, 200 USB sticks, 500 pens, 200 notebooks.
- 1 video on production and use of biogas.
- 3 radio and 2 Web TV interviews.
- 1 policy brief on integrated development of biogas in Africa for advocacy to public decision makers, national and local institutional executives, and financers (350 leaflets in English / French).
- 4 articles in a popular magazine (500 copies in English / French).
- 2 national newspaper articles (Benin and Senegal).
- 1 Web article.
- 1 WhatsApp group.
- 7 presentations at scientific and technical seminars.

Publications

- Médoc J.-M. and van Veenhuizen R., 2017. WABEF: Western Africa bio-wastes for energy and fertilisers. Urban Agriculture Magazine (32): 11-17.
- Kamaté M. and Médoc J.-M., 2017. Teriya Bugu in Mali. Urban Agriculture Magazine (32): 18-20.
- Lekoto J. and Médoc J.-M., 2017. Centre Songhai: Integrated development of renewable energy in Benin. Urban Agriculture Magazine (32): 20-23.
- Ba M. and Médoc J.-M., 2017. WABEF Support to renewable energy development in Senegal. Urban Agriculture Magazine (32): 24-25.
- van Veenhuizen R. *et al.*, 2017. Integrated development of biogas in West Africa. Leusden: Ruaf, 4 p. (RUAF Policy brief).
- Médoc J.-M. *et al.*, 2017. WABEF: une boîte à outils pour promouvoir la méthanisation des résidus organiques en Afrique de l'Ouest. In: Recueil des résumés JRI 2017. Club Biogaz ATEE, UniLaSalle. Beauvais: Club Biogaz ATEE-UniLaSalle, Résumé, 50.



Cover of the Urban Agriculture Magazine #32 highlighting the article on WABEF.

RESULTS

Outcomes

- Awareness raised among decision makers, institutional executives of public institutions (ministries, agencies, municipalities), researchers, university staff and engineers of sharing data, particularly on bio-waste deposits and the necessary implementation of their quantification and qualification in terms of agronomic and energy potentials.
- Key players from ministries' directorates, local institutions, technical and outreach institutions (chambers of agriculture, professional organisations and farming co-operatives), and chambers of commerce and industry identified for the collection and management of bio-waste data.
- Bioslurries as a new bio-waste managed in terms of quality assessment (for which national and regional standards on fertilising material need to be updated to include bioslurries) to qualify them in term of agronomic values and correct usage as fertiliser in agriculture.

Impacts

Usage

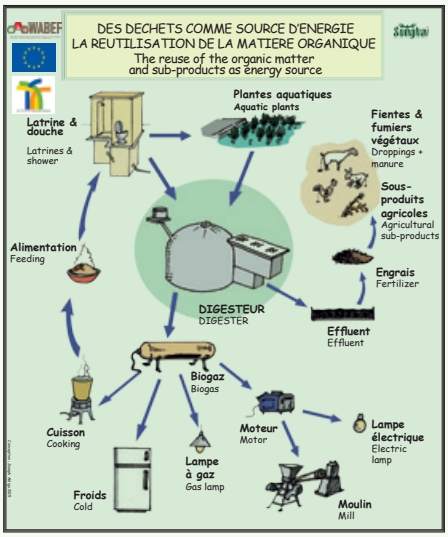
- A first identification campaign on data collection of bio-waste deposits carried out in Senegal in the Peanut Basin by the Institut Sénégalais de Recherches Agricoles (ISRA) and the Biogas National Programme of Senegal (BNP-SN) identified agricultural bio-wastes suitable for anaerobic digestion.
- 2 students trained in the project implemented the methodology to identify and qualify available bio-wastes in the vicinity of Kaolack and Zinguinchor (Senegal) to promote the construction of biodigesters in their villages.
- The identification of bio-waste deposits induces an important leverage effect for research projects dealing with the urban food-waste-energy nexus.
- The agricultural interest of bioslurries issued from individual and industrial biodigesters has a significant market value. Thecogas and the BNP-SN are engaged in a standardisation process for bioslurry to provide farmers with a satisfactory cost-effectiveness ratio of its usage as fertiliser. ISRA and CIRAD are assisting by assessing the agronomic value of current bioslurries produced in fixed dome biodigesters and of new bioslurries produced at laboratory and field level.
- >10 entrepreneurs (from Senegal, Congo and France) are using the WABEF business model templates to convert bio-wastes into energy and fertilisers to assess the viability of their business ideas.
- 3 companies have approached CIRAD to support the development of a biogas value chain in Ivory Coast and Senegal.

Policy implications

- In Mali, the National Agency for the Development of Biofuels (ANADEB) is introducing the development of a national programme on biogas with the following objectives: Research and management of various waste materials for biogas; Distribution of 7,000 biogas digesters (2017-2021); Operationalisation of a bio-energy quality control laboratory.

Sustainability

- CIRAD with the BNP-SN and ISRA will continue their collaboration on bio-waste research.
- CIRAD in partnership with Senegalese and Ethiopian research and academic institutions are engaged in the project 'OR4FOOD' – Organic Residual Products for biofortified Food for Africa (funded by the African Union).
- The Malian Biogas National Programme and the demonstration plants at Songhaï in Benin and Teriya Bugu in Mali remain operational.



Poster explaining the re-use of bio-waste (i.e. organic matter) as inputs in a biogas plant to produce energy and fertiliser.

Visit to 4 biodigesters in parallel digesting the waste-water and faecal sludge from the Rubaga Hospital, Kampala, Uganda (November 2014). © J.-M. Médoc

Visit to the industrial lagoon biogas plant treating palm oil mill effluent in Kwae, Ghana (May 2016). © M. Ba

Visit to the Safisana grid connected biogas plant (in construction) in Aïschaman slum near Accra, Ghana (May 2016). © M. Ba

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