Assessing the prospects and requirements for bioenergy development in seven demand sectors in Sub-Saharan Africa

Biogas CHP plant at Uilenkraal dairy farm, Western Cape Province, South Africa (credit: www.engineeringnews.co.za)

As part of a larger team, NIRAS-LTS investigated the barriers, market and policy issues, business models and financial solutions to identify potential commercial-scale opportunities for bioenergy in the region

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- **SDG:**#7, #9, #12, #5
- **SECTORS:**Development Consulting
- **COUNTRIES:**Ethiopia, Ghana, Kenya, Mozambique, Nigeria, Rwanda, South Africa, Tanzania, Uganda and Zambia
- **DONOR:**UK Foreign Commonwealth and Development Office (FCDO)
- **CLIENT:**Carbon Trust (on behalf of FCDO)
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- **PARTNERS:**Aston University, E4tech and AIGUASOL

NIRAS-LTS partnered with Aston University, E4tech and AIGUASOL for a two-year research project entitled **'Bioenergy for Sustainable Local Energy Services and Energy Access in Africa - Phase 2'** (BSEAA2), part of the Transforming Energy Access (TEA) programme, funded by UK Aid from the UK Government. Two leading technologies became the focus in seven prioritised demand sectors.

The BSEAA2 project delivered practical outputs to support the expansion of bioenergy markets in sub-Saharan Africa. The outputs provide comprehensive and tailored information regarding the technical, economic and commercial feasibility of bioenergy developments, taking into consideration the local market conditions of each target country and demand sector.

Antoinette Gous: BSEAA2 Project Coordinator under the UK aid funded Transforming Energy Access Programme managed by Carbon Trust

Context

Sub-Saharan Africa has a huge variety of bioenergy feedstocks with an enormous potential to meet Africa's burgeoning demand for modern energy services. Making more effective use of biomass-based energy can play an important role in improving energy access. Given that biomass feedstocks are closely related to agricultural practices and land use, suitably designed bioenergy investments have the potential to improve agricultural productivity, localise energy supply, reduce greenhouse gas (GHG) emissions, reduce deforestation, generate supply chain economic activities, deliver social benefits and empower poor communities.

However, bioenergy development has been extremely constrained with a low success rate of commercial deployment in Africa. Key barriers to its commercial utilisation span various aspects covering biomass resource, technology, economics, finance and institutional and regulatory frameworks.



Biogas purification and bottling plant at Olivado (EPZ) Ltd, Murang'a County, Kenya (credit: Hannes Muntingh)

Biomass resource related barriers include high dispersal, poor supply infrastructure and high sourcing costs. Technical barriers to conversion include insufficient understanding amongst local players of feedstock-technology fit and a lack of technologies tailored to African contexts. Financial barriers include inadequate or non-existent supply chains, high costs of pre-treatment and conversion, and insufficiently robust and tested business models. Institutional barriers meanwhile include inadequate understanding of interfaces between different supply chain stages and actors, alongside unfavourable institutional and regulatory frameworks.

Rationale

While the common barriers to wider adoption of bioenergy in Africa are well-known, a more comprehensive understanding of the requirements and opportunities for catalysing bioenergy development in sub-Saharan Africa is still largely missing. BSEAA Phase 2 was therefore designed as an applied research programme aimed at generating evidence-based analysis, practical resources and tools to assist entrepreneurs, investors and policymakers in assessing the feasibility and application of bioenergy to catalyse action for the further development of commercial-scale bioenergy in the region.

Overview

The findings of the BSEAA Phase 1 project (2016 to 2017) concluded that the highest potential option for catalysing development of commercial-scale bioenergy in SSA was supporting the scale up of proven and innovative technologies that have shown some degree of economic and operational success across sub-Saharan Africa. Accordingly, building upon the results of BSEAA Phase 1, this research focused on opportunities for anaerobic digestion (AD) and combustion for electricity and/or heat generation in the

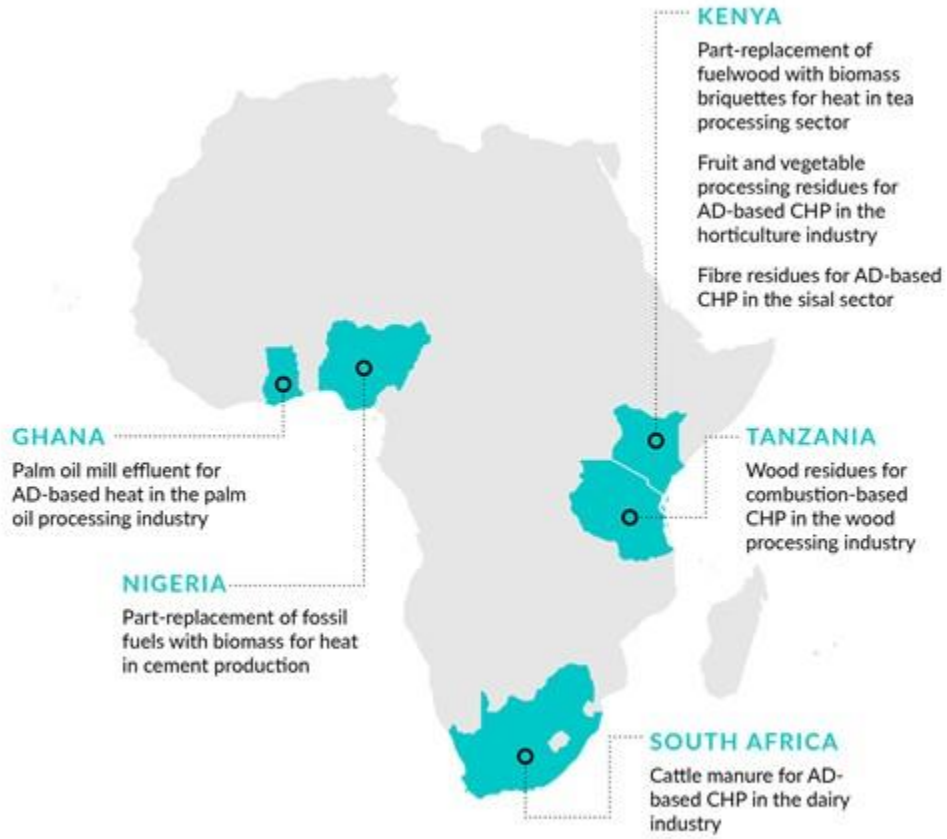
range 10 kW to 5 MW. Opportunities, challenges and requirements for commercial deployment of these technologies were investigated in ten countries (Ethiopia, Ghana, Kenya, Mozambique, Nigeria, Rwanda, South Africa, Tanzania, Uganda and Zambia), through the six themes of biomass resources, technology, economic competitiveness, commercial viability, institutional, market and regulatory frameworks, and gender and inclusion (G&I).

I found the LCC toolkit highly aligned with our work at WASE. If adopted, I believe that the tool will beautifully illustrate the cost-benefit analysis of our industriWASE system. It'll present our clients with their base case versus the industriWASE case, eventually helping them see the added benefits that industriWASE offers.

Faryal Rohail- Project Manager at WASE, UK

Project findings and conclusions

The project began with the identification, analysis and screening of a range of bioenergy 'pathways', to identify the most promising opportunities for further investigation. This resulted in the shortlisting of the seven priority demand sectors in five countries.



The seven shortlisted demand sectors were investigated in more detail to explore the experiences of both adopters and non-adopters of bioenergy technologies through the study's six inter-linked themes. Detailed analysis for each demand sector highlights the constraints and opportunities for bioenergy development. A summary of the key conclusions from across these seven sectors is presented below:

- The availability of sufficient and suitable feedstock is generally not a barrier to adoption of bioenergy, provided there are durable and commercially viable **aggregation systems in place and clarity of ownership,** particularly if the feedstock is not available on site.
- Technology is rarely a limiting factor for combustion-based CHP, though more **local adaptation and supply chain development for AD technology** would boost the economic case for biogas.
- The economic case for bioenergy, especially for combustion-based CHP, requires significant **on-site demand for heat**, otherwise this resource is wasted.
- In all cases there should be a transparent enabling environment to **enable bioenergy electricity suppliers to access the national grid** (e.g. cost-reflective Feed-in-Tariffs , net-metering, wheeling to third parties).

Bagasse briquette from White Coal, Kisumu. Photo by Simon Thuo

The BSEAA2 project has been very timely given the current focus on the potential of next generation bioenergy technologies. From the perspective of an early-stage impact investor, I have found the work both relevant and rigorous. The written reports along with the mass-energy balance and levelised cost of energy calculation tools provide a framework which will be extremely useful in assessing the technical and commercial viability of future bioenergy investments.

Nick Goddard, UK Venture Partner, Factor[e] Ventures

Bioenergy for thermal applications offers the most growth potential within the sectors studied. Investment in biomass-based electricity generation is largely limited to enterprises with their own significant internal requirements. Wider adoption is constrained by unsupportive or poorly enforced policies, with a need for much stronger government commitment, particularly for supporting grid electricity exports.

A stand-alone study on the prospects for commercial biomass gasification in sub-Saharan Africa was also undertaken. Drawing upon African and relevant global experiences in gasification over the past forty

years, the study concluded that the challenges hindering gasification development in Africa are too onerous to overcome. This gives no room for optimism that gasification can be a commercially sustainable technology for the region.

Key achievements:

This research will lead to an improved understanding of the commercial, economic and institutional requirements and opportunities for scaling up generation and application of bioenergy for various uses in low-income countries in sub-Saharan Africa. The team has developed a range of research reports, tools, policy briefings and databases to guide developers, investors and policy makers advance bioenergy development in the region. These include:

- Series of seven comprehensive technical reports on bioenergy opportunities in seven promising demand sectors in sub-Saharan Africa (cement, tea, wood processing, palm oil, horticulture, dairy and sisal)
- Seven accompanying policy briefs highlighting relevant regulatory and market conditions, and measures required to catalyse further adoption of commercial-scale bioenergy in sub-Saharan Africa
- Validated economic Life Cycle Costing (LCC) toolkit and mass-energy balance (MEB) model, to inform economic and technical potential respectively for entrepreneurs and financiers considering investment in bioenergy in Africa
- Database of technology providers and manufacturers providing a curated list of prominent technology providers who have undertaken or supported projects in BSEAA2 target countries.
- Database of bioenergy projects across 10 target sub-Saharan African countries
- Report on Prospects for commercial biomass gasification in sub-Saharan Africa

The developed BSEAA2 toolbox is robust and timely; it would be a veritable tool to teach our MSc students case studies, particularly in the Bioenergy Conversion Technology course, in the MSc Energy Access and Renewable Energy Technology programme at the University of Port Harcourt, Nigeria.

Dr E.O. Diemuodeke- Faculty of Engineering and Asst. Director of Offshore Technology Institute, University of Port Harcourt, Nigeria

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