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**ANNEX 5-3-2: Practical Guidelines for Investors in Sustainable
Bioenergy in Africa**

COMPETE

**Competence Platform on Energy Crop and Agroforestry
Systems for Arid and Semi-arid Ecosystems - Africa**

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Practical Guidelines
For
Investors In Sustainable Bio-Energy In Africa

December 2009

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Introduction

These Practical Guidelines for Investors have been written in the framework of the project COMPETE (Competence Platform on Energy Crop and Agroforestry Systems for Arid and Semi-arid Ecosystems - Africa), co-funded by the European Commission in the 6th Framework Programme – Specific Measures in Support of International Cooperation (Contract No. INCO-CT- 2006-032448).

The objective of the COMPETE project is to stimulate sustainable bioenergy implementation in Africa. COMPETE has established a platform for policy dialogue and capacity building in the major multi- and bi-lateral funding organisations and key stakeholders throughout the bioenergy provision and supply chains. COMPETE carries out a comprehensive, multi-disciplinary assessment of current land use, energy demand and technology innovation focused on Africa to identify pathways for the sustainable provision of bioenergy, which will:

- improve the quality of life and create alternative means of income for rural populations in Africa
- aid the preservation of the critical functions of arid and semi-arid regions in Africa as intact ecosystems
- enhance the equitable exchange of knowledge between EU and developing countries

E+Co was invited to participate in the COMPETE project to contribute to the financing work package, aimed at sharing E+Co's experience as a dedicated investor in clean energy in Africa, Asia and Latin America. E+Co invests in local clean energy enterprises and projects in more than 22 countries to promote greater access to energy.

These guidelines were prepared in the context of the 'International Conference on Sustainable Bioenergy Projects in Africa,' addressing the Barriers and Opportunities for Financing (29 September to 1 October 2009 in Dakar, Senegal). This conference is organised by COMPETE in close cooperation with the United Nations Environment Programme (UNEP).

These guidelines introduce potential small to medium scale (up to US\$5m) investors and project developers to some barriers and opportunities of investing in bio-energy in Africa from the viewpoint of a practitioner. E+Co's experience with investing in clean energy demonstrates that there is indeed an investment opportunity. With a clear investment strategy and with appropriate financing products for projects and entrepreneurs, bioenergy in Africa can be a profitable opportunity for investors.

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1. Sustainable Investing in Renewable Energy in Emerging Markets

Sustainable energy in developed countries has gained momentum since the consequences of running out of fossil fuels and of course the effects of climate change have been realized.

Now that this has led to technological solutions for a new energy future, a true market place is needed. And that's where emerging markets have an advantage over old economies. Emerging markets have ample renewable energy resources (including bioenergy) that are hardly being used, and are looking to add new clean and affordable generation capacity. Moreover, these countries have high energy costs, so renewable energy can be financially attractive. So, there is a market to implement the new energy technologies.

All that is needed is qualified entrepreneurs, adequate financing, and then an appropriate regulatory and legal framework.

Focusing on financing, you might assume that local banks and governments would take care of that. Unfortunately not yet or not enough. Local funding in emerging economies has other priorities, such as growing the traditional economy. And financing of renewable energy, including biomass, biogas and biofuels, requires specific skills and a risk-attitude that many banks in emerging markets do not yet have.

Financing renewable energy in emerging markets is a market for dedicated investors with a clear vision on a specific segment, such as bioenergy. Financiers with aligned interests (commercial, social and environmental) can provide a pool of funding for the market opportunity that sustainable energy in emerging economies represents.

Given the early stage of the renewable energy market in many emerging economies, these funds face particular challenges: over-average lead time for projects to be profitable; relatively small average size of the investment, especially for those funds targeting energy enterprises serving rural populations or off-grid solutions. This comes with high costs of getting started (engaging funders, training local staff) and limited financial returns. Therefore, these investment funds often combine commercial investors and capital providers with a high appreciation of the social and environmental benefits of clean and affordable energy.

In conclusion, there is indeed a market place for sustainable energy in emerging economies. Early stage specialists have set the stage and are now scaling up their activities. New groups of funders, such as private investors seeking a 'triple bottom line return' (people, planet and profit) are partnering with these funds to leverage their experience, pipeline and networks. And, in some regions, local banks and investors act as co-financier in projects or funds, an important next step in creating a sustainable local financing market for sustainable energy in emerging markets.

Paul van Aalst



2. Energy Sector – Overview

The vast majority of countries in Africa struggle to meet the energy demands necessary for the transformation and growth of their economies to improve the livelihood of their people. One third of global population without access to energy live in Africa and only 8% of total rural and 52% of urban population have access to energy¹. The average rate of electricity access in sub-Saharan Africa² was around 25% in 2005. The demand for energy far exceeds the current level of production and supply of energy.

2.a Electricity

Electricity supply is very low in most African countries. Electricity accounts for about 8% of primary energy used in Africa. The conventional power utilities have failed to produce adequate electricity to match the demand generated by an average annual economic growth of 6% over the past decade. The conventional power sector suffers from major operational challenges including outdated and inefficient generation equipment and high transmission and generation losses. These challenges, coupled with the excessive demand over supply, result in unreliable power supplies fraught with power cuts and rationing and low access levels. Electricity is mainly available in the urban centers to middle and upper income households. Electricity is also available to formal industries and commercial and service sectors. However, due to electricity unreliability, many industries and commercial buildings rely heavily on diesel generators. The electricity grid penetration rate in urban poor and rural communities in most Sub-Saharan Africa countries is about 2%.

Electricity demand far exceeds supply. Even South Africa, which accounts for 45% of total electricity generated in Africa and has one of the most efficient and extensive grid networks suffered acute power shortages in 2008. In 2006, Tanzania recorded excess demand of 5,268 GWh, while in 2007 Ghana's and Uganda's demand outstripped supply by 3,541 GWh and 5,342 GWh respectively.

With the exception of South Africa, which derives the bulk of its electricity from coal, most African countries generate electricity primarily from hydro and thermal sources.

2.b Petroleum

Petroleum products contribute significantly to the primary energy used in Africa, particularly in the commercial and services sector and industries. Whilst petroleum products account for about 12% of primary energy that reaches consumers in East Africa, it accounts for about 20% of primary energy consumed in West Africa. In 2008, total oil consumed in Africa was 2.8 million barrels per day. Meanwhile, Africa

¹ International Energy Agency 2006, Barnes 2007

² Sub-Saharan Africa does not include South Africa and North Africa



produced 488 million tons of oil in 2008, or 12.8% of the world's total³. Kerosene is often used, primarily for lighting in most rural households. The transportation sector accounts for about 60% of total petroleum products consumed in Africa. Most African countries import crude oil. The high oil import bill exposes sub-Saharan Africa's energy sector to price shocks in the international oil market.

2.c Biomass / Wood fuels

Africa is the world's largest consumer of biomass energy (firewood, agricultural residues, animal wastes, and charcoal), calculated as a percentage of overall energy consumption. Africa consumed an estimated 640 GWh of solid biomass in 2006, according to the International Energy Agency. Most of Africa's biomass energy use is in sub-Saharan Africa. Biomass accounts for 5% of North African, 15% of South African (minus South Africa), and 86% of sub-Saharan energy consumption.

Biomass in the form of firewood and charcoal are consumed mainly in low income households in urban and rural communities for cooking and lighting purposes. In the formal services sector, restaurants, canteens and school kitchens use massive amounts of biomass for cooking.

Presently biomass used in most households in Africa generally is from non-renewable sources. It is a major cause of deforestation and degradation in Africa. Deforestation has negative implications for the local environment, such as increased erosion, as well as the global environment, in which acceleration of climate change and threatened biodiversity are risks. Many African nations have had over three quarters of their forest cover depleted. Biomass is also a major cause of indoor air pollution, a major cause of respiratory illnesses in sub-Saharan Africa.

2.d Clean Energy

In addition to the detrimental effects of traditional energy resources, high oil prices and depletion of established fossil fuel reserves have prompted interest in clean energy that is accessible, reliable, and affordable.

Africa has enormous clean energy resources. The continent has 1.1 GW of hydropower capacity, 9 GW of geothermal potential and abundant biomass, solar and significant wind potential⁴. To date, the substantial clean energy potential in Africa is scarcely being utilized. Although real investment opportunities already exist, substantial improvements in the legal, energy and financial sector are required to benefit from these resources in a sustainable way. To meet Africa's energy demand for sustainable economic growth and transformation, clean energy must be a critical component of the energy mix.

³ BP Statistical Review of World Energy. June 2009.

⁴ Karekezi and Ranja 1997



3. Potential Applications for Biomass Energy

Biomass energy projects convert organic matter - plants, trees, agricultural residue, and animal waste for example - into useable energy carriers including methane gas and transportation fuels like ethanol and biodiesel. This conversion process can be achieved through a variety of technological options including: cogeneration, anaerobic digestion, gasification, direct combustion, pyrolysis, gasification, cogeneration, liquid biofuels and landfill gas capture as described in detail below.

Biomass accounts for more than 10 percent of global energy use. In parts of the developing world it accounts for up to 90 percent. Biomass is an indigenous fuel source that is readily available and inexpensive throughout much of Africa. It can also be effectively converted to electricity and heat due to recent technological developments that have proven robust. These factors strongly suggest that biomass will play a significant role in the development of energy sectors across the world.

There is growing government support⁵ in the form of production subsidies, liberalization of the power sector, de-bundling of the power sector, standardized independent power producers power purchase agreements, standardized renewable energy feed-in tariffs and establishment of long term regional concessionary agreement in South Africa, Kenya, Tanzania, Ghana, and Uganda. One of the key drivers is changing government perception in favor of green energy as reliable option in the quest to expand energy sources. Increasingly, green energy projects are viewed as an effective tool to increase the levels of energy security in both off-grid and grid connected applications.

From the foregoing, bioenergy technologies for power generation, cogeneration and anaerobic digestion, hold the most promise for independent power generation in most African countries, particularly those listed above, due to the progressive development in the power sector in these countries. Also these countries have very well established industries whose characteristics and need for power make these technologies comparatively cost effective.

Bioenergy cooking fuels investment opportunities exist for biomass briquettes in most sub-Saharan Africa especially Tanzania, Senegal, Ghana, Kenya, Zambia and Cameroun where charcoal prices are extremely high up to \$26 per 50 kg bags and rate of deforestation has reached alarming rates. Biomass briquettes (carbonised) is a cheaper cooking alternative (< \$15 per 50 kg bag) if raw material⁶ is obtained for free. Although the investment cost is relatively high in excess of US\$ 200,000 compared to charcoal production in the informal sector, the payback period over a period of

⁵ Driven by local and international pressure to meet energy demands to stimulate economic growth and also meet renewable energy targets to reduce Green House Gas emissions

⁶ Sawdust, rice husks, groundnut husk



6 years is reasonably short. Biomass briquette become an unpredictable prospective if the raw materials is not readily available on site and have to be purchased and transported to site.

The price of crude oil is largely correlated to the investment opportunities for bioenergy fuels such as ethanol and jatropha oil. At best biofuels could be used as gasoline blends. The impact of biofuels production on land and food production has sparked an ongoing debate on the appropriateness of biofuels for Africa. The policy direction that will emerge out of this debate will determine the future for commercially viable biofuels industry in Africa.

Cogeneration

The most promising bioenergy technology in Africa for power generation is cogeneration. Cogeneration is the simultaneous production of more than one form of energy, usually thermal and electricity, using a single fuel and facility. Furnaces, boilers, or engines fuelled with biogas can cogenerate electricity for on-site use or sale by capturing the heat created as a by-product of electricity generation instead of emitting it through cooling towers or flue gas. Cogeneration can result in net fuel use efficiency of over 60 percent compared to about 37 percent for simple combustion. Electric power generators can become cogenerators by using residual heat from electric generation for industrial or domestic heating.

Cogeneration provides reliable, efficient and clean energy to industry that have joint requirements for heat and electricity. The technology is sound and proven largely in the sugar industry globally and in Africa. Apart from Mauritius where forty percent of the national generation capacity of 725 MW is generated from cogeneration power plants, the co-generation market in Africa is very much in its early development phase. In Mauritius the cogeneration industry is driven by the sugar industry which accounts for about 25% of the industry largely due to availability of economic volumes of bagasse, a waste product in sugar production.

Industries such as sugar, palm oil, wood, pulp and paper, mining, rice mills, and cement are attractive for cogeneration in a number of countries⁷. These industries typically require long hours⁸ of operation and lots of reliable power. Grid electricity tariffs are steadily rising annually (45% per annum in South Africa) and combined with the need for process heat, cogeneration plants provide a feasible, reliable, cost effective alternative. A recent collaborative⁹ initiative “Cogen for Africa”¹⁰ plans to develop about 40 MW of cogeneration power plants in East Africa over next 6 years.

⁷ Ghana, Kenya, South Africa, Uganda, Tanzania

⁸ At least 18 hr operational cycles per day

⁹ Global Environment Facility, United Nations Environment Programme, Africa Development Bank, AFREPREN/FWD

¹⁰ <http://cogen.unep.org>



World production of sugarcane amounted to 885 million tonnes of cane in 2000. On the basis of 100 kWh of electricity exported to the grid per ton of cane using the latest state of art technology, around 88,500 GWh per annum electricity could potentially be exported from the cane sugar industries. Sugar mill cogeneration worldwide had reached almost 1,100 MW installed and operating capacity with an additional 450 MW under construction in 2000.¹¹

Sugar is a major agricultural export commodity for several Eastern and Southern African countries. Estimates reveal that up to 10 Sub Saharan Africa countries¹² can generate 3,247 GWh per annum of energy, representing 12.73% of their current electricity consumption from bagasse-based cogeneration from sugar cane¹³. Karekezi estimates that Ethiopia, Kenya, Tanzania and Uganda have the potential for bagasse-based cogeneration of approximately 14%, 9.5%, 7% and 5.5% of the current national installed capacity respectively¹⁴.

Ghana generates about two million tonnes per annum of wood residues, which are available to generate energy and for other purposes. It is estimated that 600 GWh/yr of electricity can be generated from cogeneration by 2008 and increasing to 1,300 GWh/yr by 2015.¹⁵

There is investment opportunity for project developers to develop cogeneration power plants as independent power producers on a Build, Own, Operate and Transfer (BOOT) basis. This business model takes the financing burden of the plant from the host company and provides the opportunity for the host company to own the plant when the BOOT agreement expires. The host company has the added benefit of reliable, clean and cost effective power. Cogen for Africa reckons cogeneration potential of 732.4 MW in selected countries¹⁶. According to SAPPI, a paper producing company in South Africa that has developed 230 MW of cogeneration power, South Africa has 2000 MW cogeneration power potential.

Cogeneration projects have two main sources of revenue, namely power and process heat. Typically, average total cost of power production from an efficient cogeneration plant is about US\$ 0.104/kWh¹⁷. Erratic supply of power, limited generation capacity, poor maintenance culture and obsolete generation and transmission equipment, poor financial health of existing power utilities combined with increased demand have

¹¹ Deepchand. Promoting equity in large scale renewable energy development: the case of Mauritius. Energy Policy. Elsevier Science, Oxford, U.K., 2002.

¹² Burundi, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Sudan, Tanzania, Uganda Zimbabwe

¹³ Deepchand, Karekezi and Kimani, 2002

¹⁴ Karekezi, Stephen and Waeni Kithyoma. "Perspective from Eastern and Horn of Africa." World Council for Renewable Energy. Renewables in Africa – Status and Prospects.

¹⁵ Electricity Company of Ghana, 2006.

¹⁶ Kenya, Ethiopia, Malawi, Sudan, Swaziland, Tanzania, Uganda

¹⁷ UNDP Bioenergy Primer 2000



significantly increased the competitiveness of cogeneration in relation to the national grid.

Frost and Sullivan¹⁸ indicate that cogeneration has the ability to achieve up to 90% efficiency compared to 40% efficiency levels that presently prevails in the market. The technology has seen immense progress with a lot of advanced, more efficient new generation turbines and boilers. The recent improved technology enables cogeneration plants to achieve higher profit margins than regular sources of generation and thus are able to offset the significant start-up and maintenance cost in the long run.

The cost parameters vary widely depending largely on the feedstock, type of turbine, boiler, and the pressure and temperature of the steam. An important characteristic of steam turbines and boilers is that their capital costs (per unit capacity) are scale-sensitive¹⁹. Cogeneration plants require significant start up cost in the form of technical and economic feasibility studies, plant design costs and capital expenditure. A typical 3MW turbine cost in the region of \$1.37 million while the boilers can cost between \$8 million and \$20 million. Therefore a developer requires an average of US\$15.5 million to establish a 3 MW cogeneration plant. Joint ventures between project developers, private and public investors could however minimise the start-up cost.

Factors that revenue and costs associated with cogeneration plants in Africa include;

- Local electricity tariffs
- Reliability of national grid
- Efficiency of the steam-rankine system of the cogeneration plant
- Availability, reliability and chemical characteristics of feedstock
- Level of demand of thermal and electrical energy by host company
- Scale of cogeneration plant

¹⁸ www.energy.frost.com

¹⁹ This is the main reason coal and nuclear steam-electric plants are built in the range of 500 to 100 MWe



Anaerobic digestion

Anaerobic digestion converts organic matter to a mixture of methane, the major component of natural gas, and carbon dioxide. Biomass, such as wastewater (sewage), manure, or food processing wastes, is mixed with water and fed into a digester tank without air. The use of this type of technology results in the generation of biogas.

Experts estimate that the Ghanaian poultry industry has the potential to generate 61 GWh per annum²⁰. Similar opportunities to capture and burn methane from wastewater are present in other sub-Saharan African countries and include various sectors, such as livestock farming, municipal wastewater management, and industrial processes which produce liquid waste that decomposes in pools. A particularly viable option is in the municipal waste sector, where bioenergy is already generated in large quantities in several cities of Sub-Saharan Africa. It is estimated that municipal waste can generate up to 150 GWh of energy per annum in the 3 most populous cities in Ghana²¹.

The anaerobic digestion system generates two main outputs: biogas and sludge. Revenue is therefore generated from biogas for cooking or electricity generation and sludge for fertilizer. Biogas for cooking is used as a cleaner and cheaper alternative to charcoal, liquefied petroleum gas or electricity. To distribute biogas for cooking, piping is required with the provision made for removing water that may condense out of the gas in the pipes. Biogas stove burners is also required at cooking points. It is typical that the feedstock is obtained at no cost. The business model for biogas for cooking can either be a fee-for service or outright purchase of the system on credit or with cash up front. The business model pursued by entrepreneur developers is determined largely by the economic class of the prospective customers and population density of the community in which the systems are being built and promoted. The major cost for biogas for cooking is the digester, sludge drier, gas storage and distribution units and stove. The capital expenditure for biogas for cooking varies significantly depending on the size of the digester. Small system cost between \$100 and \$300 while larger systems cost \$1000 and above.

Biogas for electricity and flue gas generation are mostly large plants that utilize industrial and municipal waste streams. Revenues from these plants are generated from sales of electrical and thermal energy and fertilizer. Electricity is generated from spark or compression ignition diesel engines that are fired by biogas. Typical gas production is 2.5-8.5 Nm³/day²² per m³. These types of systems are typically complex and require detailed technical and feasibility study prior to the project development and implementation phase. Also key equipment includes digester, gas clean up and

²⁰ Electricity Company of Ghana, 2006.

²¹ Electricity Company of Ghana, 2006.

²² KATANI LTD, Hale-Tanzania



storage unit, gas distribution pipes and engine. For a 25 year plant life and a 10% discount rate, the capital charge rate of a typical anaerobic biogas plant in Africa is 12.75% per annum. In a recent estimate for the total cost of methane from an upflow anaerobic sludge blanket (UASB) reactor (300,000 GJ/year capacity or larger) with a typical industrial feedstock is less than \$2/GJ (less than \$0.07 per liter of diesel equivalent under European conditions and about \$1/GJ under Brazilian conditions). This makes this technology highly competitive with many fossil-fuel alternatives given the present level of international oil prices.

Direct Combustion

Biomass such as wood, garbage, manure, straw, and biogas can be burned without processing to produce hot gases for heat or steam. Direct combustion consists of burning the biomass input by direct heat. Examples of direct combustion include burning wood in fireplaces or stoves, burning garbage in fluidized bed boilers, and producing heat to generate electric power. The latter is often the most cost effective biomass technology, particularly if the biomass resource is within close proximity. Stoves and furnaces are among the most common of the small-scale applications of direct combustion of biomass. Improved biomass cook stoves burn fuel more efficiently and reduce indoor smoke. Furnaces utilizing wood chips, logs or straw heat homes more efficiently and reduce emissions compared with traditional fireplaces.

Pyrolysis

Pyrolysis is the thermal degradation of biomass by heat in the absence of oxygen. Biomass resources, such as wood or garbage, are heated to a temperature between 800 and 1400 degrees Fahrenheit, but no oxygen is introduced to support combustion. Pyrolysis of biomass produces pyrolysis oil or bio-oil, which is a renewable liquid fuel. While bio-oil has undergone successful tests in turbines, engines and boilers, commercial applications are limited due to high financial and energetic costs.

Gasification

Like anaerobic digestion, gasification uses biomass to create a combustible gas. However gasification takes place at much higher temperatures. During gasification, about 65% of the energy is captured and converted into combustible gases. The gases are then converted into natural gas, which can be used to fuel vehicles, generate electricity, or converted into synthetic fuels. Gasification is less commercially viable than direct combustion because it is more technologically advanced and therefore more costly. The most commonly used types of gasifiers are fixed-bed and fluidized-bed. Among the advantages of gasification in comparison to direct combustion is superior efficiency, by as much as 50%, as well as suitability of a variety of biomass feedstock.



Liquid Biofuels

Fuel alcohol is produced by fermenting sugars (directly or after conversion of starch to sugar) to alcohol, and then separating the alcohol water mixture by distillation. Feedstock such as sugar cane, wheat, barley, potatoes, waste paper, sawdust, and straw contain sugar, starch, or cellulose and can be converted to alcohol by fermentation with yeast. Ethanol from cellulose is still in the pre-commercial stage and not ready for use in Africa. Ethanol is the alcohol product of fermentation usable for various industrial purposes, including alternative fuel for internal combustion engines.

Gasohol (blend of ethanol and gasoline) is a proven fuel and a commercially viable supplement or replacement to gasoline use in programmes in Malawi, Zimbabwe, Kenya and Ghana. At the peak of the Kenya programme, it produced 45,000 litres per day using surplus molasses that was an environmental hazard because it was dumped into nearby rivers.²³ The long term prospects of widespread use of biofuels is dependent on performance of the sugar cane industry, world market for molasses and the world prices of oil.

Biodiesel from *jatropha curcas* plant is suitable for use as industrial diesel oil directly while blending it with up to 20% by volume with regular diesel can be used for vehicles. Plant oil (mostly *jatropha*) is a common fuel used for rural electrification. Biodiesel is used in cars, both pure (B100) in modified engines and in blends (B5, B10). Also, pure plant oil can be used in transport. Several African countries, with the endorsement of governments, have established biofuels from *jatropha* as an energy source. Presently 106,100 hectares of *jatropha* are under cultivation with Madagascar and Zambia boasting the largest area with about 35,000 hectares each. Biodiesel can be used in diesel generators for rural electrification projects.

Landfill Gas

Landfill gas is generated by decay (anaerobic digestion) of buried trash and garbage in landfills. When the organic waste decomposes, it generates gas consisting of approximately 50 percent methane, the major component of natural gas and a potent greenhouse gas. The gas generated is captured for electricity generation.

²³ Baraka, M.L. *The Kenyan Experience with Ethanol for Transportation*. In: ATAS Bulletin on Energy Systems, Environment and Development - A Reader. New York: United Nations, 1991.



4. Financing Bioenergy Projects

From the foregoing, substantial investment opportunities exist for bioenergy projects in Africa. However the sector has continued to experience low investment level compared to other parts of the world. Most of the existing projects have been financed as demonstration projects through multilateral and bilateral arrangements. Also development finance institutions such as the African Development Bank, Development Bank of South Africa, International Finance Corporation of the World Bank, the German Investment and Finance Group (DEG), Entrepreneurial Development Bank of the Netherlands (FMO) and the European Investment Bank fund very large scale projects. Investment organizations such as Bamboo Finance, Acumen, Grofin, Root Capital and E+Co are dedicated funds that target SMEs, including clean energy projects. E+Co is the only specialist clean energy investor in Africa.

It is crucial that bioenergy investors and develop must consider the following issues in any bioenergy project in Africa:

Financing Barriers

- Inexperienced project developers with limited track record and projects that typically greenfield
- Inappropriate and limited local co-financing opportunities
- Bundling of small projects required to achieve economies of scale
- High upfront cost

Financing Risks

- Long term investment in fragile market
- Incomplete regulatory and legal framework
- Few benchmarks- limited track record
- Moderate risk that needs to be proven
- Reasonable actual returns, not excessive
- Inadequate cash when project becomes viable
- Challenging environment to secure and assemble all documentation, rights, purchase contracts and permit and financial commitments in a timely and efficient manner

Financial Solutions

- Incorporate clean affordable and reliable energy in desired returns
- Maximise lessons learned to speed up learning curve and team up with experienced and dedicated financiers
- Maximise funding opportunities in government policy priorities in the bioenergy sector
- Utilize appropriate financial instruments and terms



Capacity and experience of local developers

Although bioenergy technologies have been proven, there is little knowledge and expertise within the entrepreneurial community in Africa on the bioenergy sector. Given the very few active projects in operation, experience and management of the bioenergy sector within Africa is limited. It is typical to find a promoter who is highly technical or a businessman who has only an academic knowledge of bioenergy as a technology and business. Investors require more than money to engage in the bioenergy sector. The investment package must include technology transfer and management expertise.

Most bioenergy investments are start-up projects with very limited track records. It is common to come across very well written business plans, however, thorough investigation and due diligence reveals that the promoters may not have thorough knowledge and insight of the local regulations, environmental policy, technology and overall management of the project. It is very important to move beyond the business proposal to do a thorough assessment of the capacity of the developer / promoter / entrepreneur to indeed implement the plan.

Finance stages, instruments, risks and returns

The full spectrum of finance needed for bioenergy projects is presently only available in a limited way in Africa, offering ample opportunities for investors. Much of risks associated with investments in the bioenergy sector in Africa are perceived risks that can be eliminated by informed investors. For those risks that remain, there are ample mitigation measures.

The financing of bioenergy projects typically require a combination of debt and equity investments as indicated below in a typical sequence:

- **Feasibility study:** This refers to finance for a thorough investigation into the technical and financial viability of the project given the biomass feedstock available. The characteristics of feedstock and waste are critical in determining its appropriateness for any bioenergy technology option. It is important to test these characteristics in order to ensure that the design is adaptable to local conditions. This study is typically in excess of USD 100,000 depending on the size of the project. Typically local project promoters do not have these funds as equity for the project and struggle to secure funding from investment organizations given the high risk inherent in such studies. E+Co can provide part of the funding for feasibility studies if the pre-feasibility studies provide strong evidence of viability.



- **Pre-implementation:** If a viable project is presented in the feasibility study, the next stage of financing is required to mobilize the different stakeholders (design engineers, equipment suppliers, construction and operational team and finalize purchase agreements, etc.) to prepare the project implementation. This is an investment typically between USD 100,000 and USD 1 million. Together with the costs of the feasibility study, it typically represents the equity component of the project, which is critical to attract investors for the next phase. This next phase could include development finance institutions with investment thresholds in excess of USD 5 – 10 million. This segment can deliver high double digit returns to specialized investors. E+Co typically provides finance for this segment and invites co-investors to maximize the opportunities in the sector.
- **Project Finance:** This refers to finance required for the full implementation of the project, typically composed of a combination of equity and long-term debt capital. Given the absence of local project finance institutions, bioenergy project promoters have been relying on local financial institutions that typically provide short term debt that does not suffice for large bioenergy finance. Until recently, lack of local market knowledge and data has discouraged foreign investors from filling this gap. Increasingly financial and energy regulations enable investors to tailor finance best suited for these projects to optimize returns. Cooperation with specialized investors is recommended to benefit from lessons learned and to optimize appropriateness within the local context.
- **Equity Finance and Exit Opportunities:** Most large scale bioenergy projects require significant equity finance in order to raise debt finance. Although a number of private equity funds, such as Fidelity Capital, Actis, Aureos, and AfricInvest are active in Africa, they focus on investing in established enterprises with a strong growth potential. Given that most bioenergy projects are startups they do not qualify for these funds. Other mid size development-oriented investment funds such as Grofin, Acumen, Bamboo and E+Co provide equity investments in selected Africa countries. Due to limited exit options, most transactions are designed to have self liquidating exit instruments.
- **Risks:** Bioenergy projects are typically require long term investments in the region of 8-10 years. However the market conditions are fragile and opaque in some countries due to uneconomical tariff structure, poor legal and regulatory infrastructure. Also it is difficult to make any informed projections (typically excessively optimistic) due to limited track record , bench marks and standards for bioenergy projects in Africa.



Developers typically experience cost overruns and run short of cash in the development of the project to reach viability. Also developers face acute challenges in gathering data and securing supply and purchase contracts, permits and rights. It is typical for prospective developers to advance projects without accurate and reliable data and documents which poses great risks for the project.

- **Returns:** Bioenergy projects are not measured by the traditional financial returns alone. The additional returns generated, such as monetization of carbon offsets, creation of new jobs, production of byproducts and additional income from energy generation, are measured with the same rigor as financial returns. Developers must therefore include revenue potential of these indicators in their presentation to investors.
- **Market:** Whilst there is a substantial shortfall in the supply of traditional energy, securing competitive prices and buyers for energy produced from biomass is a key element in the development of bioenergy projects. Electricity and some petroleum products are often subsidized so for larger bioenergy projects to be profitable, many projects require government support or industrial buyers (“inside the fence” projects), whereby the energy produced substitutes or complements existing energy supply. However, Power Purchase Agreements (PPAs) from independent power producers with national (public and private) energy companies are becoming increasingly common in most African countries in an effort to meet growing demand for energy despite persistent supply shortfalls.



5. Sustainability of biomass resource

Bioenergy projects depend largely on the continuous supply of feedstock in the form of crops and waste materials. Promoters must demonstrate that there is ample evidence of a sustained feedstock supply to operate the plant. Issues to consider and justify to prospective investors include:

5.a Energy Crops

When producing bioenergy from energy crops, crops directly exploited for their energy content, several issues around the sustainability of the investment need to be considered, such as:

- *Availability of land and land ownership:* Significant land area mass of land is required for energy crop plantations. Africa has substantial arable land for agricultural purpose. Land is either owned by traditional chiefs, government and individuals. The land tenure system differs from country to country. It is always important to confer with a local legal expert or the local investment authority for the verification of documents that are used in any land transaction. Very few land owners have deeds to their property. Even with government acquired and leased land, it is important to verify whether agreements between the government and the original owners of the land are binding and the tenure of that agreement. Land can be leased for up to 100 years in several African countries.
- *Outgrower schemes:* This model utilizes the local farming community by guaranteeing them market for their produce at a pre-arranged price. It creates jobs and contributes to local development. It also saves the project developers the cost and difficulties associated with land acquisition. The challenge with this scheme is loss of control of the reliability of biomass feedstock. Outgrower farmers have the tendency to demand higher prices for their produce and may stop growing the feedstock. Developers must ensure that they have formal agreements on price and other incentives, production levels, etc with farmers to convince investors of the stability of the scheme.
- *Productivity and plantation running costs-* More land is required as the productive capacity of the energy crop being employed decreases. The cost of running a plantation may be a substantial percentage of the total project cost and there is the risk that the land turns out not to be economically suited for such an activity. Developers must seek to use improved yields of energy crops that are adaptable to local climate conditions.



- *Government policy: Restrictions exist on commercial cultivation of certain energy crops in African countries. The government of South Africa, for example, has declared Jatropha an invasive crop and therefore does not support its proliferation, and cultivation as a commercial crop is banned. Also the debate around food-versus-fuel prevails in some African countries against the backdrop of famine in Africa. Investors need to familiarize themselves with government policies at the energy and agricultural ministries in the target country of operation.*

5.b Waste to Energy

With regard to the use of waste for the production of bioenergy, several sustainability issues may need to be considered, including:

- *Availability and Reliability of Waste Streams:* The reliability and availability of a waste stream and residues is largely dependent on the financial and operational stability of the producer firm. A market disruption in the producer business affects the output of the company and consequently the production and supply of waste. For example, if the price of meat, processed timber, sugar or starch fall, the industry may cut back on production and consequently affect the production of animal waste, saw dust, bagasse or starch waste. Therefore, a successful investment requires thorough investigation of the producer industry's future prospects as well as formal agreements between the waste stream producer and the bioenergy company.
- *Chemical Composition of Waste Streams:* Equipment is designed to suit the chemical characteristics of a specific waste material stream. Changes in the chemical composition of waste material due to changes in production technique or a different variety of raw material have the potential to disrupt operations of the bioenergy project.

Proximity of Factories and Available Land: Waste stream availability is enhanced when there are several waste producer factories located in close proximity to each other and there is adequate land to accommodate the waste for processing into energy. Therefore, the location of bioenergy projects is critical in that regard. The viability of projects is also enhanced if producer company energy requirements are not met by existing supply, as energy generated by bioenergy project is often supplied and sold to producer and surrounding companies.



6. Carbon Financing and Bioenergy

Certain sectors within the bioenergy arena represent a significant carbon finance opportunity for Africa. Cooking with solid fuels such as wood and charcoal are responsible for a considerable amount of global greenhouse gas emissions worldwide. Indeed, scientists estimate that 18% of global warming is caused by black carbon²⁴, which comes primarily from burning biomass and diesel. In Africa most households still cook on three stone fires on inefficient stoves, underscoring the scale and scope of the issue and the potential opportunities implicit in efforts to disseminate improved cook stoves or household biogas units. Moreover, widespread agricultural waste combined with lack of electrical grid capacity present an excellent opportunity for larger scale biogas installations and the carbon credits that result. Direct combustion of renewable biomass in thermal plants can provide a promising carbon finance opportunity under the right circumstances. Finally, opportunities for carbon finance are present in rare cases where biodiesel is produced from the waste of another industry rather than from primary agricultural feedstock.

Of the approximately 1,500 CDM projects that are registered worldwide, Africa is host to only 28. These are mostly landfill gas, N₂O destruction or natural gas flaring projects related to the petroleum industry. Only 5 are strictly biomass projects. These 5 consist of 2 bagasse fired plants, 1 methane from livestock facility and 2 fuel switching projects²⁵. There is an unknown number of voluntary carbon finance projects since no consolidated database exists, but there are at least a dozen large-scale improved cookstove projects currently under development or registered. Although Africa is far behind the rest of the developing world in carbon finance investment, increased interest in the continent and saturation of other carbon markets make Africa the next frontier within the industry.

Issues and Potential Barriers

When scanning prospective bioenergy projects for development of carbon finance assets, it is important to consider four broad categories of issues and potential barriers. First, the concept of **additionality** is central to carbon finance projects. This concept refers to project developers' need to prove that the project would not have happened in the absence of carbon revenues being sought. Without this, carbon offsets fail to 'offset' a buyer's emissions, and carbon credits become meaningless from a climate change perspective. There are many ways to prove additionality²⁶, but a common pitfall is partnering with local firms that are already engaged in commercial practices in the absence of carbon finance. This suggests that these practices do not require the

²⁴ *Third-World Stove Soot Is Target in Climate Fight*, The New York Times, April 16, 2009.

²⁵ IGES CDM project database: <http://www.iges.or.jp/en/cdm/report.html>

²⁶ The CDM and most voluntary carbon standards use the CDM additionality tool to prove additionality. When evaluating a project, complete this logic proof to avoid the pitfalls inherent in additionality: <http://cdm.unfccc.int/methodologies/PAMethodologies/tools/am-tool-01-v5.2.pdf>



help of carbon revenues, which can prompt auditors to question whether such activities are business-as-usual, and therefore not eligible for carbon finance. Most pertinent to Africa, projects that involve a large share of official development assistance (ODA) can also present problems during the carbon approval process.

Project developers should screen for whether an **approved carbon baseline and monitoring methodology**²⁷ can be applied to the project being considered. A baseline and monitoring methodology outlines sector-specific baseline calculations and ongoing monitoring requirements. In the absence of an approved methodology, project developers must propose a new one, a process that more than doubles the price of project development and can slow project approval procedures significantly.

Project scale is a third criterion when considering viability of bioenergy projects for carbon finance in Africa. Carbon projects require more than \$100,000 to develop the project, which includes site visits and drafting of in-depth documents required for registration, plus ongoing monitoring and verification expenses. These are in addition to the project's infrastructure costs. Since project development cost is more or less fixed regardless of project size, there is a strong incentive to select for large projects to maximize profit. Although the size threshold varies between sectors and methodologies, it is generally difficult to justify a carbon finance project that abates less than 10,000 tons CO_{2e} per year. Contrary to popular opinion, voluntary carbon markets only minimally reduce transaction cost compared to the CDM since the major voluntary standards, such as the Gold Standard, have borrowed so heavily from the CDM process. An exception to this rule is in the case of micro projects (<5,000 tons per year), for which some voluntary standards have developed highly streamlined approval procedures that markedly streamline approval and decrease costs. Project developers are advised to develop their own cash flow models that apply the appropriate carbon finance methodology and applicable project development costs as a screen for project scale.

Finally, project developers should be aware of the **complex and lengthy process** involved in seeking access to carbon revenues. Although carbon finance can be a viable and profitable source of additional revenues, the process should be approached with patience and realistic expectations, especially with the Kyoto Protocol expiring in 2012 and investors becoming increasingly bearish. Developing carbon finance projects in Africa can take up to 2 years in the current economic climate. Project developers should also become familiar with the history and status of carbon finance in the specific country of interest to learn what pitfalls other project developers have faced. There are often country-specific factors to consider. Although voluntary projects do not require host country approval (government officials in Africa are

²⁷ A full list of approved CDM methodologies is available here: <http://cdm.unfccc.int/methodologies/PAMethodologies/approved.html?searchon=1&searchmode=advanced>, while a full list of Gold Standard methodologies, several of which are particularly well suited to Africa, is available here: <http://www.cdmgoldstandard.org/Gold-Standard-Methodologies.347.0.html>



occasionally not aware of this fact), CDM projects require the approval of the designated national authority (DNA)²⁸. Some DNAs are more helpful than others, and unfortunately, in rare cases DNAs in Africa (and elsewhere in the world) seem to purposely hinder progress on projects in their country. Project owners are strongly advised to seek the advice and services of professional carbon finance developers who know this sector well and can usher projects through the project approval process.

Case study 1: Efficient cook stoves

Efficient cookstoves are among the strongest opportunities for carbon finance revenues from biomass in Africa. However, they are also among the most complex and little understood within the global carbon finance industry. E+Co has partnered with companies in Mali, Ghana and South Africa to harness carbon revenues from efficient stove technology. A single stove, which costs about 10 USD to manufacture, abates greenhouse gases equivalent to between 15-30 USD. E+Co's projects are being developed according to the Voluntary Gold Standard's stove methodology. Revenues from the sale of carbon offsets will be used to subsidize stoves to end users and fund business development services that will ensure that partner companies are able to expand their businesses and reach remote markets. Subsidized stoves will ensure that even the poorest members of society can afford this life saving technology.

Two of the three projects in question have recently been registered. While the approval process has been long and arduous, the ability to convert hundreds of thousands of households to cleaner cooking methods is not only attractive from an environmental and public health standpoint, but also from a financial standpoint. For the first time ever, it has become profitable to cook using cleaner and healthier cooking methods thanks to carbon finance. Stove projects can be developed either through the Gold Standard's stove methodology or via the CDM using small scale methodology AMS-II.G.

Case study 2: Large scale biogas from livestock

One of E+Co's investees, Bioter, constructs and installs biodigesters in Brazil. Biodigesters are one solution to reducing the amount of methane in the atmosphere from lagoons used to treat the waste from livestock. Bioter will soon install seven biodigestors on different swine farms within the same region in Brazil. The project consists of E+Co financing the installation of the biodigesters by providing loans to individual farmers and then developing the carbon offsets to share revenues with the swine farmers. This will be developed as a bundled project under the CDM, which will help to decrease transaction costs since none of the farms are large enough to justify a stand alone project. Yet all seven will abate about 25,000 tons CO_{2e}/yr in aggregate

²⁸ A full list of DNAs from each country is available here: <http://cdm.unfccc.int/DNA/index.html>



Experience in Brazil suggests that carbon developers often take ownership of the biodigesters and take high portions of the carbon revenues, such as 80-90%. Although this is a way to build many biodigestors relatively quickly, farmers who share in only a small portion of the carbon revenues and do not own the biodigester lack the proper alignment of incentives for project success, leading to maintenance and other problems in the future. These projects demand a host of monitoring requirements to earn credits; weekly flow and temperature recordings from the biogas units are needed to prove that systems are working as intended. The CDM's small scale methodology AMS III D is well suited for these types of applications, although there are a host of biogas methodologies that are applicable to varied circumstances. Although there are few such projects in Africa today, the potential for methane from livestock is strong. Project developers should seek farms with large concentrations of livestock in warm climates (southern South Africa would work, but tropical climates are ideal). Projects can be designed simply to flare methane or to produce electricity if high voltage power lines are present and scale is sufficient.



7. Business Plan Development

7.a E+Co's Enterprise-Centered approach

E+Co introduced a business-minded approach to tackle the joint issues of climate change and energy poverty. E+Co's investee companies deliver affordable, accessible modern energy to the billions of people in developing countries, including Africa, who currently lack it – without undermining environmental systems. The objective of E+Co is to empower local small and growing enterprises that supply clean and affordable energy to households, businesses and communities in developing countries combating poverty and climate change.

In E+Co's business model, enterprise development services is combined with investment capital. Modern energy companies in Sub-Saharan Africa need more than just capital injection to start and grow. E+Co develops a value-added relationship with entrepreneurs and management of the investee company to develop and implement the business plan, focusing on the following areas:

- a. Financial Management, as the most fundamental component (especially financial planning, analysis and preparation);
- b. Corporate Governance, particularly for owner managed investee and family owned businesses
- c. Organizational structure to optimize resource utilization
- d. Access to network of suppliers, producers, potential partners etc especially from its experience and contact in Latin America and Asia

E+Co typically can provide the optimal basic finance required to start or grow a business to the next stage of its development cycle. E+Co sets milestones for the investee company to secure additional growth capital to expand the company.

As mentioned before, bioenergy is a cleaner and often cheaper option in the long term for consumers. Bioenergy improves the quality of life of the local community, protects the environment from further degradation and is an income generating opportunity. It is therefore a social development and growth tool and delivers much more than just financial returns to investors. E+Co is dedicated to delivering triple bottom line returns. It presents a multi-level view of the impacts of the bioenergy enterprise. The social (job creation potential), environmental (number of trees saved, environmental protection, clean water produced, carbon offsets, etc.) are critical impacts and returns E+Co looks for and is an integral part of its due diligence, investment and monitoring and evaluation process.



E+Co, through its subsidiary E+Carbon, provides carbon finance services to its investee companies. E+Carbon collects data that enables it to measure the potential carbon revenue that can be generated from the operation of the bioenergy company. If projects offer carbon finance potential, E+Carbon will sign contracts with bioenergy companies that can offer significant additional revenues streams to a venture. E+Carbon may pre-finance the carbon project development process, including verification, validation, registration and issuance of carbon offsets. Since most bioenergy project developers and investors lack experience in ushering projects through the complex and arduous process of monetizing the carbon offsets from their projects, engaging a dedicated carbon financing specialist is appropriate in most cases.

7.b Bioenergy Business Plan Framework

E+Co has developed a dedicated bioenergy ‘question and answer framework’ as a tool for preparing and presenting a business proposal. The question and answer framework generates components that are found in most well prepared proposals. A proposal that adequately outlines the issues addressed in the framework will meet the entry requirements of most financiers. The framework is presented in Annex I of these guidelines. Annex II contains a short list of additional resources for project developers and financiers.



Annex I: Question and Answer framework for bioenergy business plan development

What is being proposed? *The core concept*

E.g. Industrial scale biogas; gasification for treatment of organic waste streams; production of biodiesel or ethanol; construction of household sized digesters in situ; production of saw-dust briquettes etc.

Where will the proposal be implemented (company and its customers)? *The setting/location*

E.g. Single agro-industrial, food & beverage customers; municipalities, possibility of selling back to the grid; rural, livestock-owning customers; Substitute for charcoal dependent households; Oil marketing companies and refineries etc

Who will champion the proposal and see it to completion and who else must be involved? *The team.*

E.g. Project finance and technical experts; trained artisans, local labour etc

How will the proposal be implemented? *Implementation plans*

E.g. Establish operating companies linking customer and supplier, draw up legal frameworks; dealership or branch network, government sponsored microcredit facilities, etc

Why is the proposal important and why should it be supported? *Expectations*

E.g. return on equity, carbon potential; 10% gross margin, growing to 25% after government subsidies and carbon revenue applied, public mandate for government sponsored program etc

What If things do not go as planned? *Risks and Mitigation measures (Contingencies)*

E.g. Project diversification, insistence on turnkey and performance contracts; total disappearance of government programs will lead to focus on institutional customers with larger ability to pay



To Whom is the proposal addressed? *The audience*

E.g. Equity investors, carbon companies, social investors funding feasibility studies and pilot plants etc. A well-balanced response to each of these questions and a good understanding of the target audience stands a great chance of securing the resources required to implement the project.

What Lender and Investor look for in a Bioenergy Proposal

Lenders emphasize risk management and look for:

- Predictable cash flow
- Assumption of major uncertainties by others, including insurers and owner-entrepreneurs
- Guarantees that all funding is available
- Collateral and security interests
- Clear procedures for default, termination, repossession and similar events.

Investors look at these things also but their focus is more on opportunity management, placing emphasis:

- On the size of the market
- On the reasonableness of the base case
- On potential upsides and downsides
- On management's abilities and knowledge

Entrepreneurs and project developers must frankly try to analyze their proposal from a bankers' or investors' perspective to ensure that proposals meet expectations and are realistic.



Annex II: Additional Resources

- REED Entrepreneurs toolkit: http://www.eandco.net/tagfiles/2/REEDToolkit1-4_web_e5261e83.pdf or via www.ared.org
- UNFCCC guidebook for preparing technology transfer projects for financing: http://www.eandco.net/tagfiles/2/Practitioners_Guide_0e87081d.pdf or http://unfccc.int/resource/docs/publications/pract_guide_06_en.pdf
- UNDP Bioenergy report: <http://www.undp.org/climatechange/carbon-finance/Docs/Bio-carbon%20in%20Africa%20-%20harnessing%20carbon%20finance%20for%20forestry%20and%20bio-energy.pdf>
- Innovative Options for Financing the Development and Transfer of Technologies in the framework of the United Nations Framework Convention on Climate Change (UNFCCC)
<http://unfccc.int/ttclear/pdf/Workshops/Canada/Montreal%20background%20paper.pdf>



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