COGEN FOR AFRICA – FULL SIZE PROJECT BRIEF ANNEXES

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ANNEX A: INCREMENTAL COST ANALYSIS

Project Outcomes	Baseline	Alternative	Increment
Outcome 1: Capacity of cogeneration project developers, technical service providers and local manufacturers developed and enhanced	• Inefficient and low-pressure cogeneration systems mainly for captive energy generation will continue to be implemented in industries, thus, limiting the experience and expertise of project developers, technical service providers and local manufacturers to the existing (baseline) technologies • Pre-feasibility studies conducted in-house with limited expertise from outside by a few forward looking companies • Local manufacturing capability will remain low and experience limited to inefficient and low-pressure systems	• Comprehensive study conducted on the fuel resources available, their potential for cogeneration and the applicable technologies to implement them • Initiatives made for local equipment manufacturers to develop partnerships with global equipment suppliers of efficient cogeneration systems thereby enhancing their manufacturing capability • Capacity building activities in the form of seminars, workshops and training provided to local engineers and relevant stakeholders • Technical advice and services provided to project developers and potential owners of cogeneration systems • Examples of successfully operated cogeneration installations shown to relevant potential developers/owners through visits and study tours to appropriate sites	• Detailed assessments on the availability of biomass resources potential for cogeneration conducted and made available for project developers and other stakeholders • Participation of local manufacturers in the installation of new cogeneration projects and their capability enhanced through partnerships with foreign suppliers • Skills and capability of local technical personnel on technical and project development aspects of cogeneration developed through training and capacity building activities • Software tools for technical analysis of projects developed and/or adapted and used to provide advice and training of technical personnel
	Baseline cost: 250,000 USD	**Alternative cost:** **1,568,836 USD**	**GEF: 943,836 USD** **Private sector: 375,000USD** **Total incremental investment:** **1,318,836 USD**
Outcome 2: Financing for cogeneration projects made available and accessed at terms and conditions that are favorable for investments	• Currently, financing of cogeneration systems are made through the company's balance sheet and guaranteed by collaterals. Very few companies have the means and are able to do this. Without supporting mechanisms from specialized institutions such as the Africa Cogen Centre to assist project owners in mobilizing low-cost funds, this situation	• Existing financing sources and mechanisms both local and regional/international that are relevant for the sector are identified • To provide flexible mechanisms appropriate for cogeneration projects innovative financing structures will be designed • Training of project developers and financing institutions are conducted aimed at enhancing the	• Existence of financing institutions, funds and innovative schemes that have been tapped/accessed for new investments in cogeneration projects • Through workshops, forums and training organized by the Africa Cogen Centre, the capacity of project developers to package projects for financing are enhanced; relevant financing institutions increased their understanding in capability in assessing cogeneration systems

	• is not foreseen to change • The existing capability of the financing institutions in evaluating cogeneration projects is limited resulting to a high perception of risks for cogeneration projects	success of accessing funds for cogeneration projects • Assistance provided to project developers and financing institutions in the financing of projects	• Project developers received assistance in mobilizing funds for cogeneration projects
	Baseline cost: nil	**Alternative cost:** **1,071,356 USD**	**GEF: 1,071,356 USD** **Total incremental investment:** **1,071,356 USD**
Outcome 3: Commercial, technical, economic and environmental benefits of modern and efficient cogeneration systems demonstrated in a number of new cogeneration plants and confidence on the certainty of the cogeneration market enhanced	• Some cogeneration plants may be rehabilitated or fine tuned to be self sufficient and covering the factories' energy requirements, while a few may able to sell small amounts of electricity to the grid, but with the absence of successful examples of highly efficient cogeneration plants that profitably sell excess power in high quantities to the grid, the potential of the market will not be maximized • The lack of available information required to make investment decisions and lack of support for project development does not encourage investments on cogeneration systems to happen	• Project development guide reflecting best practices in both project development and implementation of cogeneration systems developed for reference and training purposes • To assist project developers in the development process, Cogeneration Investment Packages (CIP) will be prepared for selected sites and promote the CIPs for private sector project development and investment • Support to, and implementation of, Full Scale Promotion Projects (FSPPs), while pipeline of projects will be supported and advanced to a level where a replication can happen • Assistance and services provided to project developers for projects in the pipeline	• Existence of the Project Development Guide which is made accessible to project developers and other stakeholders • A minimum of 6 CIPs developed and promoted to the private sector for investments • A minimum of 6 FSPPs or 40 MW cogeneration capacity implemented or being constructed and have received support from the Africa Cogen Centre for their development, implementation and promotion
	Baseline cost: 10,000,000 USD	**Alternative cost:** **61,551,306 USD**	**GEF: 1,551,306 USD** **Private sector: 50,000,000 USD** **Total incremental investment:** **51,551,306 USD**
Outcome 4: More favourable policies and institutional arrangements that support cogeneration	• General policies that do not contain more favorable provisions and incentives to cogeneration • Absence of clear regulations for sales	• Policies that contain more favorable provisions and incentives to cogeneration compared to those prior to project implementation endorsed for approval • Existence of clear regulations allowing sales of power	• Support provided to policy makers and relevant agencies in formulating policies and regulations supporting cogeneration • Policies, regulations and incentives that are more

promoted	of power from cogeneration to the grid at favorable terms • Cogeneration not sufficiently incorporated in power master plans of target countries	from cogeneration to the grid at favorable terms • Cogeneration incorporated in the power master plans of target countries • Existence of an institutionalized one-stop center providing information and competent services on cogeneration • Advocacy activities carried our to influence policy reforms and implementation. Support is also provided to policy makers and relevant agencies in policy formulation and enhancements • A one-stop information and service center within the Africa Cogen Centre establishment to provide central venue for source of information and services for cogeneration • Promotional strategy formulated for the whole project and promotional materials prepared and disseminated to relevant stakeholders • Project website for internal and external audience developed and updated continually of the website • Support provided to utilities and relevant agencies in drafting and setting the stage for the approval of Standard Power Purchase Agreements (PPAs)	clear and more attractive to investments in cogeneration submitted to relevant authorities for approval • A one-stop information and service center established and services to stakeholders who need them effectively provided • Overall strategy on promoting cogeneration developed, promotional materials produced and disseminated to relevant stakeholders • Existence of Project website containing relevant information for stakeholders • A Standard Power Purchase Agreement appropriate for cogeneration drafted and presented to the approving authorities
	Baseline cost: 100,000 USD	**Alternative cost:** **2,132,956 USD**	**GEF: 1,304,356 USD** **National governments: 353,600 USD** **Coopener: 375,000 USD** **Total incremental investment:** **2,032,956 USD**
Project Coordination, including monitoring and evaluation (M&E)	• No project management or coordination activities will occur in the baseline • Collaboration and linkages among stakeholders non-existent or limited	• Establishment of Africa Cogen Centre as a center of excellence for cogeneration in the African region • Application of M&E activities to monitor performance and outputs and document lessons learned for replicability and sustainability • Collaboration and linkages made with stakeholders, relevant programs and other GEF-funded projects	• Existence of the Africa Cogen Centre having international and regional/local experts providing support and expertise to the cogeneration industry in the 7 participating countries of Africa; organizational structure of the Centre well established such as the Project Management Council which provides technical and operational guidance & the Project Steering Committee which

			provides direction and strategic guidance to the Centre • M&E lessons applied for the effectiveness of the project • Sustainability of the Project charted through a sound Business Plan and integrated in the design of the activities of the Project
	Baseline cost: nil	**Alternative cost:** **Total alternative cost:** **1,161,635 USD**	**GEF: 1,161,635 USD** **Total incremental investment:** **1,161,635 USD**
TOTAL	**Baseline cost: 10,350,000 USD**	**Alternative cost:** **67,486,088 USD**	**GEF: 6,032,489 USD** **Private sector: 50,375,000 USD** **National governments: 353,600 USD** **Coopener: 375,000 USD** **Total Incremental cost:** **57,136,089 USD**

ANNEX B: LOGICAL FRAMEWORK

Project Planning Matrix (PPM)	**Project title: Cogen for Africa**		
Objectives and Outcomes	**Objectively Verifiable Indicators**	**Sources of Verification**	**Important Assumptions/Risks**
Development Goal: Creation of a self-sustaining cogeneration industry in Africa thereby contributing to the reduction of CO2 emissions.	• Tons of CO2 equivalent emissions mitigated • Total investments in new cogeneration systems • Significant portion of electricity consumption of the participating countries supplied from cogeneration plants	• GHG emissions mitigation calculations • Government/Utility records • Statistics • Reports	• Recognition of the participating governments of the importance of reducing GHG emissions and their continuing commitment towards doing it • Cogeneration technologies installed are replacing existing or future more polluting technologies
Project objectives: The overall objective of the Cogen for Africa project is to help transform the cogeneration industry in Eastern and Southern Africa into a profitable cogeneration market and promote widespread implementation of highly efficient cogeneration systems by removing barriers to their application.	• MW of installed cogeneration capacity • MWh of generated power • No. of new cogeneration systems implemented • Amount of new cogeneration investments	• Records of implemented projects • Statistics • Reports	• Key stakeholders such as government agencies, project developers and financing institutions receptive to the support and measures to be provided by the Cogen Centre • Stable political and economic situation
OUTCOMES			
Outcome 1: Capacity of project developers, technical service providers and local manufacturers of modern and efficient cogeneration systems developed and enhanced	• Number of project developers with capacity to develop and implement high pressure cogeneration systems • Number of local personnel representing different stakeholder groups that have been trained • Responsibilities/roles of regional/local experts increased towards the end of Project completion vis-à-vis international experts • Capability of local manufacturers to produce parts of cogeneration systems enhanced • 3 visits and study tours to successfully operating cogeneration plants in Mauritius	• List of participants to capacity building activities • Evaluation forms on capacity building activities • Training materials and seminar/workshop proceedings • Composition of regional/local experts vis-à-vis international experts in the Africa Cogen Centre • Report on partnerships created/assisted • List of participants to visits/study tours • Evaluation forms on visits/study tours • Progress reports	• Level of interest from relevant stakeholders to receive training • Existence of local manufacturers possessing certain level of capability to start with • Permission from reference installations to allow visits

	• At least 1 visit to each operating FSPP	• M&E documents • Midterm evaluation • Terminal report	
Outcome 2: Financing for cogeneration projects made available and accessed at terms and conditions that are favorable for investments	• Existence of financing institutions and financing schemes that are actively providing funds to cogeneration projects • Project developers trained and received advice/services • Funds from financing institutions tapped by new investments in cogeneration projects • No. of projects that have accessed funds • Total amount of funds accessed by new cogeneration projects	• Cogen Centre activity report • Financial packaging documents • Annual reports of banks/developers • Progress reports • M&E documents • Midterm evaluation • Terminal report	• Availability of external funds for the African region • Projects proposed eligible for the funds • Political and economic stability
Outcome 3: Commercial, technical, economic and environmental benefits of modern and efficient cogeneration systems demonstrated in a number of new cogeneration plants and confidence on the certainty of the cogeneration market enhanced	• New cogeneration systems implemented and seen as showcases for their technical reliability, economic viability and environmental impact • Standard Power Purchase Agreements (PPA) proposed to approving authorities • Advice/services provided to new cogeneration investments	• Record of new cogeneration systems from owners • Standard Power Purchase Agreement documents • Government gazettes • Promotional materials • Progress reports • M&E documents • Midterm evaluation • Terminal report	• The case and benefits of Standard PPA accepted by key stakeholders • Operation of the relevant industries for cogeneration remains viable • Political and economic stability • Cost of kWh production below buyback tariff • Off-taker of electricity remains reliable and financially viable
Outcome 4: More favourable policies and institutional arrangements that support cogeneration promoted	• Policies that contain more favourable provisions and incentives to cogeneration compared to those prior to project implementation endorsed for approval • Existence of clear regulations allowing sales of power from cogeneration to the grid at favourable terms • Cogeneration incorporated in the power master plans of target countries • Existence of an institutionalized one-stop center providing information and competent services on cogeneration	• New Bills, Acts and other regulatory documents • Power master plans • Government gazettes • Utility announcements/reports • Progress reports • M&E documents • Midterm evaluation • Terminal report	• Government continues to recognize renewable energy and energy efficiency as priority • Willingness of the government agencies to receive support/assistance on policy formulation and enhancements • Efficient legislative performance

OUTPUTS			
Outputs or Outcome 1: Capacity of project developers, technical service providers and local manufacturers of modern and efficient cogeneration systems developed and enhanced			
1.1 Review of fuel resources and assessments of their potential for cogeneration 1.2 Relevant technologies for cogeneration and their suppliers identified and their information inputted in the Database 1.3 A framework for partnerships between foreign equipment suppliers and local manufacturers developed and established 1.4 Local technical personnel trained and assisted on technical and project development aspects of cogeneration 1.5 Visits organized for relevant stakeholders to successfully operated cogeneration references	• Comprehensive study on the fuel resources available, their potential for cogeneration and the applicable technologies conducted and reported during the initial phase of project implementation • A database containing foreign and local manufacturers of cogeneration equipment/components designed, implemented and continually updated • Participation of local manufacturers in the installation of new cogeneration projects and their capability enhanced through partnerships with foreign suppliers • No. of partnerships forged between foreign suppliers and local manufacturers • Training conducted for local technical personnel of project developers and other stakeholders on technical and project development aspects of cogeneration • No. of local technical personnel trained • No. of projects assisted/provided advice on technical and project development matters • Software tools for technical analysis of projects developed and/or adapted and used to provide advice and training of technical personnel • Visits (3 times during the first 4 years by different participants) to reference cogeneration plants in Mauritius organized for project developers, policy makers and other relevant stakeholders aiming to convince them of the technical reliability, economic viability and environmental friendliness of the systems;	• Fuel resources and potential assessment study report • Technology assessment study report • Database outputs and records • Cogen Centre activity report on matchmaking activities • List of participants to training activities • Evaluation forms on training activities • Training materials and seminar/workshop proceedings • List of participants to visits/study tours • Evaluation forms on visits/study tours • Progress reports • M&E documents • Midterm evaluation • Terminal report	• Availability of data/statistics on resources • Availability of data on suppliers and local manufacturers • Level of interest from relevant stakeholders to receive training • Existence of local manufacturers possessing certain level of capability to start with • Permission from reference installations to allow visits

	Visits to FSPP sites organized (around year 4 onwards) aiming at further replication of cogeneration projects in other industries and sectors		
Outputs for Outcome 2: Financing for cogeneration projects made available and accessed at terms and conditions that are favorable for investments			
2.1 A portfolio of relevant financing sources identified and creation/opening up of innovative financing schemes applicable to cogeneration facilitated 2.2 Project developers trained and assisted in financial structuring, financial packaging and accessing of funds 2.3 Financing institutions trained and assisted in evaluation and assessment of cogeneration technologies	• Existence of financing institutions, funds and innovative schemes that have been tapped/accessed for new investments in cogeneration projects • Innovative financing structures appropriate for cogeneration designed • No. of projects that have accessed funds for cogeneration • Total amount of financing provided to new cogeneration projects • Capacity building activities (workshops, forums, training) organized for project developers and relevant stakeholders • No. of project developers trained • Assistance provided to project developers in mobilizing funds for cogeneration projects • No. of projects assisted to obtain financing • Capacity building activities organized for relevant financing institutions • No. of financing institutions trained	• Cogen Centre activity report on financing activities • List of participants to capacity building activities • Evaluation forms on capacity building activities • Training materials and seminar/workshop proceedings • Financial packaging documents • Annual reports of relevant companies/financing institutions • Progress reports • M&E documents • Midterm evaluation • Terminal report	• Cogeneration seen by commercial financing institution as a viable lending portfolio • Decision of project developers/owners to invest in cogeneration projects
Outputs for Outcome 3: Commercial, technical, economic and environmental benefits of modern and efficient cogeneration systems demonstrated in a number of new cogeneration plants and confidence on the certainty of the cogeneration market enhanced			
3.1 Project Development Guide completed 3.2 Cogeneration Investment Packages developed and promoted 3.3 Full Scale Promotion Projects (FSPPs) implemented and promoted for replication	• Existence of the Project Development Guide which is made accessible to project developers and other stakeholders • A minimum of 6 Cogeneration Investment Packages (CIPs) developed and promoted to the private sector for investments	• Published version of the Project Development Guide • Statistics on recipient of the Guide • Copies of CIPs • Promotional materials on FSPPs (e.g. leaflets) • Progress reports	• Willingness of potential owners to use the services within the project • Existence of projects appropriate and eligible for FSPPs

3.4 Technical assistance provided to pipeline of projects (i.e. non-FSPP projects)	• A minimum of 6 FSPPs implemented or being constructed and have received support from the Cogen Centre for their development, implementation and promotion • No. of projects in the pipeline identified and received assistance • No. of replication projects implemented	• M&E documents • Midterm evaluation • Terminal report	• Willingness of project owners to comply with obligations required from FSPPs
Outputs for Outcome 4: More favourable policies and institutional arrangements that support cogeneration promoted			
4.1 Policies and regulations in the different participating countries reviewed and analyzed 4.2 Appropriate regulations, incentives and other measures supporting cogeneration formulated, and submitted to the relevant authorities and decision makers 4.3 Key decision-makers made aware of policy and institutional options for promoting cogeneration investments and encouraging cogeneration-based rural electrification 4.4 One-stop information and service center established and service provided to stakeholders 4.5 Promotion strategy and information dissemination program developed and implemented 4.6 Standard Power Purchase Agreements (PPAs) with reasonable tariffs and conditions in the participating countries	• Review and analysis of policies and regulations conducted during the initial phase of the project implementation and recommendations on policy interventions/enhancements provided • Support provided to policy makers and relevant agencies in formulating policies and regulations supporting cogeneration • Policies, regulations and incentives that are more clear and more attractive to investments in cogeneration proposed and endorsed to relevant authorities for approval • A one-stop information and service center with four units (i.e. Commercial/project development, financing, policy, technical) established and services to stakeholders who need them effectively provided and a Business Plan prepared for sustainability after project completion • Overall strategy on promoting cogeneration developed, promotional materials produced and disseminated to relevant stakeholders • Project website designed, implemented and contains relevant information for stakeholders; website continually updated and effectively accessed by stakeholders • A Standard Power Purchase Agreement containing a transparent tariff calculation	• Policy review and recommendation report • Activity reports on advocacy activities • Activity reports on support/assistance to policy makers • New Bills, Acts and other regulatory documents • Government gazettes • Strategy document on the one-stop information and service center • List of services provided by one-stop information and service center • Business Plan for the sustainability of the one-stop information and service center • Promotional strategy document • Promotional materials • Website • Statistics on website activities (no. of visits, frequency, downloads, trends, etc.) • Drafts of Standard Power Purchase Agreements • Government announcements and gazettes • Progress reports • M&E documents • Midterm evaluation • Terminal report	• Government continues to recognize renewable energy and energy efficiency as priority • Willingness of the government agencies to receive support/assistance on policy formulation and enhancements • Efficient legislative performance • Stakeholders' recognition of the need for the services of the one-stop center • Usefulness of the information contained in the website • The case and benefits of Standard PPA accepted by authorities and key stakeholders

drafted and the stage set for approval	formula and long term contract duration drafted and presented to the approving authorities in 7 countries		
ACTIVITIES	**Means**		
Activities for Outcome 1: 1.1 Investigate availability of biomass resources and assess their potential for cogeneration 1.2 Identify applicable technologies for cogeneration, relevant suppliers of equipment and their capabilities 1.3 Design and develop a database consisting of foreign equipment suppliers and local manufacturers 1.4 Design and implement a matchmaking service between foreign equipment suppliers and local manufacturers 1.5 Develop and/or adapt software tools for technical analysis to be used for analysis of projects and training purposes 1.6 Conduct capacity building activities through seminars, workshops and training 1.7 Provide technical advice and services to project developers and potential owners of cogeneration systems 1.8 Organize visits and study tours to successful cogeneration installations	• Manpower: xxx • Laboratory analysis of fuel samples • Company brochures of suppliers • Resource persons/trainers • Office facilities and supplies • Office equipment and computer facilities • Training facilities and supplies (venue, computers,…) • Database software programme (e.g. FoxPro) • Data from suppliers, manufacturers and other relevant companies for the Database • Existing software to be adapted • Reference cogeneration projects to visit	**Sources of information to monitor progress:** • Cogen Centre activity reports • Progress reports • M&E documents • Midterm evaluation **Costs:** 1,568,836 USD, out of which GEF incremental financing will be 943,836USD	• Risks that the available fuel resources will diminish in the medium to long term • Risks that the existing capability of local manufacturers does not reach the minimum required for partnership with foreign suppliers
Activities for Outcome 2: 2.1 Identify and review existing financing sources and mechanisms relevant for the sector and the region 2.2 Design and recommend financing	• Manpower: xxx • Office facilities and supplies • Office equipment and computer facilities • Resource persons/trainers • Training facilities and supplies (venue,	**Sources of information to monitor progress:** • Cogen Centre activity reports • Progress reports • M&E documents • Midterm evaluation	• Risks that the potential project developers/owners will not be willing to put in the required equity contribution

structure appropriate for cogeneration projects 2.3 Design and develop financial analysis software tool to be used for project analysis and training 2.4 Conduct training of project developers and financing institutions 2.5 Assist project developers and financing institutions in the financing of projects	computers,…) • Inputs to financial packaging activities (e.g. Business Plan, Fuel Supply Availability Study, Fuel Supply Agreement, Feasibility Studies, Shareholders' Agreement, EPC Proposal/Contract, O&M Plan/Contract, etc.) • Software tools • Financial analysis model	• **Costs:** 1,071,356 USD, out of which GEF financing will be 1,071,356 USD	
<u>Activities for Outcome 3:</u> 3.1 Develop a project development guide for reference and training purposes 3.2 Identify and select candidate sites for projects, prepare Cogeneration Investment Packages (CIP) for selected sites and promote the CIPs for private sector project development and investment 3.3 Select, support and implement FSPPs 3.4 Identify a pipeline of projects for replication 3.5 Provide assistance and services to project developers for projects in the pipeline	• Manpower: xxx • Relevant data & experience to be inputted into the Project Development Guide • Resource persons/trainers • Office facilities and supplies • Office equipment and computer facilities • Statistics from relevant agencies • Studies on tariff setting from other countries • Software tools • Financial analysis model	**Sources of information to monitor progress:** • Cogen Centre activity reports • Progress reports • M&E documents • Midterm evaluation **Costs:** 61,551,306 USD, out of which GEF financing will be 1,551,306 USD	• Risks that there are other investment opportunities that are more attractive than investing in cogeneration systems
<u>Activities for Outcome 4:</u> 4.1 Review and analyze existing policies and regulations, and recommend policy interventions and enhancements to support cogeneration 4.2 Design and implement advocacy activities to influence policy reforms and implementation 4.3 Support policy makers and relevant agencies in policy formulation and	• Manpower: xxx • Office facilities and supplies • Office equipment and computer facilities • Documents on existing policies and regulations • Documents on policy interventions in other countries • Facilities to conduct dialogues/forums with policy makers • Professional printing service (outsource) • Website host	**Sources of information to monitor progress:** • Cogen Centre activity reports • Progress reports • M&E documents • Midterm evaluation • **Costs:** 2,132,956 USD, out of which GEF financing will be 1,304,356 USD	• Risks that the Governments concerned will not have the political will nor prepared/ willing to pay the cost of making renewable energy, energy efficiency and cogeneration a priority

enhancements 4.4 Design and establish a one-stop information and service center within the Africa Cogen Centre 4.5 Develop a promotional strategy for the whole project, prepare promotional and other relevant materials and disseminate them to relevant stakeholders 4.6 Develop a project website for internal and external audience and update continually 4.7 Assist utilities and relevant agencies to draft and set the stage for the approval of Standard Power Purchase Agreements (PPAs)	• Documents and materials for website		

ANNEX C: RESPONSE TO PROJECT REVIEWERS

STAP expert review and IA/ExA response

Technical Review of Cogen for Africa Project Proposal

Reviewer: Eng. Ikhupuleng Dube, Zimbabwe

Introductory notes

The report is now fully developed and thorough so as to facilitate an objective review.

Scientific and technical soundness of the project

1. Has he most appropriate and effective approach been used to remove the barriers?

Comprehensive analytical work has been carried out in this project brief. The approach used is appropriate and effective. The concept of the Cogen for Africa Project and the methodologies used in its implementation are based on proven and tested approaches that have been used elsewhere. The strengths of these approaches have been adapted to suit the African context and business environment. The regional nature of the project addresses the common barriers faced by countries in the region and proposes various activities for removing the barriers, which are appropriate. The project targets the removal of barriers that exist and is geared to assist in the transformation of cogeneration industry into a profitable cogeneration market through capacity building, technical assistance, and institutional support for policy formulation. These are essential and effective activities to remove the identified barriers. The strength of the project is its ability to link barrier removal to commercial activities of the project. It is expected that the implementation of the projects and proposed activities will act as showcases in convincing other potential project developers/owners of the technical reliability, economic viability and environmental friendliness of these types of cogeneration systems.

2. Has the most appropriate and effective approach been used to reduce the costs of the technologies?

Costs likely to be reduced through the maximization of the benefits realized through the usage of the proposed highly efficient cogeneration systems in the sugar factories. This would inevitable improve the efficiency in the use of process steam and electricity in the sugar processing thereby freeing up more bagasse to generate additional electricity for sales to the grid. The costs of the system should be ideally not be judged based on the cost of technology alone but should include other avoided costs arising from the implementation of technology. Specifically to cogeneration additional cost benefits arise of the implementation of the project are:

- Use of indigenous, cheap renewable fuel source instead of imported, finite fossil fuel
- Elimination of disposal problems and associated costs for biomass residues
- Loss reduction and improvement in quality and reliability of supplies
- Additional income
- Opportunity for increasing rural electrification levels
- Reduction of transmission and distribution losses
- Less burden for the national government in electricity generation investment
- Environmental benefits
- Improvement of the voltage profile on the local network was improved which translate into improved quality of service to local consumers

These additional benefits are often not considered in the economic benefits of the systems, when compared to other competing technologies such as large scale fossil generation and are adequately highlighted in the project proposal.

3. Was the potential market determined on the basis of RETs data and databases?

The potential market for cogeneration was covered in very much detail in the brief. Credible data and databases for assessing the potential market for cogeneration in Africa were used. Relevant data on critical technical parameters for assessing the market potential for cogeneration were considered, analyzed and presented in the proposal. These include considerations such as:

a) Installed capacities, demand and supply capacity balances
b) Availability of bagasse in participating countries and proposed expansions
c) Current status of cogeneration and installed capacities
d) Electricity supply and demand
e) Investments by independence power producers
f) Power development plans (including renewable market share)

The databases are supported by pre-feasibility studies in issues relating to:

a) Past and future trends in production of baggase
b) Energy requirements and sources
c) Monthly electricity load patterns of the plants
d) Monthly energy supplied from the grid to plants
e) Plant steam requirements
f) Sources and prices of electricity
g) Technical assessment of plants including:
    - Baggase handling systems
    - Steam and boiler handling installations
    - Grid supply configuration

h) Institutional and policy issues
i) Regulatory issues
j) Information, technical and capacity building needs

The information was collected through credible and verifiable data sources (with comprehensive citations of the sources of data) and data collected through direct contacts with some sugar estates. The potential market for cogeneration was determined by sound techniques backed up by adequate data sources.

4. Has an evaluation of the demand-side mechanisms to support after sales-service been undertaken?

   By having the Sugar Plantations as the key beneficiaries of the proposed cogen plants, it can be expected that their dependence on these plants will be a strong incentive for effective after-sales service.

5. Adequacy of the financing mechanism?

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   The financing mechanisms are in two categories, namely funds for the Center operating costs and technical assistance and funds earmarked for cogeneration projects. Funds for the center's operational costs and technical assistance are envisaged to come from GEF (to cover incremental costs), international co-funding and national governments. Two issues are pertinent regarding the center's operational and technical assistance costs, namely the adequacy of financing mechanism to meet the requirements of running the center's activities and the commitment and availability of funds from other non GEF sources.

   The funds earmarked for the center's operation and technical assistance seem to cover the anticipated requirements, based on very detailed submissios in the brief of the budget for various activities, the expertise and manpower requirements to execute the activities and the assumptions in drawing the budgets of the activities envisaged. GEF's contribution is based on the incremental costs that are substantiated in the brief.

Fund from the national government are earmarked to cover National Cogen Offices in respective countries. The funds are earmarked for rental for the office spaces of these National Cogen Offices and the operating costs such as mailing, communication utilities, etc. will be contributed as in-kind contribution by the national governments. The project is endorsed by the national governments through supporting documentary evidence.

Potential funding from other sources to cover various activities has been identified and discussed in the brief. Contacts have been established with different potential financiers and information is provided on the organization, type and level of financing, contact persons geographical applicability and status of commitment. The commitment is at different phases of development including sources whereby submissions have been submitted and are awaiting approvals and sources where submission are still to be submitted or discussions are in progress. The information provided seem to indicate a high probability of interest by other players to fund the project under varying modalities.

The bulk of the funds are through private sector participation. Documentary evidence is provided by interest of different groups in the private sector to participate and support the project. These are backed up by detailed costing and financial analysis (including sensitivity analysis) of the plants in different participation. The costing data and assumptions used are typical of such plants. Though some financing aspects of the project are sill to be concluded, this is a financial sound projects backed up by commitments of the major stakeholder groups with documentary evidence.

6. Adequacy of the introduced financial incentives?

   The wide scale benefits of the project as outlined in the various section of the brief are adequate incentives. These incentives are complemented by additional incentives such as the proposed grants, concessional/soft loans, seed capital, subsidies, provision of credit guarantees and other financial incentives.

7. Comments on the design of demonstration project?

   This is a very carefully thought, analyzed and developed project, based on sound research principles and backed up by well documented and presented data and facts. It draws its inspiration from the success of the cogeneration industry in Mauritius, which stems from the investments in, and use of, high pressure boiler systems and highly efficient condensing/extraction-condensing turbo-generators which allow the project owners to implement much higher capacities than what the mills need, thereby giving them opportunity to sell excess power to the grid. In the Mauritius case, the sale of electricity to the grid has been facilitated and encouraged by the favorable buyback tariffs and terms reflected in a transparent and long-term Standard Power Purchase Agreements (PPA). The regional approach undertaken is similar to the Asia Cogen Project.

   The design of the project hinges of activities that are covered systematically and logically and very are very credible. They cover critical areas such removal of barriers, policy and regulatory enhancements, creating of awareness, training, linkages to the private sector, technology and skills transfer and innovative financial mechanism through a well proposed Center of Excellency. Risks are identified and mitigation measures presented. The role dimensions of different stakeholders are well articulated backed by commitment by the critical stakeholders.

   The development of the Full Scale Promotion Project is based on an extensive analysis of the needs assessment among stakeholders. This is demonstrated by the level of discussions which were held with potential developers of cogeneration projects to assess their need, including pre-feasibility studies covering a range of barriers. The commitment of these stakeholders is well documented.

   The proposed National Offices would ensure effective dissemination and ensure that regional commonalities are taken advantage of and also define the project within the national context. This will help effective replication of the project.

8. Will a process be put in place to monitor the project?

The processes to monitor the project are extensively covered in the brief. A logical framework (Project Planning Matrix) has been developed adequately for all the expected outcomes and indicators for each outcome are presented. The suggested indicators are relevant and verifiable. Detailed work plan, schedules and milestone for the projects have been developed covering a period of six years. The plan logically covers all the relevant activities of the project.

9. Is the barrier removal supported by an underlying policy framework?

   Inventory of policies supporting cogeneration are adequately covered by the brief (Section 2). This is backed up by letters of committed form the governments and participating institutions in the region.

10. Is the proposed activity feasible from an engineering and technical perspective?

Cogen is feasible and is used in various regions of the world.

Identification of global environmental benefits

These are extensively covered and demonstrated in brief. The methods used are sound.

How does the project fit within the context of the goals of the GEF

The draft brief has specifically identified the Operational Programs and GEF Strategic Priorities to which it is directly relevant (Section 3.1)

Regional Context

Current status and policies on cogeneration in participating countries is extensively outlined in the brief. Regional commonalities exist. Useful lessons can be derived both within the region (Mauritius) and outside the region (ASEAN Cogen Project).

Replicability of the project

Possibility of replicating project to other countries of the region is excellent. In concept the proposed Program itself is a replication of activities successfully implemented in the Far East. The proposed mid-term review will allow additional countries to participate in the second phase. A francophone replication or Program extension could be initiated for Western Africa later. Members of the AFREPREN/FWD network would benefit through its information dissemination procedures and the physical presence of the network in all energy sector related activities in the region.

Sustainability of the project

The commercial nature of the proposed project greatly enhances its sustainability.

Secondary issues

Linkages to other focal areas

Covered well in the brief

Linkages to other programmes and action plans at the regional subregional levels

Covered in detail in Section 5 of the brief

Other beneficial or damaging environmental effects

This are covered well in the brief

Degree of involvement of stakeholders in the project

Among the key stakeholders, the sugar companies, and financing institutions and policy makers clearly involved and are have been actively engaged in discussions.

Capacity building aspects

Various activities envisaged under the project

Innovativeness of the project

The project is very innovative and if implemented will have positive market transformation in cogeneration within the region and beyond

RESPONSE
We greatly appreciate the reviewer's concurrence to the concept, design and appropriateness of the Project in contributing to the reduction of greenhouse gasses through the transformation of the cogeneration industry in the 7 participating countries in Africa.

His comments reflect the understanding and contention of the proponents that there is a need to support the removal of the existing barriers in order for the highly efficient cogeneration systems to be implemented in the participating countries of the African region. Without this support, the industries in these countries will continue to operate the existing inefficient obsolete systems and miss the benefits and opportunity brought about by the implementation of modern and clean cogeneration systems.

ANNEX D: THE DESIGN OF THE AFRICA COGEN CENTRE

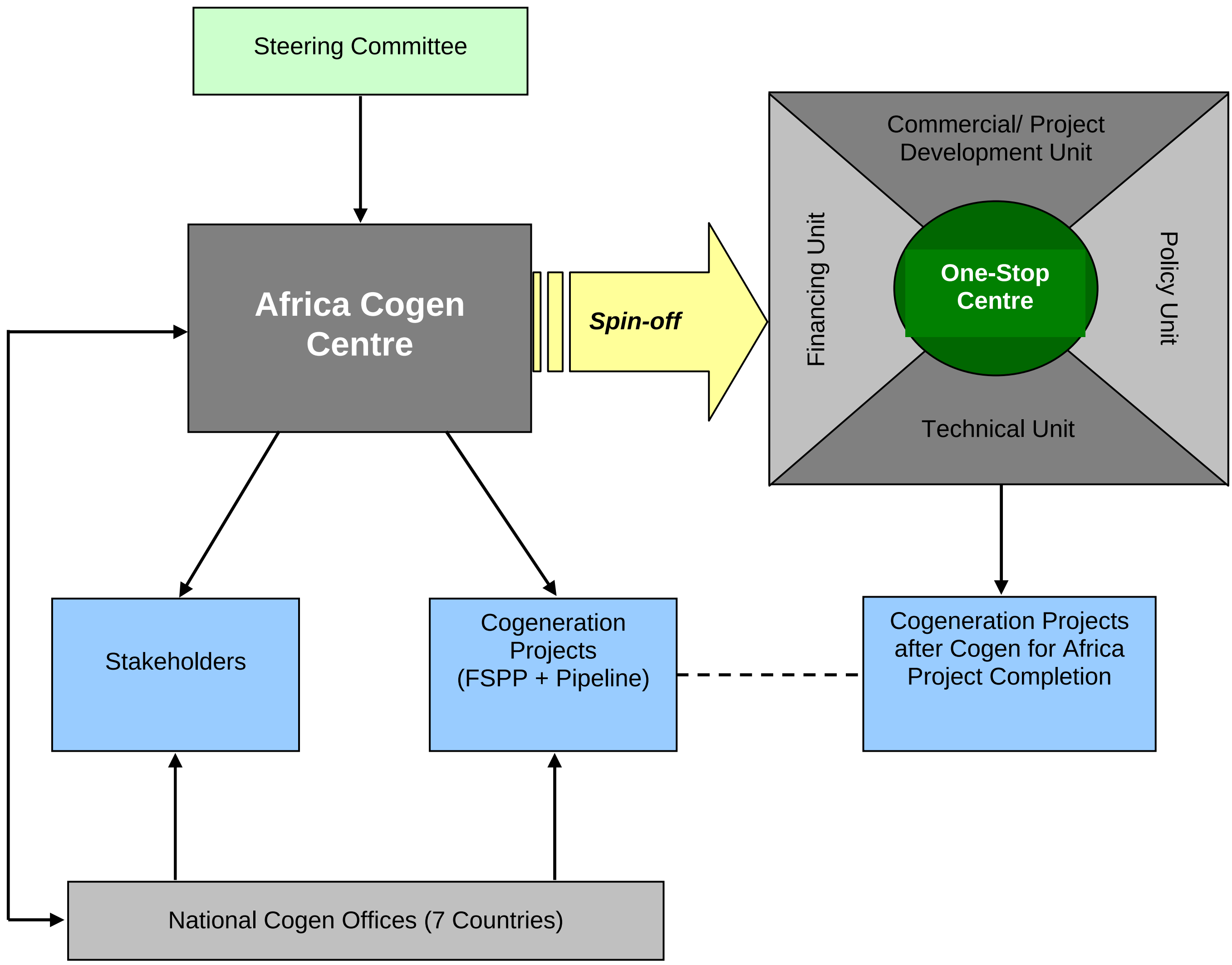
A major platform for the implementation of the Cogen for Africa Project is the creation of a regional center of excellence to be called the Africa Cogen Centre. This center will be modeled on the Cogen Asia Model but taking into account some of the region's specific needs and characteristics, as well as on the successful Mauritius' experience. It will operate as the center of excellence for cogeneration in the African region. The Africa Cogen Centre will be set up to consist of four functional units covering the areas of technical, financing, project development/commercial aspects, and policy matters. These units will be manned by both International and Regional/Local Experts and will act as a one-stop information and service center providing advice, assistance and services to stakeholders of cogeneration investments.

The Africa Cogen Centre will report and will be accountable to the Project Steering Committee while being supported on the national level by National Cogen Offices which will be set up in each of the countries participating in this Project. The National Cogen Offices will be the first level contact and will liaise with stakeholders in their respective countries.

Upon completion of the project, the one-stop information and service center is expected to spin-off into a self sustaining entity which will continue to provide institutional and practical support to the cogeneration industry in the region.

An overview of this concept is presented in graphical form in the following figure.

Overview of the Cogen for Africa Project concept



It is proposed that AFREPREN/FWD be appointed as the Executing Agency of the Cogen for Africa Project. The Executing Agency shall create and host the Africa Cogen Centre which shall manage the activities of the Project.

Role and services of the Africa Cogen Centre

The role and services of the Africa Cogen Centre are given below. The services have been categorized according to the stakeholder groups served.

Services for (Potential) Project Developers/Owners:

- Support project development process through:
    - the identification of opportunities
    - assistance in preparation business concept and plans
    - identification and selection of technologies and suppliers
    - technical advise to potential investors
    - assistance in pre-investment and feasibility studies
    - assistance in structuring security arrangements (drafting of contracts/agreements and follow up on contractual obligations)
- Support in mobilizing funds and arranging financing through:
    - identification of relevant financing institutions and schemes
    - design of appropriate financing structures for cogeneration projects
    - assistance and facilitation in creation of innovative financing schemes for cogeneration projects
    - assistance in financial structuring and packaging and related activities such as preparation of Financing Plan, Information Memoranda, Term Sheets and other documentation
    - assistance in presentation to, and negotiation with, financing institutions
    - advice in drafting of Financing Agreement
- Support the development of FSPPs through:
    - advice and assistance on application and eligibility
    - financial support, whenever applicable
    - assistance in PPA formulation and seeking approval from authorities
    - advice in project management and supervision during construction and commissioning
    - advice in the design of O&M framework and training of operators
- Conduct training and capacity building activities on, but not limited to, the following aspects:
    - investment appraisal and decisions
    - financial analysis and financing concepts
    - conduct of techno-financial and feasibility studies
    - project development process
    - biomass fuel and combustion characteristics
    - power systems and design concepts
    - fundamentals of cogeneration technology
    - basic and conceptual design of cogeneration systems
    - technology assessment
- Assist in activities leading to environmental and carbon finance participation
- Prepare and disseminate Cogeneration Policy Guidance
- Organize visits and study tours to reference cogeneration installations
- Provide country specific and regional market information

Services for Financiers and External Investors:

- Identify opportunities for financing
- Support in the assessment of project bankability through:
    - conduct of due diligence of projects
    - technical evaluation of projects
- Conduct training and capacity building to financing institutions in matters related to:
    - fundamentals of biomass fuels and cogeneration technologies
    - assessment of cogeneration technologies

- Organize visits and study tours to reference cogeneration installations
- Provide country specific and regional market information

For Equipment Suppliers (foreign and local):
- Identify potential projects
- Provide access to Cogen Database on potential partners and their capabilities
- Assist in forging partnerships between foreign equipment suppliers and local manufacturers
- Provide country specific and regional market information

For African Policy Makers:
- Provide cogeneration policy guidance, including matters such as:
    - regulations, consents and permits on sales of electricity to the grid from renewable energy and/or cogeneration
    - utility grid connection for sale of firm/non-firm excess electrical power
    - fiscal and non-fiscal incentives
- Assist in drafting and formulating Standard Power Purchase Agreements
- Arrange dialogues between governments and end users to facilitate understanding of requirements from both ends in order to come up with mutually beneficial policies and regulatory measures
- Organize visits and study tours to reference cogeneration installations

Coordination, Administrative and Secretarial Services:
- Overall coordination and management of the Project
- Set up the premises of the Africa Cogen Centre and prepare for mobilization
- Identify and recruit national, regional and international experts and staff
- Select, negotiate and contract National Cogen Offices in all participating countries
- Liaise with, train and provide technical assistance to National Cogen Office staff
- Procure office and Project equipment, furniture, supplies, etc.
- Set up IT network and devices
- Prepare Inception Report and Detailed Work Plan
- Manage the financial activities and reporting of the Project
- Procure and adapt Management Information System which will capture, record and report on financial, administrative and management information of the Project
- Organize meetings, and provide administrative support to capacity building activities
- Organize production and printing of reports and promotional materials
- Provide secretarial and administrative services to all the Units and personnel of the Project

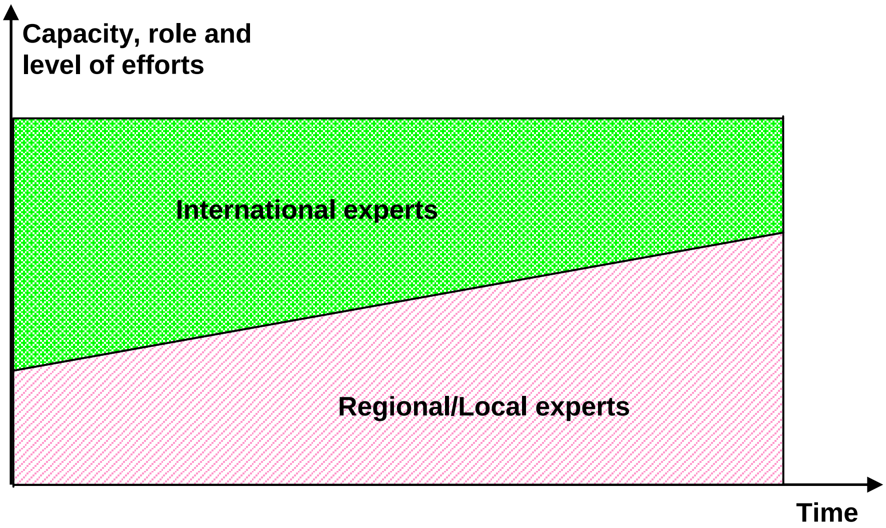
Personnel

The proposed personnel of the Africa Cogen Centre will consist of both International Experts and Regional/Local Staff. Details of the qualifications and responsibilities of the personnel are provided in the Full Size Project document.

The involvement and contribution of the International Experts will ensure:
- high quality technical and financial implementation of the project
- that lessons and experience in other parts of the world are considered and adapted, whenever necessary
- transfer of knowledge and capability to regional/local personnel.

Thus, the person-power requirements and responsibilities of the International Experts are structured to fulfil the above factors. It is expected that at the beginning of the project, the capacity contribution and level of efforts of the International Experts will be high. As time progresses and internal capacity building takes place, the capacity contribution and level of efforts of the International Experts are expected to diminish and the Regional/Local expertise takes a more centre stage in the activities of the project. The figure below illustrates this idea.

Contribution and involvement of International Experts vis-à-vis Regional/Local Experts

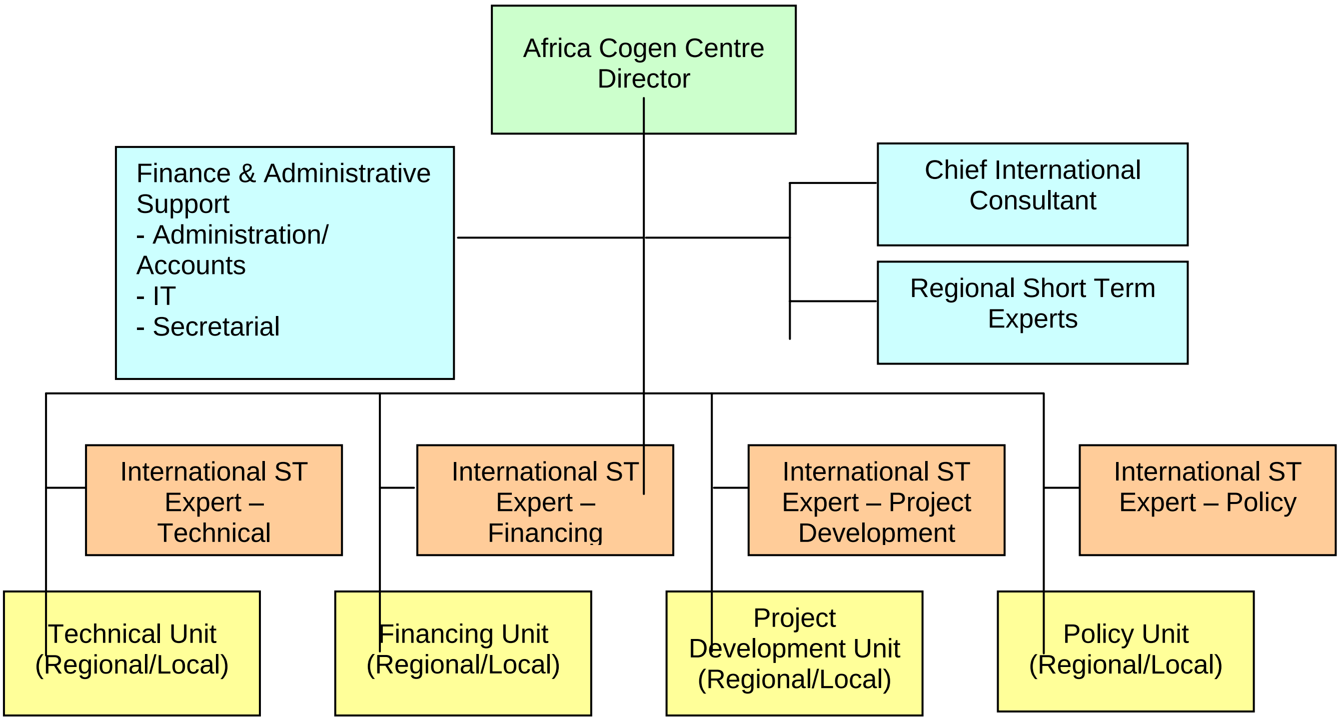


The personnel are organized to effectively fulfil the major outcomes of the project on one hand, and to prepare for sustainability on the other hand. These are ensured through the following means:

- The appointment of a Regional/Local professional to act as the Director of the Africa Cogen Centre
- The division of functions and responsibilities into four functional groups according to the four different units described earlier
- The Regional/Local personnel take leadership, responsibility and "ownership" of the work within the different units through the Unit Heads, while the International Experts provide guidance, advice, training, inputs and act as resource individuals
- The Regional/Local personnel shall be employed on a full time basis for the duration of the Project, with three Regional Experts working on a short term basis. The capacity, involvement and responsibilities of the Regional/Local personnel will increase in time.
- The International Experts shall consist of one full time personnel for the duration of the Project with the rest of the Experts working on short term basis according to specific outputs and assignments. The role and involvement of the Short-Term International experts will decrease in time.

The organizational structure of the Africa Cogen Centre and the distribution of the personnel according to their roles and functions are given in the following figure.

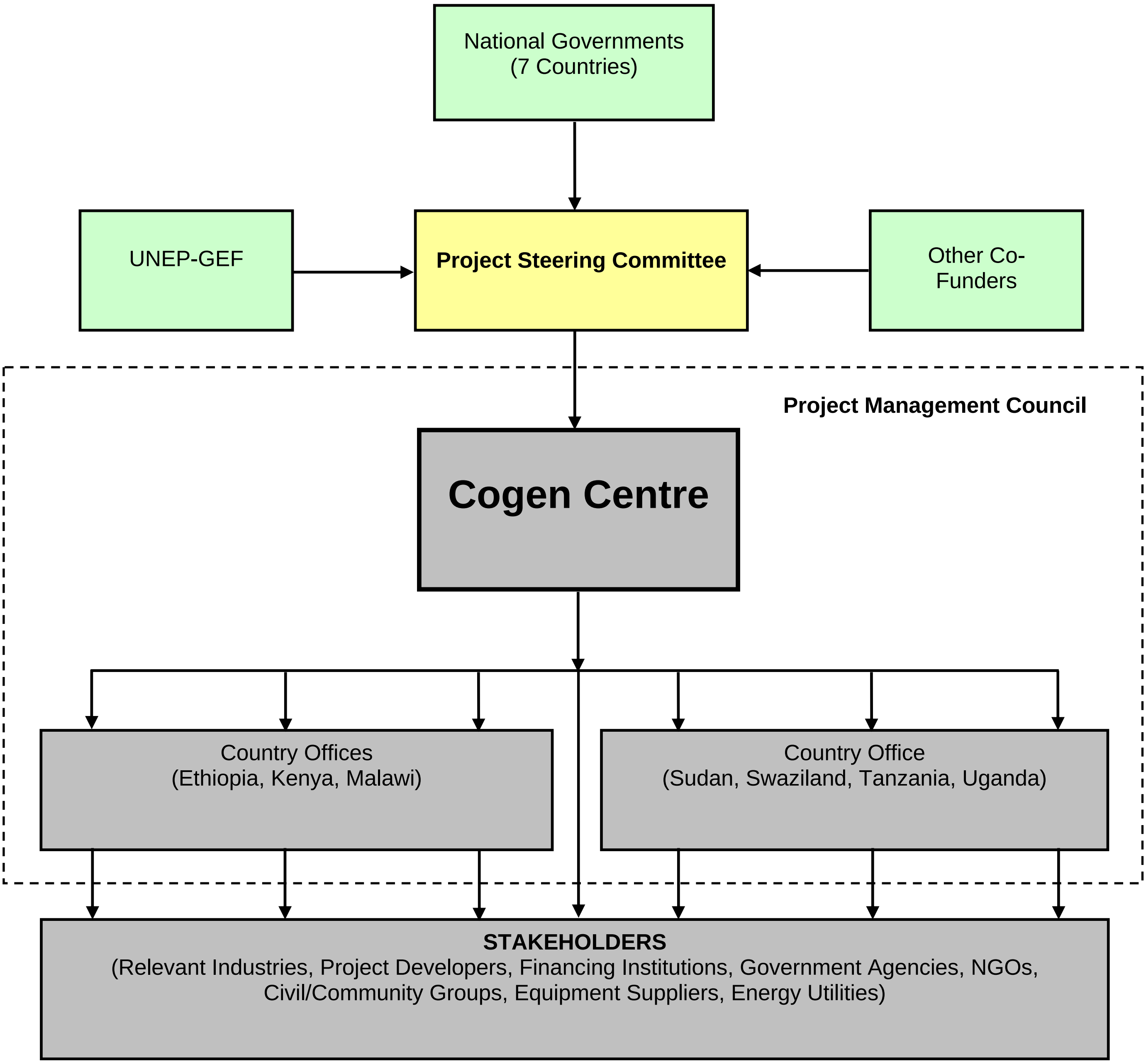
Organizational structure of the Africa Cogen Centre



Notes: IT = Information Technology
ST = Short-Term

The figure below shows the project management structure of the Cogen for Africa Project. The Africa Cogen Centre, which manages the day-to-day operations of the Project, reports to the Project Steering Committee. The National Cogen Offices reports to the Africa Cogen Centre and are in direct contact with the stakeholders in their respective countries. The Africa Cogen Centre monitors and supervises the activities of the National Cogen Offices and supports them through training and technical assistance. Under certain circumstances, the Africa Cogen Centre could also have a direct link/contact with the stakeholders through the provision of assistance/advice by the Experts of the Centre.

Project management structure of the Cogen for Africa Project



ANNEX E: STAKEHOLDER GROUPS, THEIR INVOLVEMENT AND ROLE IN, AND BENEFITS FROM, THE PROJECT

Stakeholder/ Beneficiary	Reason for involvement	Role/Nature of involvement		Benefits to stakeholders
		Project preparation	Project implementation	
(Potential) End-users of cogeneration systems	Potential owners and hosts of cogeneration projects	Consultations; discussions on cogeneration potential; provision of information; hosting of visit to factory site	Development and implementation of Full Scale Promotion Projects (FSPPs); equity participation; possible Project Steering Committee (PSC) representative from the industry	Technical, commercial &financing advice; training & capacity building; mobilization of funds for projects; assistance in liaising with government agencies; policy and institutional support; visits to successful cogeneration sites; reliable & readily available information on cogeneration
Project developers	Expertise and funds in developing cogeneration projects; provision of equity	Consultations; discussions on cogeneration potential; provision of information;	Development and implementation of Full Scale Promotion Projects & other cogeneration projects; equity participation; possible PSC representative from the industry	Identification of Cogen business opportunities; technical, commercial &financing advice/services; training & capacity building; mobilization of funds for projects; assistance in liaising with government agencies; policy and institutional support; visits to successful cogeneration sites; reliable & readily available information on cogeneration
Financing institutions	Source of funds (equity, loans, etc.) to the projects	Consultations; discussions on funding potential; provision of information	Funding of projects; possible PSC representative from the industry	Funding opportunities; training & capacity building on assessment & evaluation of cogeneration projects; visits to successful cogeneration sites
Fuel suppliers (biomass residues, etc.)	Source of fuel for cogeneration plants	Consultations; discussions on availability of fuel (mainly bagasse at this stage); provision of information	Supply of (biomass) fuel	Business opportunity; possibly free steam & electricity as trade off
Local manufacturers	Manufacturing & construction of components	Invited to national stakeholders' meetings	Supply & installation of local components; possible Project Steering Committee (PSC) representative from the industry	Partnerships with foreign suppliers of cogeneration equipment; matchmaking service; enhanced manufacturing experience; business opportunity
Equipment suppliers	Source of efficient, high-pressure cogeneration systems	None so far	Supply of cogeneration systems and components; possible equity	Opportunity for equipment supply; opening up of market; matchmaking opportunity with local manufacturers; delocalization of manufacturing; participation in FSPPs

			stakes in projects; assistance in sourcing of bilateral and export credit support	
Policy makers/government agencies	Policy and regulatory support; enabling environment	Consultations; discussions on policy and regulatory framework; provision of information; assistance in meeting with other stakeholders	PSC member; policy formulation & enhancements; Approval of regulations; incentives; subsidies; licensing & permits	Advice and support in policy formulation; workshops & forums on cogeneration; energy security; private sector investment in energy services; visits to successful cogeneration installations and FSPPs
Power utilities	Gird connection; purchase of power from cogeneration plants	Consultations; discussions of national electricity demand & future requirements; provision of information	PSC member; purchase of power from cogeneration plants; dialogue through policy papers, workshops, etc.	Additional installed capacity from private sector funding; lesser burden for capital investment in generation capacity and transmission & distribution costs; decentralized source of power & increased stability at end-of-line parts of the grid
Local consultants and service providers	To provide local expertise and services	None so far	Target of capacity building; provision of local expertise	Training and capacity building; increase of expertise & experience in high-pressure cogeneration projects; business opportunities
Communities surrounding the cogeneration installation, including women & marginal groups	Direct & indirect recipients of economic, social & environmental impacts of cogeneration	National stakeholders' meetings	Regular consultations; source of labour market for the employment requirements of projects	Job creation; economic/social benefits of electrification for projects with rural electrification component; cleaner air compared to existence of inefficient systems; information from website

ANNEX F: MONITORING AND EVALUATION PLAN

M&E activities	Frequency /Timing	Aspects to be monitored & evaluated/ Description	In-charge of activity	Approval
Project implementation Manual	After 3 months	Administrative, financial and reporting policies of the Project	ACCD	PSC
Written Reports				
Inception report	After 3 months	Mobilization; staffing; detailed work plan; detailed budget; Project Implementation Manual	ACCD	PSC; IA
Quarterly progress report	Quarterly	Quarterly accomplishments; work plan for the next quarter	ACCD	PMC
Annual progress report	Yearly	Annual accomplishments; Expenses for the year completed; next year's work plan and budget	ExA	PSC; IA
Mid-term progress report	After 3 years	First half-term accomplishments; half-term expenses; update of Project work plan; lessons learned, recommendations and suggestions for re-orientation of activities (if necessary)	ExA	PSC; IA
Final report	After 6 years	Project accomplishments; Project expenses and financial report; records and evidences of all outputs; lessons learned and recommendations for future actions	ExA	PSC; IA
NCO progress reports	Quarterly	Country accomplishments; work plan for the next quarter	NCO staff	PMC
Mission reports	After each mission	Relevant aspects of the mission (according to defined template)	Individual experts	ACCD
FSPP monitoring	After commission-ing of the plants	Technical feasibility, economic/financial viability and environmental impact of the Full Scale Promotion Projects (FSPPs)	CIC; External service providers	PSC
PSC meetings and minutes	Every 6 months	PSC meetings will discuss policy and strategic matters of the Project and provide direction & guidance to the Project. It will also approve selection of Full Scale Promotion Projects, endorse adaptations to the Project components during the Project execution, evaluate the performance and impacts of the Project, and approve Progress, Midterm and Terminal Reports	ACCD	PSC; IA
PMC meetings and minutes	Every 6 months	The PMC will provide technical and operational guidance to the Programme, select of Full Scale Promotion Projects, monitor and evaluate the progress of the activities and approve quarterly planning of activities	ACCD	PSC
Financial & Management Information System (FMIS)	Throughout the Project; continuous	Accounting transactions; financial management & reporting; monitoring and control of project expenditure; Project resource data tracking; tracking mechanisms for co-financing & expenditure; standard forms & templates	Finance/ Admin. Manager	ACCD; IA
External audit	Every year	Auditing of accounts and financial	External	IA

	& After 6 years (final audit)	management; use of international accounting standards	auditor	
Mid-term Review	After 3 years	Review of progress on execution & achievement of project outcomes as specified in the Project Document; fine-tuning of work plans for the second half of the project; improving project approaches and optimizing implementation arrangements; recommendation on adaptive measures; extensive and transparent consultation with all key stakeholder groups	ExA	PSC
Terminal Evaluation	After 6 years	Achievements, outcomes & impacts compared to baseline; lessons learned and recommendations for future actions; evaluation according to GEF Project Review Criteria	IA; Independent evaluators	IA
Other deliverables				
FSPPs	Project end	About 6 FSPPs or 40 MW of new and efficient cogeneration projects	ACCD; CIC	PSC
Training and capacity building activities	2 training per year from year 2 to year 6	Capacity building activities (workshops, forums, training) organized for relevant stakeholders on technical, project development and financial aspects of cogeneration	Assigned experts	ACCD
Project Development Guide	Year 2	A guide in developing and implementing cogeneration systems using best practices	Assigned experts	CIC
COGEN Database	Year 1	A database containing foreign and local manufacturers of cogeneration equipment/components	Assigned expert	ACCD
Cogen for Africa website	Year 1	Project website containing relevant information on cogeneration and the Project for stakeholders	Assigned expert	ACCD
Feasibility studies	Project end	A minimum of 6 feasibility studies and several other pre-feasibility studies for new cogeneration projects	External service providers	CIC
Fuel resources study	Year 1	Comprehensive study on the available fuel resources and their potential for cogeneration	Assigned experts	CIC
Study on applicable technologies	Year 1	Review and assessment of technologies applicable for cogeneration that have been implemented successfully in similar environments	External service providers	CIC
Business Plan	Year 2 & year 4	Business Plan for sustainability of the Africa Cogen Centre after project completion	External service providers	ACCD;PSC

Notes:
ACCD = Africa Cogen Centre Director
CIC = Chief International Consultant
ExA = Executing Agency
IA = Implementing Agency
NCO = National Cogen Offices
PMC = Project Management Council
PSC = Project Steering Committee

ANNEX I: WORK PLAN, SCHEDULE AND MILESTONES

Outcome/Activity		Year 1				Year 2				Year 3				Year 4				Year 5				Year 6			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Outcome 1 *Capacity of project developers, technical service providers and local manufacturers of modern and efficient cogeneration systems developed and enhanced*	**Activity 1.1:** Investigate availability of biomass resources and assess their potential for cogeneration	■	■	■																					
	Activity 1.2: Identify applicable technologies for cogeneration, relevant suppliers of equipment and their capabilities	■	■																						
	Activity 1.3: Design and develop a database consisting of foreign equipment suppliers and local manufacturers		■	■																					
	Activity 1.4: Design and implement a matchmaking service between foreign equipment suppliers and local manufacturers			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Activity 1.5: Develop and/or adapt software tools for technical analysis to be used for analysis of projects and training purposes			■	■	■																			
	Activity 1.6: Conduct capacity building activities through seminars, workshops and training			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■				
	Activity 1.7: Provide technical advice and services to project developers and potential owners of cogeneration systems		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Activity 1.8: Organize visits and study tours to successful cogeneration installations			■				■				■				■				■				■	
Outcome 2 *Financing for cogeneration projects made available and accessed at terms and conditions that are favorable for investments.*	**Activity 2.1:** Identify and review existing financing sources and mechanisms relevant for the sector and the region	■	■																						
	Activity 2.2: Design and recommend financing structure appropriate for cogeneration projects		■	■																					
	Activity 2.3: Design and develop financial analysis software tool to be used for project analysis and training			■	■																				
	Activity 2.4: Conduct training of project developers and financing institutions				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■				
	Activity 2.5: Assist project developers and financing institutions in the financing of projects			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

Outcome 3 *Commercial, technical, economic and environmental benefits of modern and efficient cogeneration systems demonstrated…*	**Activity 3.1:** Develop a project development guide for reference and training purposes																								
	Activity 3.2: Identify and select candidate sites for projects, prepare Cogeneration Investment Packages (CIP) for selected sites and promote the CIPs for private sector …																								
	Activity 3.3: Select, support and implement Full Scale Promotion Projects (FSPPs)																								
	Activity 3.4: Identify a pipeline of projects for replication																								
	Activity 3.5: Provide assistance and services to project developers for projects in the pipeline																								
Outcome 4 *More favorable policies and institutional arrangements that support cogeneration promoted*	**Activity 4.1:** Review and analyze existing policies and regulations, and recommend policy interventions and enhancements to support cogeneration																								
	Activity 4.2: Design and implement advocacy activities to influence policy reforms and implementation																								
	Activity 4.3: Support policy makers and relevant agencies in policy formulation and enhancements																								
	Activity 4.4: Design and establish a one-stop information and service center within the Africa Cogen Centre																								
	Activity 4.5: Develop a promotional strategy for the whole project, prepare promotional and other relevant materials and disseminate them to relevant stakeholders																								
	Activity 4.6: Develop a project website for internal and external audience and update continually																								
	Activity 4.7: Assist utilities and relevant agencies to draft and set the stage for the approval of a Standard Power Purchase Agreements (PPAs)																								
Project management, coordination, common activities and reporting	Overall coordination																								
	Mobilization																								
	Project Kick-off meeting	**o**																							
	Project Steering Committee meetings		**o**		**o**		**o**		**o**		**o**		**o**		**o**		**o**		**o**		**o**		**o**		**o**
	Project Management Council meetings		**o**				**o**				**o**				**o**				**o**				**o**		

	Launching seminars			**o**																					
	Cogeneration weeks					**o**				**o**				**o**				**o**				**o**			
	Inception report	**o**																							
	Quarterly progress reports	**o**	**o**	**o**		**o**	**o**	**o**		**o**	**o**	**o**		**o**	**o**	**o**		**o**	**o**	**o**		**o**	**o**	**o**	
	Annual progress reports				**o**				**o**								**o**				**o**				
	Mid-term progress report												**o**												
	Final report																								**o**

ANNEX J: SUMMARY OF CO-FINANCIERS

Name of organization/Fund	Contact details	Type of financing	Geographical coverage	Commitment
1. Triodos Bank	Rene Magermans Managing Director rene.magermans@triodos.nl Ashignton Ngigi, Local Representative in Kenya ashington@integral-advisory.com	Fund & Portfolio management/ Prefers 2-3 additional partners to set up fund for mini hydro & cogen	Africa-wide	Submitted letter of interest
2. DEG (Deutsche Investitions und Entwicklungsgesellschaft mbH)	Eric Kaleja Sr.Investment Manager, East Africa POBox 52074-00200 Nairobi,Kenya/ T254203872122/111F254203872103 deg@kfw.co.ke	Long term financing for start up or expansion projects	Africa-wide	To prepare
3. E+Co	Gavin Watson Investment Officer T27126653454 gavin@energyhouse.com	Seed and growth capital in the form of debt or equity to SME	Uganda, Ethiopia, Tanzania, Zambia, South Africa, Gambia, Senegal, Mali, Ghana	Submitted letter of interest
4. FINN fund (Finish fund for Industrial Cooperation Ltd)	Helena Korhonen Sr.Investment Manager, Renewable Energy and CIS POBOX391(Ratakatu27)FI-00121 Helsinki, Finland/ T358934843307/M358408228296/F3589 34843347 helena.korhonen@finnfund.fi	Co-financing on cogeneration investments projects	Kenya, Uganda, Tanzania, Malawi, Ethiopia, Swaziland, Sudan	Submitted letter of interest
5. GTZ (German Technical Cooperation)	Holger Liptow Director, Climate Protection Programme Dag-Hammarskjold-Web1-5, Postfach 51 80 Eschborn, Germany 65726/ T496196794103F496196796320/M4915 112162803 holger.liptow@gtz.de	Project investment and Technical Assistance	Africa-wide	To confirm interest
6. AICAD/JICA (African Institute for Capacity Development)	African Institute for Capacity Development (AICAD) P.O.Box 46179-00100, Nairobi, KENYA Web: http://www.aicad.or.ke Email: hirabayashi@aicad-jica.org	Project investment and Technical Assistance?	Africa-wide	To request
7. EIB (European Investment Bank)	Carmelo A. COCUZZA EIB East & Central Africa Office Tel +254 -20 273 5260/1 Mobile +254 722 20 88 11 Fax + 254 20 271 3278 COCUZZA@eib.org	Credit line via regional/national finance institution e.g. EADB. Approval of credit line with EADB progressing fast	Africa-wide	To prepare
8. EADB (East African Development Bank)	David James Chief credit officer (djames@eadb.org)	Interested in project financing (east Africa, Kenya Uganda and Tanzania); could support pre-feasibility studies; additional information for further assessment and, if appropriate and possible, provide a Letter of Support for the two initiatives	East Africa (Kenya Uganda, Tanzania)	Submitted letter of interest
9. AfDB (African Development Bank)	Dr. Vyas; W.Klunne/Y.Rfaoui, L.Borin (Private Sector) R.E exparts BP323-1002 Tunis Belvedere, Tunisia/T21671103004 w.klunne@afdb.org/y.arfaoui@afdb.org l.borin@afdb.org	Co-finance small hydro projects	Africa-wide	Submitted letter of interest

Name of organization/Fund	Contact details	Type of financing	Geographical coverage	Commitment
10. AfD/Proparco	C. de Gromard AFD/ Département Infrastructures et Développement urbain" "Chef du Service Infrastructures & Mines and an Investment Officer " 33 1 53 44 35 57, 33 1 53 44 31 16	Provides guarantees, loans or equity in projects. They specialise in limited recourse finance. Projects of 7M$ or greater are preferred. Can provide loans of as low as US$ 3million	Africa-wide	Submitted email of interest for Small Hydro
11. ABSA (Amalgamated Bank of South Africa)	Alwyn Wessels Project Finance Absa Towers East 3rd Floor 170 Main Street Johannesburg Email: Alwynw@absa.co.za	Co-financing of cogeneration projects, must have South African involvement Projects of at least US$10million preferred	South Africa (or projects with South African component) Africa-wide through Barclays Bank	To prepare
12. KENGEN (Kenya Electricity Generating Company Limited)	Edward Njoroge Managing Director KENGEN P.O.Box 47936 00100 Nairobi Kenya	Co-financing of electricity generation projects, up to 50% of investment costs	Kenya	Submitted letter of interest for Small Hydro and Cogen
13. Kenya Commercial Bank (KCB)	MD, Terry Davidson Managing Director	Financing small hydro projects in the tea sector	Kenya	Submitted letter of interest for Small Hydro
14. Stanbic Bank - Kenya	Mike du Toit Managing Director David Wafula	Financing small hydro projects in the tea sector	Kenya	Submitted letter of interest
15. Standard Chartered Bank Structured Trade Finance Africa	Birju Sanghrajka Wholesale Banking Standard Chartered Bank Birju.Sanghrajka@ke.standardchartered.com	Financing small hydro projects in the tea sector	Africa	Submitted letter of interest for Small Hydro and Cogen
16. K-REP Bank	Kimanthi Albert Mutua Managing Director M0722511785 www.k-rep.org Email: k-rep@arcc.co.ke	Loans to tea factories for energy projects	Kenya	To request
17. COOPENER	Jean-Michel SERS"The COOPENER Team European Commission Intelligent Enegy Executive Agency (IEEA) European Commission; B-7 01/36, B-1049 Brussels "Jean-Michel.SERS@cec.eu.int	Co-financing for international projects which address non-technological issues and aim to improve access to modern sustainable energy services for poverty alleviation and social economic development in developing countries	Kenya, Uganda, Tanzania, Ethiopia, Rwanda, Burundi, Malawi, Mozambique, Zambia, Swaziland, Sudan	Proposal submitted
18. REEEP	International Secretariat Beverly.Robbins@reeep.org or www.reeep.org.	TA, specifically targets expansion of sources of finance, improved communications between existing and potential providers of financing and ensuring the establishment of innovative risk mitigation tools that will reinforce these efforts	Kenya, Uganda, Tanzania, Ethiopia, Rwanda, Burundi, Malawi, Mozambique, Zambia, Swaziland, Sudan	Proposal submitted
19. PROINVEST/CDE	Mr. Gaston Baganzicaha, PROINVEST gba@proinvest-eu.org http://www.proinvest-eu.org/	Technical assistance activities that lead to investment. Works through two principal modalities – namely: (i) Strengthening ACP intermediary organizations and business associations; and, (ii) Direct support to	Africa-wide	To prepare

Name of organization/Fund	Contact details	Type of financing	Geographical coverage	Commitment
		individual companies.		
20. Swaziland Industrial Development Corporation	Mbuso Simelane Finance and Administration Manager Email:mbuso@sidc.co.sz	Co-financing for cogeneration projects in sugar factories	Swaziland	To prepare
21. Standard Bank Swaziland Limited	Tineyi Mawocha Managing Director Email: mawochat@stanbic.com	Co-financing for cogeneration projects in sugar factories	Swaziland	Submitted letter of interest for Cogen
22. EU office	Vanessa Dick/Johan Canvenberg Vanessa.Dick@cec.eu.int	Technical Assistance	Africa-wide	To request
23. ORET/FMO	FMO/ORET at Netherlands embassy: Roeland Kollen, commercial attache, Riverside lane, PO Box 41537, Nairobi, Kenya, tel 020 4447413, email: rad.kollen@minbuza.nl	Project investment	Africa-wide	To request
24. International Finance Corporation	Jean Philippe Prosper Regional Manager Phone: 3226300/400	Project investment and Technical Assistance	Africa-wide	To request
25. Danida	Thomas Hernoe Senior Project Manager Carl Bro International AB thomas.hernoe@carlbro.se	Mixed credit - Technical Assistance	Africa-wide	To prepare
26. GroFIN	Chris Venter chris@grofin.com	SME financing	East and southern Africa	To request
27. Actis	Kungu Gatabaki Investment Principal PO Box 43233-00100 Nairobi Kenya Telephone: +254 20 219952/3/4 Fax: +254 20 219 744 Email: info@act.is	Project investment	Africa-wide	To request
28. BASE	Virginia O'Brien virginia.sonntabob@energy.base.org	Technical Assistance	Africa-wide	To request
29. DBSA (Development Bank of Southern Africa)	Ms Jean Madzongwe Energy Specialist	Project investment	Southern Africa	To request
30. USAID (U.S Agency for International Development)	Dr. Griffin Thompson Energy Team Leader Ronald Reagan Building, Room 3.08B, Washington, DC 20523-3800 Washington, DC USA +1 202 712 1750 +1 202 216 3230 gthompson@usaid.gov	Investment & TA	Africa-wide	To request
31. IN-SHP (International Network for Small Hydro Power)	Prof. Tong Jiandong Director General, International Center on SHP P.O. Box 202, 310002 Hangzhou, China Hangzhou China +86 571 87070070 Ext 6317 or +86 571 870 23380 +86 571 87023353 hic@mail.hz.zj.cn http://www.inshp.org	Technical Assistance and co-finance of demo projects	Africa wide	Submitted email of interest for Small Hydro

ANNEX K: PRE-FEASIBILITY ASSESSMENT OF COGENERATION IN SELECTED SUGAR FACTORIES

FINCHAA SUGAR FACTORY, ETHIOPIA

EXECUTIVE SUMMARY

1. PROJECT DESCRIPTION AND BACKGROUND

a) Name, Location and Type of Industry:

Finchaa Sugar Factory is a state-owned sugar industry located at about 357 km West of Addis Ababa in Wollega Region.

b) Plant Structure, Capacity and Other Relevant Information:

Finchaa Sugar Factory is an integrated agro-industry that combines the following components:

i. A cane processing plant with a nominal capacity of 4000 TCD, design capacity of 4400 TC/24 hours, with provisions upgradeable to 6000 TCD, 6600 TC/24 hours,
ii. A 45,000 liters per day Technical/Power Ethanol Plant and
iii. A 6800-hectare sugar cane plantation irrigated by canals and pumping stations.

The nominal and anticipated annual production capacities of the sugar factory are shown in table 1 below:

Phase	Nominal Crushing Capacity, (TCD)	Annual Production Capabilities				
		Sugar (ton)	Ethanol (Liters)	Cultivation (Ha)	Cane (Tone)	Harvest (Ha)
I	4000	85000	809,200	6,800	722,000	4010
II	6000	1,270,000	1,213,600	9,306	1,072,000	5950

Table 1: Nominal and anticipated annual production capacities of FSF

Most of the installed units and stations of the factory have more capacities than required for 4000TCD. Almost all major units and stations of the factory can operate at a design capacity of about 5100 TC/24 hours or at a nominal capacity of about 4600 TCD. there are also a few stations with short of capacity including river injection water pumps , crystallizer stations and centrifugals needing optimization.

c) Production Records and Seasonality Pattern

The initial erection and commissioning phase of the project planned at the establishment of the enterprise, was successfully completed at the end of 1997/1998.

At normal conditions, the usual annual sugar and ethanol production season of the factory has been from November to May. As the factory is producing white plantation sugar, crushing of cane and production of sugar and ethanol are carried out within the same season.

Starting from the initial campaign season of 1998/1999, all stations of the factory have proven to operate at a nominal capacity of 4000 TCD and design capacity of 4400 TC/24 hours.

Since the initial campaign season of 1998/1999, the factory has been commercially operating with increasing annual sugar production. The annual sugar production records of the last seven years, starting from the first campaign season of 1998/99, are shown in table 2 below. In the last campaign season of 2004/2005, the initial capacity of the factory was achieved by producing 86,422 tones of sugar from 758,475 tones of sugar cane, which is slightly higher than the initial nominal production capacity.

Year	**2004/05**	**2003/04**	**2002/03**	**2001/02**	**2000/01**	**1999/00**	**1998/99**
Campaign days	200	223	210	199	189	211	212
Sugar produced, tons	86,422	80,450	77,453	72,236	64,592	65,148	52,511
Sugar cane crushed, tons	758,475	683,761	654,648	617,283	573,911	577,925	476,033

Table 2: Plant annual cane crushing and sugar production records

2. RESOURCE ASSESSMENT

a) Estimated Production of Bagasse:

In Finchaa, when sugar cane is crushed for extracting juice, bagasse comes out of the last mill (the fourth mill) with about 47% to 49% moisture. The average fiber % cane at Finchaa Sugar Factory varies between 13.78 % and 15.93%, depending on the varieties of cane crushed.

The wet bagasse % cane varies between 28.1 and 32.37. The average bagasse production (bagasse % cane) at Finchaa is in the order of 30.24%, with moisture content of 48%.

Based on the capacity levels of the sugar factory utilized, bagasse production is estimated at about 30.24% of the cane crushed as illustrated in table 3 below.

Estimated production of bagasse at different operating levels are shown in table 3 below:

Product	**Nominal Capacity**	**Nominal capacity**	**Design capacity,**	**Achievable capacity TCH**
	Kg/TC	t/h	t/h	t/h
Sugar Cane	1000	169.2	200	218
Bagasse	302.4	51.2	60.5	65.9

Table 3: Estimate of production of bagasse at different operating capacity levels

Corresponding to the maximum 758,474 tons cane crushed in 2004/05-crop season, the bagasse produced was 213,966 tons as shown in table 4 below.

The physical characteristics of bagasse produced since the initial campaign season of the factory are shown in table 4

Fiber % cane	13.78	14.34	14.61	14.96	14.92	15.02	15.93
Bagasse % Cane	28.21	29.07	30.54	30.68	30.88	30.65	32.27
NCV of bagasse)	1904	1933	1878	1935	1942	1822	1915

Table 4: Physical characteristics of bagasse produced at FSF

b) Past and Future Trends in Production of Bagasse

Production of bagasse during the past seven-campaign season is shown in table 4 below.

Description	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05
Cane crushed, tons	676,033	577,925	573,911	617,283	654,649	694,271	758,474
Bagasse% cane	32.27	30.65	30.88	30.68	30.54	29.07	28.21
Bagasse produced, tons	218,156	177,134	177,224	189,382	199,930	201,825	213,966

Table 5: Actual bagasse production trend since the initial campaign season

From the table, the past trend of actual production shows that as the amount of cane crushed increases, bagasse production also increases.

As the design and achievable capacities of the factory are approached, production of bagasse also increases with the amount of cane crushed until the limit of the achievable capacity. Afterwards, the rate of bagasse production will be constant until the implementation of the envisaged factory expansion.

c) Estimation of Energy Potential of Bagasse

Based on sugar and moisture contents on bagasse (%pol bagasse and %moisture bagasse) the average energy potential (lowest calorific value) of bagasse is estimated at about 1918 kcal.

d) So far no cost has been attached to bagasse in using it for steam generation in the factory.

3. Energy Requirements and Sources

a) Daily, Monthly and Yearly Electricity Load Pattern

Electrical energy is required for operation of the sugar factory during the crop period, for pumping the factory and irrigation water requirements and for lighting and power requirements of the township, villages and other support facilities.

Daily Electrical load of the factory power plant

DATE	AVERAGE RATE OF POWER GENERATION, KW	TOTAL KWH	FACTORY REQUREMENT	EXPORT TO NEARBY LOAD CENTERS
01/11/2005	3875	93000	93000	0.00
02/11/2005	4500	108000	87000	21000
03/11/2005	5255	109195	75595	33600
04/11/2005	4446	106700	89900	16800
05/11/2005	4836	116077	86677	29400
06/11/2005	4958	118982	85382	33600
07/11/2005	5108	122602	80602	42000
08/11/2005	5364	128740	86740	42000
09/11/2005	5018	120443	91043	29400
10/11/2005	5065	121559	83759	37800
11/11/2005	4942	118599	84999	33600
12/11/2005	5120	122874	85074	37800

13/11/2005	5227	127441	89641	37800
14/11/2005	5283	126800	89000	37800
15/11/2005	5239	125732	83732	42000
16/11/2005	4728	113469	88269	25200
17/11/2005	5114	122728	89128	33600
18/11/2005	5144	123451	85651	37800
19/11/2005	4621	126650	88850	37800
20/11/2005	5277	131850	94050	37800
21/11/2005	5494	124000	90400	33600
22/11/2005	5188	124500	90900	33600
23/11/2005	4598	102300	81300	21000
24/11/2005	3975	95400	95400	0
25/11/2005	3124	71850	71850	0
26/11/2005	0.00	0.00	0	0
27/11/2005	3517	34748	34748	0
28/11/2005	4621	110900	89900	21000
29/11/2005	5426	130200	92400	37800
30/11/2005	5608	134600	96800	37800
	Total	3313390	2481790	831600

Table 6: Daily Electrical load of the factory power plant

Monthly Electricity Load of the Factory

Table 7 shows average rate of power production, total power generation of energy from the factory power plant and factory load and exported energy during the months of 2004/2005 selected as a representative campaign year

S/N	Months, of 2004/2005	Average rate of production, kW	Total generation, kWh	Factory load, kWh	Energy exported to nearby Load centers, kWh
1	November	4580	3215160	2601960	613200
2	December	4830	3482430	2659230	823200
3	January	4940	3566680	2726680	840000
4	February	4840	3126640	2479840	646800
5	March	4480	2938880	2464280	474600
6	April	4950	3331350	2680350	651000
7	May	4900	2092300	1617700	474600
			21753440	**17230040**	**4523400**

Table 7: Monthly Energy generation from own power plant, factory load and export to nearby support facilities (2004/2005 crop season data)

Monthly Imported Electric Energy from Ethiopian Electric Power Corporation (EEPCO)

S/N	Month in 2004/2005	Energy Imported, KWH
1	July	592,200
2	August	610,200
3	September	568,300
4	October	707,800
5	November, 2004	801,400
6	December, 2004	846,500
7	January, 2005	680,500
8	February, 2005	783,600
9	March, 2005	738,200
10	April, 2005	873,900
11	May, 2006	1,144,700
12	June 2005	854,100
	Total Imported energy	9,201,400

Table 8: Monthly imported electrical energy pattern in year 2004/2005

Yearly Electricity Load Pattern of the Factory

Years	2000/01	2001/02	2002/03	2003/04	2004/05
Campaign days	189	199	210	223	200
Total Down time%	25.09	23.96	22.83	23.24	16.67
Hours of campaign season	4536	4776	5040	5352	4800
Effective hours of the season	3398	3632	3889	4108	4000
Power from own power plant	17,227,340	16,807,642	20,228,667	18,655,022	20,723,324
Factory consumption	14,908,540	15,817,642	19,796,5772	15,302,222	16,199,924
Export to internal load centers	2,318,800	990,000	4,320,900	3,352,800	4,523,400
Import	8,141,090	12,019,100	9,627,632	10,640,800	9,201,400

Table 9: Yearly Electrical load Pattern of the factory

b) Daily, Monthly and Yearly Steam Requirement Pattern Including Quality of Steam Required

The factory needs high pressure steam required to drive the prime movers including turbines of the shredder milling plant, boiler feed water pumps and power generators. The low-pressure exhaust steam obtained from the prime movers and turbo-alternators are used as process steam for heating and concentration of cane juice.

The quality of steam produced by the existing two 65 t/h each water tube boilers using bagasse is at a pressure of 30 bar and 400^{o}C. The exhaust from the turbo-alternator sets and other turbine prime movers is 1.25 bar.

Daily steam requirement of the factory

Date	Stem Consumption, tons
01/11/05	2252
02/11/05	2294
03/11/05	2112
04/11/05	2272
05/11/05	2344
06/11/05	2377
07/11/05	2333
08/11/05	2377
09/11/05	2348
10/11/05	2232
11/11/05	2249
12/11/05	2285
13/11/05	2411
14/11/05	2583
15/11/05	2742
16/11/05	2363
17/11/05	2806
18/11/05	2582
19/11/05	2669
20/11/05	2828
21/11/05	2377
22/11/05	2768
23/11/05	2447
24/11/05	2328
25/11/05	1231
26/11/05	Non
27/11/05	1377
28/11/05	2098
29/11/05	2339
30/11/05	2266

Table 10: Daily steam requirement of the factory

Monthly Steam Requirement of the Factory

2003/04 & 2004/05	Monthly steam requirement averaged over the months of two crop seasons, tons
November	65746
December	65000
January	64250
February	57050
March	54100
April	52550
May	59300
Total	417996

Table 11: Monthly steam requirement of the factory

Yearly Steam Requirement Pattern

Campaign season	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05
Steam, Tons	299900	366100	397300	397600	416600	419400	433900

Figure 12: Yearly steam requirement pattern

c) Sources and Prices of Electricity and Steam

i. Source of steam

Two 65 t/h, 30 bar water tube boilers firing bagasse fuel produce the required steam for power generation, prime movers and for process heating. The bagasse used as a fuel is derived from cane knifing, shredding and wet milling process comprising four mills of the milling plant of the factory.

There is no cost attached for using steam in the factory.

ii. Source of Electricity

During crop season, using the steam generated at 30 bars and 400^{o}C by the two 65 t/h 30 bar factory boilers, the 7 MW Turbo-Alternator Power Plant generates electric power required for the factory proper and nearby load centers including two irrigation pump stations, township, three villages and other support facilities.

During the out of crop season, the required power for the factory and all the remote and nearby irrigation pump stations and the township and villages are supplied from Ethiopian Electric Power Corporation (EEPCO) Grid Supply System. The Grid Power Supply System also supplies the power required for factory start up and standby requirements.

The electricity tariff for industrial consumption is Ethiopian Barr (ETB) 0.3339, which is equivalent to 0.04 USD at the rate of ETB 8.6 for 1 USD.

4. TECHNICAL ASSESSMENT

a) COGENERATION TECHNOLOGIES CURRENTLY IN PLACE

BAGASSE HANDLING SYSTEM

i. Bagasse Elevator

A rubber belt type bagasse elevator driven by a motor is used to receive bagasse from the discharge chute of the last mill and convey and discharge it into the top flight of the bagasse conveyor through a bagacillo-screening chute.

The sides of the belts have some wear and tear showing exposed cords and need some kind of dressing. Operating capacity and nominal speed of the elevator are 90 t/h and 60 m/min, respectively.

ii. Bagasse Conveyor

A motor driven scraper type bagasse conveyor is used to receive bagasse from the bagasse elevator and to convey it to the two boilers with the excess either recycled onto the bagasse-recycling conveyor or to the surplus bagasse conveyor. The capacity of the

conveyor is 90 t/h on the bottom flight and 75 t/h on the top flight. The maximum conveyor chain speed is 37 m/s.

iii. Bagasse Recycle Conveyor

An electric-motor driven scraper type bagasse conveyor is used to receive bagasse from the bagasse bagasse store and/or the bottom flight of the bagasse conveyor and deliver it to the top flight of the bagasse conveyor. The conveyor is made of two strands of roller chain. The capacity of the elevator is 75 t/h of bagasse running at a maximum chain speed of 37 m/min.

This conveyor system is horizontal from the tail shaft to the intermediate shaft and inclined at about 46^{o} from the intermediate shaft to the head shaft.

iv. Surplus Bagasse Conveyor

A geared electric motor driven troughed rubber belt conveyor receives the surplus bagasse from bagasse conveyor and discharges from both sides of the conveyor into bagasse storage or to an open area beyond the bagasse storage where it is stock piled in a loose heap using a front-end loader.

The belt is of three-ply construction with a vulcanized synthetic material and rubber. The speed of the belt is about 66 m/min.

All the boiler bagasse conveyor system has sufficient capacity for 6600 TC/24 hours. The chutes of the conveyor system need gradual replacements by stainless steel for reducing chokes during start up after stoppages

v. Drag Conveyor

The drag conveyor part of bagasse handling system had several damages caused by the bolt fasteners being used.

vi. Bagasse Store and Re-Claim System

The bagasse store is of a limited capacity storage. However, it works well in recycling bagasse in the main boiler conveyor system. The storage building has an undersized volume and can only handle a limited amount of bagasse. The existing excess-bagasse open field at the end limit of the bagasse conveyor has also a small area. The storage system for bagasse is not sufficient. Hence, most of the excess bagasse is stored in the open field at the back of the building.

Currently, preparation for construction of a larger-sized bagasse storage and re-claim system has been underway.

a. STEAM BOILER INSTALLATION:

The existing factory is equipped with 2 x 65 tones/hour, 30 bar and 400^{o}C bagasse fired Zurn boilers of standard two-drum construction. The boilers are natural circulation water tube type with furnace suitable for firing bagasse fuel. they are designed for outdoor installation with local canopy protection. Each boiler is designed for operation with the following operating conditions:

Capacity at MCR:	65 t/h
Working pressure at supper heater outlet:	30-bar gauge
Final steam temperature:	400 ^{o}C

Efficiency based on bagasse fuel:	80.5% (minimum on NCV)

The two boilers were selected for a nominal capacity of 4400 to 4580 TC/24 hours. They have demonstrated to sustain a capacity of about 5250 TC/24 hours.

The recent conducted feasibility and design study of factory expansion to 12,000 TC/24 hours through 10,000 TC/24 hours has envisaged the installation of one additional boiler.

Existing Turbo-generator Station (Factory Power Plant):

Currently, the factory electrical systems are supplied with electric power from two in-plant 3.3-KV, 3.5-MW backpressure turbo-alternators. The turbo alternators are designed for generating electrical power during crop season. Two 3500 KW, 1500 RPM geared backpressure steam turbo alternators are equipped with three phase, 3.3 KV, 50 Hz generators, generator coolers and accessories.

The turbines are horizontal mounted, multi-stage impulse type, each capable of readily developing the necessary power. It is designed for a maximum speed of 7000 RPM with a speed reduction gear down to 1500-RPM output speed. the turbines are designed for operating at standard steam conditions of 28 bar, 390^{o}C steam and exhaust at 1.25 bar. With the steam conditions cited above, the turbines can generate 3500 kW power each. the exhaust of the turbines discharges vertically downward.

The installed capacity of the existing factory power generating plant is 7 MW. The utilization voltages of the individual substations voltages of the factory are 3.3 KV and 400/231 volts at 50 Hz.

During crop season, the factory power plant supplies the power requirement of the factory proper and the load requirements of the following nearby load centers presently connected to it: -

- Two near by irrigation pump stations,
- River water pump station
- Main Town and three villages,
- Main Water Treatment Plant
- All other nearby support facilities.

During the initial campaign season of operation, a substantial surplus bagasse was produced and was piled up around the factory. After the elapse of two crop seasons, exporting electric power to the nearby Main Town, two irrigation pump stations, three villages and to other support facilities was started. But, although the above-mentioned load centers are physically connected to the power plant, at the early stage of the factory operation it was not possible to utilize the installed capacity of the power plant for producing more surplus electricity by using the excess bagasse available. This is due to absence of installed distribution transformer and network systems interconnecting all the remote irrigation pump stations and villages to the factory power plant. Hence, it has been often difficult to load the turbo generators by more than 5.6 MW due to lack of sufficient load to absorb additional power.

Currently, as a result of factory capacity optimization, increase in load of the two nearby irrigation pump stations, township, villages and additionally constructed schools and residential houses, the total load on the factory power plant has increased to about 6.8 MW at peak hours. This indicates that the power plant needs additional generating capacity for supplying all the nearby and remote irrigation pump stations Main Town and villages.

At a plant nominal capacity of 4000 TCD, excluding downtime, with two 65 t/h boilers operating at about 77% capacity and with fiber in cane of about 14.61%, the bagasse excess is estimated at about 8.2 t/h. Taking into account down time, excess bagasse production at the end of a campaign season is estimated at about 7700 tons.

With improved time efficiency, the amount of surplus bagasse can be increased. An additional source of energy is a significant amount of cane trash now left in the cane fields. The cane field trash is roughly estimated at about 8 tons per hectare and from about 5000 ha of cane harvested each year about 40,000 tons can be obtained. This can produce a substantial amount of steam to generate surplus electric power using a condensing turbo generator.

With the steam conditions at 30 bars and 400^{o}C a condensing turbo generator can produce approximately twice the amount of electricity per ton of bagasse, as does the existing backpressure turbo-generator. With the 8 t/h excess bagasse production rate and yield of 5 Kg steam/kW, the condensing turbo generator set can generate about 1600 kW power.

But, the current rate of excess bagasse production and the limited capacity of the existing boilers to carry additional steam loads cannot justify to recommend the purchase of a condensing turbo generator set at this juncture.

Therefore, until the implementation of the on progress expansion program of the factory to 10,000 TCD, all the irrigation water pumps, Main Town and all the villages should be put on EEPCO to relieve the factory power plant.

THE EEPCO UTILITY TIE:

The 3.3 KV EEPO utility tie was initially intended as the source to supply power only for start up and standby requirements of the factory. But, it also has served as an outlet for exporting the surplus electric power generated by the factory power plant to the nearby load centers. During the out off-crop period, the required power for the factory and nearby load centers is derived from EEPCO. Five irrigation pump stations and three villages at remote areas are all permanently supplied by EEPCO utility throughout the year.

b) Options for improving cogeneration technologies and planned improvements

It was previously mentioned that, except a few, most of the major stations of the factory have more capacity than required for the nominal capacity of 4000 TCD. The stations with short of capacities are the river injection water pumps, the crystallizer stations and the Centrifugals, which need to be optimized for the best utilization of the overcapacity of most of the major stations.

To ensure the optimum operation of the factory, bottlenecks identified through performance reviews and assessments of the undersized stations and units are being corrected.

The currently on going plant optimization program is targeted at achieving the optimum level of 4600 TCD. This is being undertaken by upgrading the stations that are short of capacity. In order to minimize the investment cost, the ongoing plant optimization activities are carried out taking into consideration the future expansion plan of the factory to10, 000 TCD.

c) Planned and/or possible cogeneration installations/investments

Factory Expansion to 417 TCH and 500 TCH

Currently, feasibility study and design for expansion of the factory to 10,000 TCD upgradeable to 12,000 TCD has been completed and preparation of a contract document for detail engineering, fabrication and erection is underway. Crushing capacity of the factory expansion plan is shown in table

Tons cane per year	Capacity required	Capacity achieved	Existing improved	Additional required
TC	**TCH**	**TCH**	**TCH**	**TCH**
1541992	**405**	**169**	**200**	**205**
1586000	**417**	**169**	**200**	**217**
1750000	**460**		**210**	**250**
1768000	**464**		**214**	**250**
1904500	**500**		**250**	**250**

Table 13: Crushing capacity

Among a number of factors considered for factory expansion by the feasibility study, the following are of interest with regard to cogeneration: -

- To design an energy efficient engineering and process systems that can save surplus bagasse.
- To use surplus bagasse for excess electricity generation to be used for all irrigation water pumps, township and villages and export surplus electricity to the National Grid.

Cogeneration at Finchaa

In order to save more steam for cogeneration, drive type comparisons for shredders and mill turbines have been made in the feasibility study. Accordingly, to avail more power for export, for pressure feeders, electro-mechanical drives and shaft mounted reducers, and for mills, electro mechanical drives and standard reducers have been recommended as the best reliable options for Finchaa Sugar factory.

In the feasibility study report, different cogeneration alternatives have been investigated and summarized under: -

Scenario 1:

Existing configuration is conserved

- Existing mills and shredder stay with steam turbines
- The new crushing tandem will be installed with electric motor drive for mills and shredders

Scenario 2:

- The steam turbine drives of the existing milling tandem and the shredder are replaced with electric motors.

- The new milling tandem will be installed with electric motors drives for mills and the shredder.

The power figures calculated from the condensing turbine are based on an hourly basis and do not consider all the bagasse lost during stoppages and others. From the yearly bagasse balance, all the bagasse lost in stops and others was estimated at 6.2% of the total bagasse available and applied in the calculations.

From the scenario analysis made in the feasibility study power balance summary is provided in Table 13 below. All figures are for 417 TCH

	Without Cogen	**Scenario 1**	**Scenario 2**
Power from backpressure turbine, KW	18,000	18,000	22860
Power from condensing turbines, KW	0	8630	8039
Total power produced, KW	18,000	26630	30,899
Total power consumed, KW	19,030	19,030	22,301
Import/Export availability for EEEPCO line, KW	- 1030	7600	8598

Table 13: Power balance summary

Installation Costs

The total investment costs are shown in table 14 below

	W/O Cogen, 000 USD	**Scen-1, 000 USD**	**Scen-2, 000 USD**
Power house equipment price	6372	11318	11318
Existing mill and shredder drives modification	0	0	650
Additional cost for steam generation	0	1809	1809
Transport, installation, civil and other costs	6000	11000	12000
Total estimated costs	12372	24127	25777

Table 14: Total investment costs

Financial Gains from Electricity Generation

The electricity tariff for industrial consumption is Birr 0.3339 per kWh.

The efficiency of the factory is assumed to be 84%

	Without Cogen	**Scenario 1**	**Scenario 2**
Duration of crop season, hours	3809	3809	3809
Loss/Gain from electricity export USD	- 127951	944,108	1068 085
Delta loss/Gain to be added	NA	127,951	127,951
Maintenance and operation costs	NA	- 25000	-25000
Pay back in year	NA	11.22	11.44

Figure 15: Financial Gains from Electricity Generation

The pay back is long

Bagasse Handling

The warm bagasse being discharged from the fourth mill would be used as fuel for the boilers that would generate 2.15 tons of steam per ton of bagasse.

The excess bagasse would be stored into a bagasse store and retrieved by a scratchier held on a moving crane. The bagasse flow in and out would be continuous to ensure a 25 - 50% surplus bagasse being present at all times on the belt feeding the boilers.

Steam and Power Generation

Power Generation

Energy balance: -

Thermal balances for the boilers and for electricity production have been calculated. For the stud two scenarios have been analyzed: -

Factory Load

The electricity consumption of the sugar complex on an hour of crushing basis after expansion to 417 TCH is given below:

	Scenario 2	Scenario 2
Factory consumption for 200 TCH at 24 KW/TCH	4800	4800
Factory consumption for 217 TCH at 24 KW/TCH	5210	5210
Electric power for mills and shredder – existing line	0 (2)	3271
Electric power for mills and shredder – new line	3550	3550
Distillery Consumption	600	600
Total electric consumption for the factory	14160	17431
EEPCO – (wet bank, main town+PS4, 5) (1)	780	780
EEPCO – wet bank, (vilages+PS1, 2, 3) (1)	655	655
Future east bank consumption Pumping stations & booster stations	2644	2644
Others and miscellaneous	791	791
Total electric consumption for the service	4870	4870
Total electric consumption	**19030**	**22301**

Figure 16: **Factory electrical load**

(1) On the basis of consumption of December 2003, November 2003, and January 2004
(2) Steam turbine driven

Steam and Power Generation

In addition to the existing two 65 t/h backpressure turbine and two 3.5 MW alternators, the following boilers and power generation equipment are recommended.

Two bagasse fired complete boilers of the two drum for top supported type, having the water tube membrane type furnaces with external large bore down-comers the boilers include spreader stocker fluidized feed continuous bagasse firing with balanced draft furnace pressure control and with silicon content cast iron traveling grate to discharge ash to an ash dewatering system. Each boiler is supposed to produces 2.15 tons of steam per ton of bagasse at 30 bars and 400^{o}C.

Standard ratings of each boilers are: -

MCR: 110 t/h
Pressure: 31 bar
steam temperature at main stop valve outlet: 420±10^{o}C

Power Generation and Equipment

Two new 17 MW condensing pass out type steam turbines with condensers and a common closed circuit cooling water system wit a multi-cell cooling tower are recommended. Speed range of the turbine is 4000 to 5000 RPM

A synchronous generator driven by the turbine through the high-speed reduction gearbox is selected with the following standard conditions:

Output: 17 MA in compared pass out extraction mode.
Rated voltage: 11 kV
Rated active power: 17 MW

At the final stage of the expansion, the factory would be completely electrified with the objective to consume the minimum amount of steam for its operation during the crop season.

From the available bagasse it would allow to maximize the production of electricity to supply all the irrigation pump stations, Main Town and villages and the excess would be exported to EEPCO. During the off-season electricity would have to be imported to supply power to the same users.

5. ECONOMIC/FINANCIAL ASSESSMENT OF COGENERATION

6. FINANCING OPTIONS ASSESSMENT

The original Finchaa Sugar Project had financing structures that involved a number financers including African Development Bank (ADB), African Development Fund (ADF), some bi-lateral financing foreign governments and the Government of Ethiopia. Therefore, It may be possible to influence these original lenders in continuing their financing support, during future expansion of the Finchaa Sugar Project.

6.1 African Development Bank (ADB):

African Development Bank:

a) Extended a loan to assist in financing the foreign exchange costs of the preparation of the detailed engineering design and tender document for the original Finchaa Sugar Project, and.

b) Lent to Government of Ethiopia a principal loan in various convertible currencies to assist in financing part of the foreign exchange cost of the project.

On completion of the Finchaa Sugar Project, the Bank evaluated the project implementation as a success. This evaluation indicates that there would be a possibility of securing additional financing support from the Bank for the future expansion program of the existing Finchaa Sugar Factory to 12,000,000 TCD. Hence, this option needs further exploring.

6.2 African Development Fund:

ADF lent to Government of Ethiopia an amount in various convertible currencies to assist in financing part of the foreign exchange cost of the original Finchaa Sugar project. Under the existing borrowing scheme of ADF, Ethiopia is eligible for borrowing. Therefore, for the new expansion program of Finchaa Sugar Project, this option has to be further looked into.

6.3 Original Sovereign Lenders to the Existing Finchaa Sugar Project

6.3.1 Sweden

Swedish Government through its Swedish Agency for International Technical & Economic Cooperation made available to the original Finchaa Sugar Project a credit facility and a grant which were utilized for the delivery of electrical distribution lines and transformer substations required for energizing the Project. Therefore, effort is needed to win the interest of Swedish Government to continue its support in financing the expansion program of Finchaa Sugar Project.

6.3.2 Australia

The Australian Trade Commission Trading as Export Finance & Insurance Corporation (EFIC) extended a credit facility that was utilized for the purpose of financing 100% of the contract price for the supply of sugar cane handling and mills equipment to be delivered by Walkers Limited.

6.3.3 The Kingdom of Spain

The Kingdom of Spain Guaranteed a loan facility accounting for 100% of the goods and services exported for the project, which was implemented through the Kimgdom's financial agent, Instituto De Credita Oficial (ICO**).** The loan facility was a "tied" loan utilized for the purchase of Spanish goods and services.

Although, Financing facilities from these / such Sovereign Lenders is often 'tied' to procurement of goods originating in the lender's home country, it is necessary to win their interest to continue financing support for future expansion of the Finchaa Sugar Project.

6.4 Development Bank of Ethiopia

Development Bank of Ethiopia is engaged in extending investment loans to aid in the development of Ethiopia. The Bank financed housing and infrastructural civil works and erection of the factory pump stations, electrical and telecommunications equipment, pre-operating costs as well as part of the working capital requirement of Finchaa Sugar project. Here also it is necessary to approach the bank to extend investment loans to support financing the new expansion project of Finchaa Sugar Project.

6.5 Development Funds

There is a number of other outside development funds, which may have interest in financing components of the future expansion program of Finchaa Sugar Project. These may include OPEC fund, SAUDI fund, KUAIT fund, ABUDHABI fund and others. These development funds are potentially open for Ethiopian Projects financing. To source funds of long term financing from these development funds needs further assessment.

6.6 Regional Development Banks

Finchaa could be eligible for loans from regional development banks such as PTA Bank, based in Nairobi and East African Development Bank, based in Kampala for which further assessment is required in sourcing project financing from these development banks.

6.7 Government Agencies

There are also other sovereign export credit agencies that can provide credits against the purchase of equipment and materials from their respective countries. Such agencies are found in USA, UK, France, Germany, Japan, Italy and India.

In addition to the above-mentioned agencies, it may be possible to secure funding to some project components from the development assistance of certain countries, such USAID, DFID, JODA, AFD, DEG, etc.

7. POLICY, INSTITUTIONAL/REGULATORY ASSESSMENT/

7.1 POLICY ASSESSMENT

94% of Ethiopia's energy requirement is covered by traditional energy source. The balance is covered by commercial energy i.e. electricity and petroleum. The supply of household fuel is associated with massive deforestation and land degradation. The high population growth rate in the country has the scarcity of fuel wood.

Committed to shaping the economic future of the country, the Government of Ethiopia adopted a strategy for sustainable economic development, which places agriculture as its driving force, namely, Agricultural Development Led Industrialization (ADLI).

Ethiopia has vast energy resources of 30,000 MW hydropower resources, 1387 million TOE biomasses resources, 17.5 million TOE agricultural residue over 100 billion cubic meter of natural gas 4000 MW of geothermal energy and 40.3 million tons of coal and oil shale energy resources. But, all these energy resources have not been developed, transformed and exploited for optimal economic development.

Therefore, GOE believes to provide the economy with the necessary energy inputs at the right time, place and affordable price. To speed up economic development objectives of the country, a comprehensive national energy policy directing and coordinating the development of energy sector, has been formulated.

The policy is included in the government's economic policy and is subject to review through time according to new developments.

General Energy Sector Policy

a) To enhance and expand the development and utilization of hydrological resources for power generation with emphasis on mini-hydropower development.
b) To take appropriate policy measures to achieve a gradual transition from traditional energy fuels to modern fuels.
c) To set, issue and publicize standards and codes which will ensure the energy is used efficiently and properly.
d) To develop human resources and establish competent institutions.
e) To provide the private sector with necessary support and incentives to participate in the development of the country's energy resource; and
f) To pay due and close attention to ecological and environmental issues during the development of energy projects.

MAIN POLICY ISSUES

Energy Resource development

Traditional fuels

a) A country wide forestation program will be undertaken to enhance the supply of fuel wood to consumers
b) To reduce the negative effects of agri-residue use for energy on soil fertility measures will be taken to modernize and increase the efficiency of the utilization of agri-residue as energy sources.

Modern Energy resource development

a) Hydropower will form the backbone of the country's energy sector development strategy, as it is the country's most abundant and sustainable energy resource.
b) Natural gas resources will be developed and utilized to meet as much of the country's demand as possible; and
c) Promising areas for oil and natural gas will be explored by providing incentives to oil companies to encourage them to take in exploration activities.

Alternative Energy recourses development Policy:

a) Solar and Geothermal energy will be used, wherever possible, for process heat and power generation;
b) Ethiopians wind energy resources will be developed to provide shaft power for water and irrigation.
c) Coal will be developed and introduced as an alternative fuel.

Energy Supply Policy

Household Energy

Government's Energy Policy to Achieve a Balance Between the Supply and Demand for Household Fuels.

- Government will seek to stabilize their prices by increasing the supply of alternative fuels and relieving the pressure on wood resources.

Agriculture Energy Supply Policy

- Government's agriculture sector energy supply policy is to increase the supply of modern energy sources to the agriculture sector.

Industrial Sector Energy Supply Policy

Government's industrial sector supply policy is:

a) To ensure for industrial energy supply will be compatible with the industrial development of the country; and
b) To ensure that industrial energy use and supply will be based on economic and efficiency criteria.

7.2 INSTITUTIONAL ISSUES

The government of Ethiopia believes to create an institution which is entrusted with policy formulation, priority setting and coordination of all energy sector development activities in order to coordinate and ensure consistency in resource development and to avoid resources waste and duplication of efforts.

For facilitating conditions for expansion of electricity services, the Ethiopian Electricity Agency has been established under the Ministry of Mines & Energy as an autonomous federal organ to regulate the activities of electricity suppliers and the prescription of provisions required.

The objective of the Agency is to promote the development of efficient reliable high quality and economical electricity services.

Main powers and duties of the Agency are: -

a) Supervise and ensure the generation, transmission, distribution and sale of electricity are carried out in accordance with proclamation # 86/1997 as well as regulations and directives issued hereunder
b) Determine the quality and standard of electricity services and ensure the implementation thereof;
c) Issue certificates of professional competence to electrical contractors;
d) Issue, suspend and revoke license for the generation, transmission, distribution and sales of electricity in accordance with this proclamation and as well as regulations and directives issued hereunder
e) Study and recommend a tariff and up on approval supervises the implementation thereof.
f) Collect license fees in accordance with rates to be prescribed by regulations;
g) Cooperate with training institutions in the field of electricity.

Requirement and Condition of License

a) No person may generate, transmit, distribute or sell electricity for commercial purposes unless he is a holder of a license.
b) Any person desiring to generate, transmit or distribute electricity for non commercial purpose shall notify the Agency in advance and produce documents evidencing that he has fulfilled environmental protection and safety conditions as required by the Agency
c) Any person generating electricity by installing a standby generator may use the existing supply system of the area by entering into agreement with the concerned licensee.

Eligibility for License

a) Any person may be issued with a license where he satisfies the qualifying conditions specified in the proclamation, regulations and directives issued hereunder as well as in the investment law and upon conditions by the Agency that he is qualified to carry on trade under the commercial code and has the financial resources, technical competences, professional skill and experience required to fulfill license obligation.
b) Any person who has been engaged in the generation, transmission, distribution and sale of electricity prior to coming into force of the proclamation shall be required to submit an application, along with the necessary particulars and obtain a license.
c) Transfer of license

   A license issued to the proclamation may be transferred to other person with the prior consent of the Agency, under conditions to be specified by regulations.

Any licensee shall:

i. Carry out the generation, transmission, distribution and sale of electricity in accordance the Proclamation, regulation and directives issued here under as well as in compliance with environmental protection laws and quality standards determined by the Agency.
ii. Keep relevant records of operation, submit reports and supporting documents to the Agency in accordance with directives to be issued by the Minister
iii. Make books and records of operation available for inspection by duly authorized official of the Agency

Suspension and Revocation of License

i. The agency may suspend or revoke a license where the license fails to comply with obligations specified to the proclamation, regulations and directives issued hereunder as well as in the license.
ii. Prior to revocation of the license, the agency shall allow the licensee such time, as it deems sufficient to rectify failure.

iii. Without prejudice to the rights of heirs, the license shall be revoked upon death of the licensee or upon liquidation or declaration of bankruptcy under the relevant law, in case of judicial person.

iv. No licensee may claim charges in case of the tariff.

7.3 REGULATORY ASSESSMENT

7.3.1 The electricity operation council of ministers of the federal government of Ethiopia issued an Electricity Operation Regulation #49/1999 on the 2nd may, 1999.

Part two of the electricity operation states the following general requirements for application of license:

7.3.2 Any application for a license of generating, transmitting, distribution importation or exportation of electricity shall be addressed to the Agency and shall contain:

a) Identity and address of the applicant
b) Feasibility study of the project
c) Environmental impact assessment
d) Documents showing the applicant's financial situation, technical competence and experience
e) Construction and installation design, and such other information the Agency may determine by directives

7.3.3 Feasibility steady shall consist of the following operation:

a) Social and economic input;
b) Estimated costs and returns of the equipment
c) Duration of the project.
d) Construction and installation programs and commencement date of operation.

7.3.4 The environmental impact assessment referred to shall consists of the following components:

a) All potential dangers to the environment along with mitigation or reclamation plan including resettlement program for displacement;
b) Estimated costs of implementation of the plan and program.

7.3.5 Application for generation license contain:

a) source of energy;
b) Map of the project site at the scale determined by the agency.
c) Total power capacity of the project
d) Power purchase contract where appropriate

7.3.6 Application for transmission license contain:

a) Preliminary route map of proposed main and alternative transmission line
b) Total length an maximum load of transmission line
c) Standard of voltage and frequency

7.3.7 Applications for distribution and sale of electricity license contains the following:

a) Source from which the distribution system draws electricity
b) Estimated number of customers to be benefited prom the project and proposed price of each unit of power to be sold;

c) Power purchase contract where appropriate

7.3.8 Application of importation or exportation license shall contain the following:

a) An agreement made with concerned automation of a country from which or to which electricity is imported or exported
b) Standard of voltage and frequency
c) Power purchase contract where appropriate

8. INFORMATION, TECHNICAL, FINANCIAL AND CAPACITY BUILDING SUPPORT NEEDS:

a) Information/Data Gaps

Presently, FSF does not have the benefit of up to date information on costs, maintenance, factory downtime, spare parts, cane yields, energy, or any of the many indicators necessary to properly manage this complex sugar factory.

There are some considerable numbers of computers at different departments and sections; but not in a well-organized and integrated manner. Installing such a system for FSF is a necessity to greatly benefit from the system. Therefore, FSF needs support:

- To establish operation, maintenance, financial, administrative, etc. database
- To develop a network computerization system and interlocking e-mail to benefit operations and to solve the communication problems arising from the geographical distance of FSF to Addis Ababa.
- To develop meaningful flows of information in a timely manner to appropriate management and staff.
- Undertake the development and implementation of a suitable computerization program involving upgrading and/or replacing the existing hardware, designing and installing a suitable network system for the factory selecting software packages customized to FSF requirements and identification of training needs and establishment of on-site and off-site training programs,
- Provide computer training service professionals

b) Required Technology Support

- Support in feasibility study, design, engineering, fabrication and erection of sugar cane processing
- Support in technology and equipment selection for cogeneration projects,
- Supports in training on the complex technology and control systems of sugar cane processing plants and cogeneration.

Some times the spare parts and materials supplied on purchase are found to be substandard. Most of the time the original suppliers of the equipment could not be available to supply genuine spare parts for the equipment they supplied earlier. Therefore, support in identifying the original suppliers or other suppliers providing genuine parts of the same equipment for solving the problems is required. Therefore,

- Support in establishing well-organized modern industrial system and equipment and in alleviating the existing problems in obtaining genuine spare parts and materials in time from the original suppliers of the existing equipments.

c) Required Financial Support

Financial supports are required for:

- Optimization of the existing factory to utilize the over capacity available
- To upgrade the factory capacity to 10,000 TCD, for which the feasibility study and engineering design has been completed.
- To train the staff the modern technology, engineering, maintenance, operation and management of the existing as well as the anticipated new sugar factory.

d) Capacity Building/Training needs

FSF is a medium sized sugar industry commissioned in 1997. It is equipped with relatively complex and latest technology. The production capacity of the factory is anticipated to increase to 10000 TCD in the near future. Thus, skilled manpower is required to cope with the complex modern sugar handling and processing technology and increased capacity of the sugar factory. Therefore, design, maintenance, handling and operation of the plant system need specialized skills.

Above all, due to the remoteness of the site, trained and skilled manpower turnover from Finchaa Sugar Factory has been very high and is a serious problem resulting in shortage of qualified, experienced and trained manpower.

Currently, the availability of qualified and experienced personnel for sugar industry is limited in the country. Therefore, support in training the available staff on the under-listed technical and management topics is a critical issue for the factory,

On technical issues: -

- Organization, maintenance and operation management of sugar factory Equipment
- Cane production, handling and process equipment;
- High pressure boilers and backpressure turbo alternators and other cogeneration equipment
- Latest design and technology of sugar processing and cogeneration systems and equipment,
- Fully mechanized bagasse handling system
- Latest technology in automatic controls and supervisory systems of sugar industry.

Management:

Senior and middle management, supervisory and highly skilled staff level need training support on the following topics for filling the gap of skilled manpower:

- Training on how to conduct a detailed review of the existing organizational structure of the sugar factory and associated duties and responsibilities for establishing a system that allows for effective and efficient utilization and management of resources.

- Training on how to conduct needs assessment and identify gaps for recruitment, training and development requirements on the basis of the organizational structure.

9. REFERENCES:

a) Technical Tender document of Management Services for Finchaa Sugar Factory, Copy submitted by Schaffer & Associates, 1020 Florida Boulevard Bouton Rouge, Louisiana USA 7002;

b) Feasibility Study Of Finchaa Sugar Factory Expansion Project, Draft Final Feasibility Study Report Document 6/12, Volume 2, Technical Study, September 2004, SOFRECO
c) Energy Policy of The Transitional Government Of Ethiopia, 1994
d) Federal Negarit Gazeta of the Federal Democratic Republic of Ethiopia, 7th July 1997, Proclamation No. 86/1997, Electricity Production
e) Hand Book of Cane Sugar Engineering, Completely Revised Edition, 1986, Hugot

WONJI SHOA SUGAR MILLS, ETHIOPIA

1. PROJECT DESCRIPTION AND BACK GROUND

1.1 Name Location and Type of Industry

Wonji-Shoa Sugar Factory (WSSF) is located 12-km south of Nazareth Town in Eastern Shoa Region in Ethiopia. It is a public enterprise agro industry engaged in cane sugar manufacturing.

1.2 Structure and Capacity of the Sugar Factory and Other Relevant Information

Wonji Shoa Sugar Factory consists of two sugar factories, and a sugar plantation on an estate farm of 5905 ha with additional cane supply from-1117 ha out growers' farms. The total area of the plantation is 7022 ha.

The two sugar factories of the state are:

1.2.1 Wonji Sugar Factory:

It has a capacity of 1450 TCD and was commissioned in 1954 and produced about 16,000 tons of the first Ethiopian sugar in the initial milling season. The main plant and machinery at Wonji are now about 52 years old and hence are outdated.

1.2.2 Shoa Sugar Factory:

Later the cane plantation area was extended and Shoa Sugar Factory with a capacity of 1650 TCD was commissioned in 1962. Shoa sugar factory is now approaching 44-years of age and its plants and machinery are also obsolete.

Wonji-Shoa Factory is 12 km south of Nazareth Town. The distance between the two plants is about 7 km. The two factories together annually crush about 590,000 tones of cane and produce about 70,000 tones of white plantation sugar with 99.5 tons of sugar content.

Annual production capacity of the two plants together is shown in figure 1 below.

Factory	Nominal Crushing Capacity, TCD	Annual Production Capabilities		
		Sugar, tons	Cane, tons	Plantation, ha
Wonji	145	***70,000***	593,000	7022
Shoa	1650			

Table 1: Nominal annual production capacities of WSSF

Currently, the performance of both factories is unsatisfactory due to age and obsolescence. Maintenance of the plants is becoming difficult, as spare parts for machinery are not available. Hence, modernizing and upgrading the plant and machinery both at the farm and factory is a paramount importance for continued operation of the enterprise.

Therefore, for ensuring long-term reliable operation of the factory with maximized sugar output, two feasibility studies for rehabilitation, optimization and expansion of the agricultural plantation and the two sugar factories were conducted at different times:

i. The final report of the 1st feasibility study was submitted in October 2001. The study envisaged increase in cane production and factory capacity to 4400 TCD. Cogeneration and export of

about 10.4 MW surplus power to the State Grid was also envisaged in one of the three Scenarios developed for evaluation. The number of campaign days considered was 220.

ii. The second and latest final report of the feasibility study was submitted just a year ago. The latest study envisaged increase in cane production and factory expansion to 12,500 TCD. Attached with the 12,500 TCD capacity, a 54-MW factory power plant is to be installed to generate and export about 27 MW surplus electric power to the State Grid Supply System. Installation of 2 x 160 t/h boilers and 2 x 27 MW DEC type turbo alternators were recommended. Wonji-Shoa Sugar Factory, owner of the feasibility studies did not allow access to specially the 2nd feasibility study report, which they consider to be secret being on preparation for implementation.

Therefore, the present report-based pre-feasibility assessment on Wonji-Shoa Sugar Factory has been organized on the basis of the previous expansion study of the existing Wonji-Shoa factory to 4400 TCD.

1.3 Production Records and Seasonality Pattern

Production records for the two factories are shown in tables 2 and 3 below.

a) Wonji

Year	2001/02	2000/01	99/00	98/99	97/98
Campaign days	225	231	230	218	193
Cane crushed, tons	270359	272803	270943	276512	235839
Sugar production, tons	33148	33448	31606	32595	25961
Molasses Production, tons	11223	11200	10601	11064	8843

Table 2: Wonji Sugar Factory annual cane crushing and sugar production records

b) Shoa

Year	2001/02	2000/01	99/00	98/99	97/98
Campaign days	221	232	226	217	221
Crushed, tons	305558	326163	325575	310477	322485
Sugar production, tons	37779	37862	38733	37803	34832
Molasses Production, tons	9024	10748	10920	10714	11115

Table 3: Shoa Sugar Factory annual cane crushing and sugar production records

The milling season of the two factories is from mid October to end of May for a duration of about 220 days. As both factories are producing white plantation sugar and molasses, cane milling and sugar and molasses production are carried out within the same season and re-melting or refining at different seasons is not applicable at the factories.

2. RESOURCE ASSESSMENT

2.1 Estimated Production of Bagasse

In Wonji-Sugar Factory, when sugar cane is crushed for extracting juice, bagasse comes out of the last mill of the tandems with average moisture % bagasse of 50%. The average fiber % cane and fiber % bagasse are 14.2% and 46.9%, respectively. The average bagasse % cane just at the last mill of the factory is about 30.29%.

Therefore, based on the capacity levels of the factory utilized, bagasse production is estimated at about 30.29% of the cane crushed as shown in table 3 below.

Estimated production levels of bagasse at Wonji Sugar Factory and Shoa Sugar Factory are shown in table 4 below:

Description	**Wonji Sugar Factory**	**Shoa Sugar Factory**
Crushing rate, TCD	1450	1650
Crushing rate, TCH	60	68.75
Fiber % cane	14.05	14.35
Physical characteristics of bagasse (laboratory figures):		
▪ Pol % bagasse	3.82	3.90
▪ Moisture % bagasse	48	49.53
▪ Fiber % Bagasse	46.94	46.86
Bagasse % cane quantity, % cane	**30.32**	**31.6**
Bagasse for other usages and losses:		
▪ For vacuum filters including losses, % cane	2.00	2.00
▪ For stoppages, % cane	1.50	1.50
Net bagasse available:		
▪ **% Cane**	**26,82**	**28.10**
▪ **t/h**	**16.09**	**19.32**

Table 4: Estimate of Bagasse Production at Wonji Sugar Factory and Shoa Sugar Factory

2.2 Past and Future Trends in Production of Bagasse

Past production trends of bagasse at the two-sugar manufacturing plants are shown in table 5 and 6 below.

2.2.1 Annual Bagasse Production at Wonji Sugar Factory

Year	2001/2002	2000/2001	99/00	98/99	97/98	Average value
Cane crushed, tons	270359	272803	270943	276512	235839	
Bagasse % Cane	30.32	30.32	30.63	29.29	31.05	30.32
Bagasse production, tons	82324	83069	82989	80981	73220	

Table 5: Annual bagasse production at Wonji Sugar Factory

2.2.2 Annual Bagasse Production at Shoa Sugar Factory

Year	**2001/2002**	**2000/2001**	**99/00**	**98/99**	**97/98**	**Average value**
Cane crushed tons	305558	326163	325575	310478	***322485***	
Bagasse % Cane	31.51	30.92	31.29	34.00	30.30	31.6
Bagasse production, tons	96273	100863	101869	105547	97726	

Table 6: Annual bagasse production at Shoa Sugar Factory

Currently, surplus bagasse of about 15,000 tons is available with the existing Wonji-Shoa Sugar Factory. Only a small quantity is being utilized for limekiln. The quantity of surplus bagasse with combined capacity expansion of the factory is anticipated to be at least three folds of the above-mentioned quantity per crushing season. Therefore, factory may face disposal problems unless find an outlet through utilizing the bagasse for production of surplus power for export to State Grid. This issue was considered in the feasibility report submitted in 2001.

2.3 Estimation of Energy Potential of Bagasse at Wonji and Shoa:

Estimate of calorific value of bagasse for the two factories is shown in table 7 below:

Description	Wonji Sugar Factory	Shoa Sugar Factory
Bagasse physical characteristics (lab figures averaged: -		
▪ Fiber % Bagasse	46.90	46.86
▪ Pol % bagasse	3.8	3.9
▪ Moisture % bagasse	48	49.53
Gross Calorific value estimate (GCV), kcal/kg	2346	2275
Net Calorific value estimate (NCV), kcal/kg	1876	1801

Table 7: Estimated calorific value of bagasse at Wonji and Shoa Sugar Factories

2.4 Price of Bagasse, If Any:

So far no price has been attached to bagasse at Wonji-Shoa Sugar Factory for using it as a fuel for production of steam for process heat and electric energy generation.

However, currently it has been noted that Matahara Sugar Factory, which is located 225-km East of Addis Ababa, sold bagasse to be utilized for housing construction material to Addis Ababa Municipality at a price of USD 40.7 per tone of bagasse. Density of bagasse is estimated at 0.15 t/m^3

3. ENERGY REQUIREMENTS AND SOURCES

During the crop season, at Wonji-Shoa Sugar factory, electrical energy is required for factory operation, irrigation water pumps, township and plantation villages.

3.1 Daily Monthly and Yearly Load Pattern

3.1.1 Daily Electrical Load of the Factories

a) Wonji Sugar Factory

The present load of the factory is around 1450 kW. The daily electrical load of Wonji Sugar Factory is estimated at about 30,000 kWh.

b) Shoa Sugar Factory

The existing load of the factory is around 1550 kW. The daily electrical load is estimated at about 35,000 kWh.

3.1.2 Monthly Electrical Load of the Factories

a) Wonji Sugar Factory

The present monthly electrical load of Wonji Sugar Factory is estimated at about 870,000 kWh.

b) Shoa Sugar Factory

The monthly electrical load is estimated at about 1,000,000 kWh.

3.1.3 Yearly Electrical Loads of The Factories

a) Wonji

Yearly (each campaign year) electrical load of the factory is estimated at 6,000,000 kWh

b) Shoa

Yearly (each campaign year) electrical load of the factory is estimated at 7,000,000 kWh

3.1.4 Monthly Imported Energy

Monthly import energy from the State Grid supply system to the existing Wonji-Shoa Sugar Factory is estimated at about 900,000 kWh.

3.2 Daily, Monthly and Yearly Steam Requirement Pattern Including Quality of Steam Required

3.2.1 Daily, Monthly and yearly Steam Requirement of existing Wonji Sugar Factory

a) The daily estimated steam requirement is about 850 tons.
b) Monthly estimated steam requirement is about 23,000 tons:
c) Yearly estimated steam requirement is about 159,000 tons
d) Existing steam conditions at Wonji Sugar Factory:

- Pressure: 16 kg/cm2
- Temperature 360 ^{o}C**,**

3.2.2 Daily, monthly and yearly Steam Requirement of existing Shoa Sugar Factory

a) The daily estimated steam requirement of is about 965 tons.
b) Monthly estimated steam requirement of is about 25,500 tons:
c) Yearly estimated steam requirement is about 178,000 tons
d) Existing steam conditions at Shoa Sugar factory

- Pressure 20 kg/cm^2
- Temperature 340 ^{o}C

3.2.3 Yearly Steam Requirement Pattern

Yearly steam requirement patterns over five years for Wonji and Shoa factories is shown in tables 8 and 9 below.

i. Wonji

Campaign season	**2001/2002**	**2000/2001**	**99/00**	**98/99**	**97/98**	**96/97**
Cane, tons	270359	272803	270943	276512	235839	254622
Steam cane ratio	0.60	0.60	0.62	0.59	0.57	0.63
Steam, tons	***162215***	***163682***	***167985***	***163142***	***134428***	***160412***

Table 8: Yearly steam requirement pattern

ii. Shoa

Campaign season	**2001/2002**	**2000/2001**	**99/00**	**98/99**	**97/98**	**96/97**
Cane, tons	305558	326163	325575	310477	322485	320402
Steam cane ratio	0.56	0.55	0.56	0.57	0.53	0.59
Steam, tons	170,787	179,280	182,236	175,990	172,260	190,347

Table 9: Yearly steam requirement pattern at Shoa.

3.2 Sources and Prices of team and Electricity

3.3.1 Sources and Prices of Steam

Steam for the process and electric power generation requirement of the existing Wonji Sugar Factory is produced by 5 x 9.5 t/h boilers each with steam pressure16 kg/cm2 (g) and temperature 360^{o}C. The boilers are burning bagasse obtained from the last mill of the factory tandem after extracting cane juice.

So far no price has been attached to the steam generated by own boiler plant for utilizing it for power generation, motive power and process heat requirements.

a) Source of Electricity

There are two sources for electricity supply: -

iii. Factory Power Plant

The present Wonji factory load is around 1450 kW

The existing Wonji Sugar Factory load is around 1450 kW and the 2 x 2100 KVA, 0.4 KV turbo alternators installed at the powerhouse of the factory supply the above cited power requirement.

There are also 2 x 2100 KVA 0.4 KV turbo generators installed at Shoa Sugar Factory to supply the power requirement of the existing factory. The power requirement of the factory during campaign season about 1650 kW.

So far no price has been attached to the electricity generated by own power plant for factory process and nearby load requirements.

iv. **State Grid system**

Irrigation pump stations and plantation villages of the agricultural estate are supplied from the State Grid. During off-seasons of the factory, the State Grid System also supplies the factory power requirements. The total annual energy imported from the State Grid supply system is estimated at about 9,000,000 kWh

Price is attached to the imported from the State Grid to the factory and other support facilities. The current electricity tariff for industrial consumption is Ethiopian Birr (ETB) 0.3339 per kWh. ETB 8.6 is equivalent to USD 1.00.

4. TECHNICAL ASSESSMENT

COGENERATION TECHNOLOGIES CURRENTLY IN PLACE

It was mentioned earlier that the performance efficiency of the two existing sugar factories is unsatisfactory due to age and obsolescence. Hence, to ensure their existence and reliable operation, the factories must be rehabilitated, optimized and expanded according to the feasibility study conducted on the two factories and submitted in October 2001. The major concern of this assessment report is on the cogeneration projects attached to the expansion program of the factories.

The existing boilers at Wonji and Shoa factories are of robust construction but are of obsolete design. These boilers are too old and need replacement. Their steam drum internals, heating surfaces, super heaters, soot blowers, refractory and insulation of the existing boilers of the two factories are deteriorated due to age.

The existing 5 x 9.5 t/h MCR boilers at Wonji, are operating to meet the steam demand of about 36 t/h at the present plant capacity. Also at, Shoa, all the existing 3 x 15 t/h MCR boilers are operating to meet the steam requirement of about 36 t/h at the present plant capacity.

The 2 x 2100 KVA 0.4 KV existing turbo alternators of Shoa factory supply the present power requirement of the factory. Also, 2 x 3.2 MW, 3.3 KV turbo alternators were newly procured in 2000 for replacement of the existing ones.

The distribution boards and local starters at Wonji and Shoa sugar factories are sturdy in construction but they are very old and are of outdated design. These boards are not provided with the required electrical instruments. Hence, electrical operating parameters like load currents, voltage and power cannot be measured at these old boards. Since local starters are being used, central control is not possible. These old distribution boards need replacement by motor control centers, which provide the required motor control and facility of monitoring electrical parameters

Options for Improving Cogeneration Technologies and Planned Improvements

From a consideration of age and obsolescence of the machinery and equipment in Wonji and Shoa sugar factories, the following alternative scenarios for optimization/ expansion of the factory to attain a combined capacity of 4400 TCD were evaluated.

Scenario-1: Expansion of Wonji Factory to 2000 TCD & Shoa Factory to 24000 TCD
Scenario-2: Expansion of Wonji factory to 2400 TCD and Shoa to 2000 TCD
Scenario-3: Installation of complete new factory with capacity 4400 TCD

Based on the analysis conducted on either Scenarios 1 or 2, the combined factory capacity upgrading to 4400 TCD needs the following replacements and major modifications.

Steam Generation Boiler Plant:

Replacement of the existing 5 x 9.5 t/h aged and obsolete boilers at Wonji with new high-pressure boilers necessitates design of bagasse handling system suitable for high capacity additional two new boilers. To suit the installation of the two new boilers, the following design changes were anticipated:

- Replacement of the existing inclined bagasse carrier with a new 40-hp motor driven carrier
- Installation of a new 60-hp motor driven horizontal bagasse carrier, in addition to the existing one,
- Installation of a new 60-hp motor driven, 25 m/min bagasse reclaim carrier;
- Installation of a new bale breaker unit for loosening baled bagasse for feeding bagasse reclaim carrier to the bagasse store yard.
- Installation of a new 7.5-hp motor driven belt conveyor for transporting bales to bale breaker unit.
- Installation of a new 5-hp motor driven belt conveyor for transporting loose bagasse from bale breaker unit to reclaim bagasse conveyor.

The average steam demand for the two scenarios 1 & 2 would be about 44 t/h and during peak hours it would be up to 50 t/h. Increasing the capacities of the existing boilers to 60 t/h to meet the steam requirement of the factory through undertaking the following major modifications/refurbishments were foreseen: -

- Installation of new bagasse feeders;
- Replacement of steam grate furnace with dump grate
- Modifications to convection tubes and additions of heating surfaces to the convection section;
- Installation of new air heaters;
- Replacement of ID fans
- Addition of forced draft and secondary air draft fans, etc;
- Replacement of drum internals;
- Modifications of air and flue duct and reconditioning of recovery insulation, etc;
- Addition of feed water pumps

But the estimated cost of additions and alterations at Wonji was about ETB 3.34 million per boiler unit amounting to about 18 million for the 5 boilers. The overall increase anticipated to be achieved in capacity of all the five boilers at Wonji was about 12.5 t/h and the cost of improving was found to be more than the cost of new boilers of similar capacity.

Through the modifications of the existing 3 x 15 t/h boilers at Shoa factory, the overall improvement anticipated to be achieved in capacity is about 5 t/h per boiler. The estimated cost was about 5.25 million Birr per boiler amounting to 15.75 million Birr for the 3 boilers. The cost of improving was found to be more than the cost of new boilers of similar capacity

After all these modifications/rehabilitations, the reliability of the boilers at the two factories would depend on the strength of the existing pressure parts retained. Hence, it was not justifiable to consider any major modifications/rehabilitation of the existing boilers. For capacity expansion of each factory in scenarios 1 & 2. Therefore, it was suggested to install one new 35-t/h, 32 kg/cm^2 (g) and 410^{o}C boiler to operate with one or two of the existing boilers to meet the average steam requirement of each upgraded factory to either 200/2400 TCD.

Power Generation & Distribution

To supply the above load requirements of each factory, installation of a new 5000 KVA 3.3 KV turbo alternator was proposed at each factory, in addition to the existing 2 x 2100 KVA, 0.4 KV turbo alternators. According to this proposal, the existing 2 x 2100 KVA turbo alternators at each plant, would remain as standby while the new 5000 KVA turbo alternator is operating.

The main power distribution board of the factories in Scenarios 1 and 2, would be extended to accommodate additional outgoing feeders required for new electrical drives of bagasse handling systems, new boilers and other machinery.

Due to age and obsolescence, all existing electrical distribution boards at each plant in Scenario 1 & 2 would be replaced by new motor control centers (MCCs) equipped with the central control and facility of monitoring of electrical parameters.

The estimated electrical load requirement of each upgraded plant in Scenarios 1 & 2 is about 3000 kW. With rehabilitation/expansion of the existing sugar factories to 2000/2400 TCD, generation of surplus power for exporting to the State Grid system was not considered.

Therefore, for the Cogen Project assessment, Scenario three (with a new factory of 4400 TCD expandable to 6600 TCD), which has cogeneration facilities for surplus power generation and export to the grid is given more attention.

4.2.3 Scenario 3 - New Plant

Both Wonji and Shoa Sugar factories are old with obsolete and outdated design of the existing machinery and equipment. To optimize or expand these old factories with the existing major plants, machinery including boilers, turbo alternators, bagasse handling systems and other essential equipments, require major modification refurbishments and/or replacements,

Even after having all these major replacements and modifications, the factories would remain with some existing equipment retained whose operational reliability would be uncertain for the future operation of the factories.

In view of the above, a new sugar factory with a capacity of 4400 TCD (183 TCH) was opted to be compared with the other two scenarios 1 & 2 in which expansion of existing factories is considered.

The following factors required for the basic design philosophies of the new sugar factory with cogeneration were considered in the feasibility report: -

- Proven technology
- Optimum use of electrical energy
- Optimum process efficiency;
- High thermal efficiency;
- Possibility of upgrading factory capacity to 6000 TCD;
- Optimum investment.

4.3 Selection of Cogeneration Capacity and Optimum Configurations of Major Equipment/Technology

In the feasibility study conducted, the following two options were evaluated: -

Option A: Factory with milling plant;
Option B: Factory with diffuser plant;

Plant and machinery requirement proposed for cogeneration in mill plant option or diffuser plant option are the same. But with regard to power export, there is an insignificant difference in the quantity of export power. For factory with mill plant, power for export is 10.5 MW while for the factory with diffuser it is 9.8 MW.

Hence, technical assessments for the major cogeneration equipments/technologies Scenario-3 are made only once as stated below: -

Bagasse Handling System: -

The bagasse handling system recommended for the new boilers consists of the following major equipment: -

a) One conveyor, with load cell arrangement for continuous weighing of bagasse with indicator, totalizer, etc;
b) One steel slat or rake type bagasse elevator of all steel construction of 1800 mm effective width and suitable length to carry 90 t/h bagasse and driven by 50-hp ac electric motor with variable speed variation arrangement through helical gear box and speed reducer to give a linear speed of 25 m/min;
c) One steel slat or rake type horizontal bagasse carrier of all steel construction of 1800 mm effective width and suitable length to carry about 90 t/h bagasse and driven by 60-hp ac electric motor with variable speed arrangements through helical gear box and speed reducer to give a linear speed of 25 m/min. The length of the carrier shall be suitable for feeding to three boilers (additional one in the future).
d) One bagasse reclaim elevator of suitable length for semi mechanized bagasse reclaim system.
e) One 20 t/h, 100-hp, 585 rpm motor driven bagasse bale breaker to convert bales into loose form suitable to feed to boiler through bagasse carriers;
f) One 6-hp motor driven 800 mm wide belt conveyor with suitable length to transport bagasse bales to bale breaker unit.
g) One belt conveyor to transport loose bagasse from bale breaker unit to bagasse reclaim elevator.
h) One belt cleaning type magnetic iron separator, to collect left pieces of bale binding wire or tramp iron pieces. The magnetic iron separator shall have capacity to separate iron weighing about 10 kg from a distance of about 300 mm

Steam Generation Plant

Installation of 2 x 50 t/h new boilers with steam conditions of pressure 45 kg/cm^2 (g) and temperature 510^{o}C provided with the necessary auxiliaries, accessories and complete sets of instrumentation, PLC and supervisory stations were proposed.

Pressure Reducing and De-Super Heating Station (PRDS)

To utilize the 3.2 MW rated for steam conditions of pressure 21 kg/cm^2 and temperature 325^{o}C, the high pressure steam from the new boilers can be reduced either by installation of one toping up turbo alternator or through suitable PRDS.

Provision of suitable PRDS station to meet the requirements of process steam make-up at different pressures was also considered.

Power Generation & Distribution System

Turbo Alternators

There are two options available for configuration of turbo alternators: -

Option - 1

- The existing 3.2 MW, 3.3 KV turbo alternator sets rated for steam conditions, pressure 21 kg/cm2 (g) and temperature 325^{o}C would be shifted from Shoa to the new sugar factory.

These turbo alternators would be supplied with required steam through the PRDS station taking steam from the proposed high-pressure boilers at 45 kg/cm^2 (g).

- 1 x 6 MW, 11 KV turbo alternator with backpressure type rated for steam conditions of pressure 45 kg/cm2 (g), and temperature 510^{o}C.

- 1 x 12 MW turbo alternator with double extraction condensing (DEC) type turbine with 1st extraction at 7 kg/cm^2 for use of sulphur burner, sugar drying, etc. and the 2nd extraction at 1.5 kg/cm^2 (g) for process and the remaining quantity of steam going to condenser.

During normal conditions, 1 x 6-MW backpressure turbo alternator set and 1 x 12-MW DEC type turbo alternator set would be in operation. The 2 x 3.2 MW turbo alternator sets taken from Shoa factory would remain as standby units.

Option - 2

- The existing 3.2-MW, 3.3 KV turbo alternator sets rated for steam conditions, pressure 21 kg/cm2 (g) and temperature 325^{o}C would be shifted from Shoa to the new sugar factory. These turbines would be supplied with required steam through the PRDS station taking steam from the proposed high pressure boilers at 45 kg/cm^2 (g)

- One double extraction condensing (DEC) type turbo alternator of 18-MW capacity with 1st extraction at 7 kg/cm^2 (g) for usage of sulphur burners, sugar drying, etc. and 2nd extraction at 1.5 kg/cm^2 (g) for the process and the remaining quantity of steam going to condenser.

Recommendations for the Specifications of Main Equipments

Proposed Cogeneration Scheme

Installation of one bigger size DEC type turbo alternator in (option - 2) is considered to be economical and more energy efficient compared to two turbo alternators having same combined capacity with same steam conditions. Hence, it was recommended to install one 18-MW DEC type turbo alternator set in addition to shifting of the 2 x 3.2 MW, 3.3 KV turbo alternator sets from Shoa to the new factory.

Electricity distribution system consists of supply at 132 KV, 115 KV, 11 KV, 3.3 KV and 400 volts and 230 volts through suitable transformers, motor control centers to various sections of the plant and other outside usages.

Power Export

Power export system would consist of high-tension boards, metering, battery, switchyard, transformers, and transmission lines up to the State Grid System.

To have adequate margin of power export, the power export system would be designed for maximum power export of 15 MW, even though the normal power export is estimated at around 10.5 MW.

Normally, 1 x DEC turbo alternator shall be operated and loaded up to 16.93 MW for exporting 10.5 MW power to State Grid and to meet 6.45 MW power towards in -house requirement for sugar factory, irrigation pumps, villages and other support centers.

Cogeneration Scheme Comparison of Milling plant and Diffuser Process Plant

Summary of cogeneration comparison results for 4400 TCD capacity factory with milling plant and cane diffuser plant option with the same steam conditions of pressure 45 kg/cm2 (g) and temperature 510^{o}C are shown in table 10 below.

Description	Milling Plant Option	Diffuser Plant Option
Cane unloading, kW	130	130
Cane preparation, kW	1070	1285
Mills, kW	1350	-
Diffuser unit, kW	-	105
Dewatering mills, kW	-	570
Rake carriers, kW	50	10
Juice handling, kW	80	140
Total power consumption, kW	**2680**	**2240**

Table 10: Comparison of power consumption of milling plant and diffuser plant

The power saving in diffuser option would be (2680-2240 =) 400 kW. The power requirement of the new factory with either option is shown in table 11

Description	With Milling plant	With Diffuser plant
Factory total power requirement, kW	**6400**	**5900**

Table 11: Total power requirement of the factory with milling and diffuser options

Comparison of Estimated Power Generation and Export

Summaries of cogeneration surplus power for export with double extraction condensing type turbo alternator set for milling and diffuser options are given in table 12 below

S/N	Description	Milling Option	Diffuser Option
1	Season days	200	200
2	Total power generation	16.93	15.68
3	In-house power requirement	6.45	5.90
4	Net power export	10.50	9.80
5	Number of operation days during campaign season	200	200
6	Number of operation days during off-season	-	15
7	Total number of operation days	200	215
8	General time efficiency, %	93	91
9	Power export per annum, MWh	46852	46100
10	Birr per MWh **	200	200
11	**Earnings per annum, Birr**	**93,70,400**	**9,220,000**

Table 12: Summaries of cogeneration surplus power for export for milling and diffuser options

** This price estimate is lower than the lowest payment that the State Grid Supply System receives from its clients which ranges from ETB 250 to 400 per MWh during 2000/2001 markets.

The above power export earnings were considered in financial analysis of Scenario 3 (new sugar factory).

Recommendation on Options for Implementation

New sugar factory with diffuser option and cogeneration was recommended for implementation.

Fuel Requirements for the Capacity and Technology Chosen

In the new sugar factory at Wonji-Shoa, bagasse is considered to be obtained from the last mill of the new factory when sugar cane is crushed for extracting juice. This bagasse is considered to contain about 50% moisture, 45.52% fiber % bagasse, and 2% pol % bagasse. The bagasse % cane is taken as 30.26 % cane.

The bagasse is supposed to be used in the boilers of the new sugar factory as fuel for generation of steam to be utilized for process heating and power generation. The available bagasse with its characteristics is shown in table 13 below.

Crushing rate, tch	183.33
Fiber cane% cane	14.38
Bagasse available, Ex-mills;	
Wet bagasse % cane	30.26
Moisture % bagasse	50
Pol % bagasse	2
Fiber % bagasse	47.52
Bagasse used for vacuum filter, %cane	1.5
Windage losses% cane	0.50
Bagasse available for steam generation, %cane	28.26
Bagasse available for steam generation, t/h	51.81
GCV, kcal	2276
NCV, kcal	1801

Table 13: characteristics of available bagasse

5. ECONOMIC/FINANCIAL ASSESSMENT OF COGENERATION

5.1. Cost of Cogeneration Technologies, Including Capital Expenditures, Development Costs and O & M

The investment cost for the new Sugar Factory at Wonji-Shoa with initial capacity of 4400 TCD expandable to 6600 TCD includes agriculture and factory investment components.

For this expansion, cane production improvement was envisaged so that the output meets the proposed factory crushing capacity. The current total estimated output of 593,000 tons of cane per annum would increase to 750,000 tons of cane per annum within a period of seven to eight years, including the time implementing the improvement proposal.

The factory investment component includes investment for cogeneration facilities for surplus power generation. To satisfy cogeneration requirement of surplus power export to the State Grid supply system, the new sugar factory of capacity 4400 TCD upgradeable to 6600 TCD (Scenario 3) was attached with cogeneration facilities (Scenario-3). This Scenario is given more attention than scenarios 1 & 2 for meeting the requirement of pre-feasibility assessment for Cogen Project.

5.1.1 CAPITAL COST ESTIMATES

a) Investment Costs for Agriculture Improvement

S/N	Description	Foreign component in local currency ETB million	Local component ETB million	Total capital in local currency ETB million in
1	Bio-fertilizer plant	1.16	0.29	1.45
2	Irrigation and drainage	10.47	42.80	53.27
3	Field mechanization	47.22	6.83	54.05
4	Harvesting and transport	26.07	3.91	29.98
5	Field equipment service	19.16	6.13	25.29
6	Spares	15.70	---	15.30
	Total	**119.78**	**59.96**	**179.34**

Table 14: Investment cost for agriculture improvement

b) Investment Cost in Factory

Detail capital cost estimates for the new 4400 TCD sugar factory expandable to 6600 TCD including cogeneration facilities is shown in tables 15 and 16. The proper cogeneration facilities and their investment costs can be seen in tables 15 and 16 under I/Ns 13, 14, and 15 in each Option.

i. Milling Option-A

I/N	Required equipment	Total investment cost in million ETB excluding import duty		
		Foreign component in local currency excluding import duty	Local procured items+ local expenditure +	Total in local currency, ETB
1	Cane unloading	3.61	1.67	5.28
2	Cane handling	5.42	4.15	9.56
3	Juice extraction plant	65.44	19.59	85.04
4	Juice treatment	3.23	1.68	4.92
5	Clarifier and filtration	7.05	3.42	10.47
6	Mol and co2 preparation	4.62	1.52	6.14
7	Juice heating and evaporation	12.93	13.12	26.04
8	Graining and crystallization	16.76	16.54	33.31
9	Condensing and cooling	2.65	1.18	3.83
10	Centrifugals	12.24	3.88	16.11
11	Sugar handling & bagging	5.96	3.21	9.17
12	Final molasses handling	1.41	10.83	12.24
13	**Bagasse handling system**	**5.26**	**3.76**	**9.021**
14	**Steam generation plant**	**60.63**	**25.96**	**86.59**
15	**Power generation plant**	**72.89**	**21.46**	**94.35**
16	Factory workshop	1.62	0.41	2.03
17	Factory laboratory apparatus and instruments	0.49	0.10	0.59
18	Factory water supply system	0.00	0.00	0.00
19	Waste water treatment system	2.77	0.70	3.48
20	Factory buildings	37.95	9.62	47.57
21	Miscellaneous items	5.21	1.32	6.53
	Piping, valves and fittings	19.56	4.06	23.62
	Machinery staging	15.65	3.25	18.90
	Spares	19.56	2.93	22.5
	Contingencies (5% on value)	22.30	3.35	25.65
	Grand total	405.21	157.71	562.941

Table 15: Detail capital cost estimates for the new 4400 TCD Sugar Factory expandable to 6600 TCD: Milling Option A

ii. Diffuser Option-B

	Required equipment	Total investment cost I million ETB excluding import duty		
		Foreign component in local currency excluding import duty	Local procured items+ local expenditure +	Total in local currency, ETB
1	***Cane unloading***	***3.61***	***1.67***	***5.28***
2	Cane handling	6.14	4.50	10.54
3	Juice extraction plant	87.18	21.00	108.18
4	Juice treatment	3.26	1.69	4.95
5	Clarifier and filtration	5.88	2.82	8.70
6	Mol and co2 preparation	4.62	1.52	6.14
7	Juice heating and evaporation	14.80	15.33	30.13
8	Graining and crystallization	16.76	16.54	33.31
9	Condensing and cooling	2.65	1.18	3.83
10	Centrifugals	12.24	3.88	16.11
11	Sugar handling & bagging	5.96	3.21	9.17
12	Final molasses handling	1.41	10.83	12.24
13	**Bagasse handling system**	**5.26**	**3.76**	**9.021**
14	**Steam generation plant**	**60.63**	**25.96**	**86.59**
15	**Power generation plant**	**72.89**	**21.46**	**94.35**
16	Factory workshop	1.62	0.41	2.03
17	Factory laboratory apparatus and instruments	0.49	0.10	0.59
18	Factory water supply system	0.00	0.00	0.00
19	Waste water treatment system	2.77	0.70	3.48
20	Factory buildings	34.79	8.82	43.61
21	Miscellaneous items	5.21	1.32	6.53
	Piping, valves and fittings	20.55	4.26	24.82
	Machinery staging	16.44	3.41	19.85
	Spares	20.55	3.08	23.63
	Contingencies (5% on value)	23.43	3.51	26.94
	Grand total	429.14	160.96	590.021

Table 16: Detail capital cost estimates for the new 4400 TCD Sugar Factory expandable to 6600 TCD: Milling Option A

Capital cost estimates were made for project item as being unit cost of CIF Port of Djibouti and hence they include overseas freight, insurance, etc.

For items to be manufactured locally, only the design charges were considered as foreign capital. The local component includes cost locally procured materials, manufacturing charges, local taxes and transportation charges, etc.

No import duty or local taxes were considered on all imported items.

Erection costs were taken in local currency but part of these amounts would be spent in foreign currency for expert service availed for supervision.
Conversion to local currency is at ETB 8.33 per USD of year 2000/2001, in which the feasibility study of the project was undertaken.

Some of the equipment additions during interim phase for the existing factories were considered so that they could be utilized in the new sugar factory. For correct capital cost estimates of the new factory, the cost of equipment utilized from the interim phase of both existing factories, was deducted as this had been already considered as installed but to be relocated.

Summary of Total Cost Estimate

Based on the above assumptions, the summary of total cost estimates for Scenario 3 is shown in table 17 below.

S/N	Description	Foreign component, in local currency, ETB Million	Local component, ETB Million	Total costs in local currency, ETB Million
1	**Scenario 3-Milling Option-A**			
	New sugar plant, 4400 TCD, expandable to 6600 TCD	370.56	143.82	514.38
	(-) Cost of reused equipment installed in interim phase Wonji and Shoa	-25.40	-8.40	-33.80
		345.16	**135.42**	**480.58**
2	**Scenario 3-Diffuser Option-B**			
	New sugar plant, 4400 TCD, expandable to 6600 TCD	394.47	147.00	541.47
	(-) Cost of reused equipment installed in interim phase Wonji and Shoa	-25.40	-8.40	-33.80
		369.07	**138.6**	**507.67**

Table 17: Total cost estimates for Scenario 3 (Options A & B)

5.1.2 PREOPERATIVE COSTS

This includes costs of land and development, project management, transport costs and travel expenses and pre-commissioning testing costs. Pre-operative cost estimates considered for the new sugar factory are summarized in table 18 below.

S/N	Description	Costs in ETB in million
	Scenario	3 A & B
1	Land development & preparation, etc	4.5
2	Project management a) Project cell b) Consultants fee (foreign currency)	 9.0 16.5
3	Establishment costs of the cell	6.0
4	Vehicles/transportation, etc.	8.0
5	Pre-commissioning testing and trials	0.8
	Total	**44.8**

Table 18: Pre-operative cost estimates for the new plant (Scenario 3)

Fund requirements for land development and project management were considered in project year-1. Establishment and transportation costs were spread over the project period and costs for pre-commissioning tests were considered in the last year of project implementation period.

5.1.3 OPERATTION & MAINTENANCE COSTS

Operation and maintenance costs for scenario 3 were derived from the total operating cost of farm and factory as a whole.

5.1.4 FINANCIAL AND ECONOMIC ANALYSIS

a) Financial Analysis

The financial analysis for expansion of the factory was undertaken for the agriculture improvement and the new plant with cogeneration facilities under scenario 3.

i. Basic Assumptions

Financial analysis was made based on the following assumptions: -

- Project life of 32 years including seven years of investment and 25 years of operation phases;
- 10.5% to discount the future benefits and costs;
- Fixed assets and preproduction expenditures were depreciated on the basis of rates in table 29 below.
- Income tax was 33% of the gross profit.
- Depreciation rates for fixed assets and pre-production expenditures are shown in table 19 below.

Description	Depreciation rate, %
Plantation dams, canals and irrigation systems	5
Irrigation machinery	12
Buildings and other structures	5
Plant machinery and equipment	12 t0 15
Agricultural machinery and implements	20
Vehicles	20
Office furniture & equipment	10
Pre-investment studies	4

Table 19: Depreciation rates for fixed assets and pre-production expenditures

ii. The Projected Financial Costs & Benefits

- **Investment cost**

For the sugar factory under scenario 3 A & B, the total investment cost is shown in table 20 below. It is composed of initial investment capital requirement and investment requirement during pre-production phase. Initial investment is composed of fixed investment and pre production expenditure while investment during production period is required for increase in net working capital.

Fixed investment cost comprises the cost of the project for agriculture improvement and factory expansion (new factory) during the initial investment period. The investment cost required for agriculture improvement is estimated at ETB 179.34 Million of which about 72% is in foreign currency.

Summary of The Initial Investment Cost of New Sugar Factory With Options A & B: (In ETB million)

No	**Description**	Scenario 3A	Scenario 3B
1	Starting capital	---	---
2	**Additional fixed investment**	**693.71**	**720.60**
	a) Agriculture	179.34	179.34
	b) Factory	514.37	541.46
3	**Pre-production expenditure**	**320.71**	**328.43**
	a) Project study & management cost	44.85	44.85
	b) Capitalized interest	275.86	283.58
	Total	**1014.4**	**1049.2**
	Foreign component, %	**54.5**	**42.6**

Table 20: Initial investment cost of new plant under Scenario 3 A & B

- **Initial Investment Requirement & Source of Finance**

The source of finance for the initial investment of the project is shown in table 21 below. The full amount of starting capital of fixed investment and 40% of the pre-production expenditure was assumed to be financed 60% from long-term bank loan and 40% from equity. Interest on the long-term is taken to be 10.5% per annum. The total loan of the project including interest accrued during construction period is to be repaid within 15 years starting from the first year of production. Initial investment and source of finance are shown in table 21 under.

		In ETB '000		
	Description	**Total Investment**	**Sources of Finance**	
			Equity	**Long-term**
	Scenario 3 A			
1	**Fixed investment cost**	**693.711**	**277,484**	**416,227**
	- Starting balance	---	---	---
	- Additional investment	693.711	277,484	416,227
2	**Pre-production expenditure**	**320,712**	**17,940**	**302,773**
	2.1Pre-production expenditure, Net of interest	44,849	17,940	26,909
	- Starting balance	7,049	2,820	4,229
	- Additional investment	38,800	15,120	22,680
	2.2 Capitalized interest	275,863	0.00	275,863
3	**Total initial investment –Net of interest**	**738,560**	**295,424**	**443,136**
4	**Total initial investment including capitalized interest**	**1,014,423**	**295,424**	**718,999**
	Scenario 3B			
1	**Fixed investment cost**	**720,800**	**288,321**	**432,482**
	a) Starting balance	---	---	---
	b) Additional investment	720,803	288,321	432,482
2	**Pre-production expenditure**	**328,429**	**17,940**	**310,489**
	2,1Pre-production expenditure-Net of interest	44,849	17,940,	26,909
	- Starting balance	7,049	2,820	4,229
	- Additional investment	37,800	15,120	22,680
	2.2 Capitalized interest	283,580	---	283,580
3	**Total initial investment –Net of interest**	**765,652**	**306,262**	**459,391**
4	**Total initial investment including capitalized interest**	**1,049,232**	**306,261**	**742,971**

Table 21: Initiation investment and source of finance

- **Revenue**

Production with the new investment on expansion (Scenario 3) was expected to start on the eighth year of the project (year 2010). There are three sources of revenues to the project. They are sugar, molasses and surplus electricity. The surplus electric energy to be generated was assumed to be sold to the State Grid system.

The main revenue of the project comes from the sale of sugar. The auction floor price of the sugar was ETB 4000 per ton during 2000/2001.

The ex-Wonji factory price of molasses was ETB 30.00 per ton in the same year.

The selling price of surplus power to State Grid was estimated at ETB 200 per MWh. This price estimate was lower than the lowest payment the State Grid receives from its clients which ranges from ETB 250 to 400 per MWH during 2000/2001.

Revenue from Scenario 3 Investment is shown in table 22 below.

S/N	Description	Scenarios 3	
		Option A	Option B
		Year 2016	Year 2016
1	Sugar;		
	Out put, tons	96,950	98,475
	Value, ETB ‘000	387,900	393,000
2	Molasses:		
	Out put, tons	27,975	28,350
	Value, ETB ‘000	839	850
3	Electric power:		
	Out put, tons	46,938	47,548
	Value, ETB ‘000	9,388	9,510
	Total revenue, ETB ‘000	**398,127**	**404,260**

Table 22: Revenue from investment on Scenario 3

- **Cost of Production**

The production cost for scenario 3 (options A & B) is made on the whole cost and benefit basis. This is the total cost required to produce the improved output of 750,000 tons of cane. The operating cost increase during the first five years to match with the capacity increase and sales program of the factory. Historical costs of the existing factories and plantation during 1996–2000 were the basis for production cost estimation.

The cost of cane at the weighbridge had been entered in the operating cost as raw material cost to the factory. Other costs including factory supplies, utilities, spare parts, labor and factory overhead are considered as direct factory costs. Excise tax was calculated at the rate of 33 % of the operating cost and is included as labor overhead costs.

The operating and maintenance costs of scenario3 were calculated from the total operating cost of the farm and the factory as a whole.

Summary of production costs for scenario 3 for the third year of operation is shown in table 23.

S/N	Cost item	In ETB '000			
		Third year of operation (year 2012)			
	Scenarios ----	**Scenario 3A**		**Scenario 3B**	
1	FACTORY COSTS	**Total cost**		**Total cost**	
	Raw materials	55,281.40	19%	55,281.60	18%
	Factory supplies	6,471.10	2%	6,531.70	2%
	Spare parts consumed	11,291.90	4%	10,934.10	4%
	Labor	6,610.40	2%	6,610.40	2%
	Labor overhead costs (taxes, etc)	31,067.10	11%	30,969.10	10%
	Factory overhead costs	2,084.50	1%	2,084.50	1%
	Sub-total	**112,806.3**	**39%**	**112,411.4**	**38%**
2	Administrative costs overhead cost	12,404.10	4%	12,404.40	4%
3	OPERATING COSTS (1+ 2)	125,210.40	43%	124,815.70	42%
4	Depreciation	92,880.80	32%	98,378.10	23%
5	Financial costs	70,688.00	24%	73,044.80	24%
6	TOTAL PRODUCTION COSTS (3+4+8)	288,779.20	99%	296,238.60	99%
7	Direct marketing costs	3,100.60	1%	3100.60	1%
9	COSTS OF PRODUCTS (6+7+8)	291,879.80	100%	299,339.20	100%
10	Foreign share, %	29.2%		21.6%	
11	Variable share	39.6%		37.1%	

Table 23: Summary of production costs for Scenario 3 for the third year of operation.

iii. Financial Analysis Results

The income statement for scenario 3 shows that the project generates profit right after its start of production in year 10. The net profit generated by the project (Scenario 3) is steadily rising through time as a result of the decline in depreciation and financial commitments. The new factory with diffuser option gives higher and better profit.

The annual net profit of scenario 3 is summarized for the reference period in table 24 below.

S/N	Description	Scenario 3A		Scenario 3B	
		Year 2016	Year 2025	Year 2016	Year 2025
1	Variable margin	282.6	282.6	293.3	293.3
2	Operating margin	204.8	265.9	204.5	272.1
3	Gross profit	147.1	265.9	144,9	272.1
4	Profit after tax	95.6	172.8	94.2	176.9
5	Retained profit	95.6	172.8	94.2	176.9

Table 24: Annual net profit of scenario 3

b) Cash flow

From the discounted cash flow, the Net Present Value and Internal Rate of Return (IRR) of the project discounted at 10.5% for Scenario 3 is shown in table 25 below.

Parameter	Scenario 3A	Scenario 3B
Net present value ‘000	395,513	403,744
Internal rate Of Return (IRR)	15.56	15.54

Table 25: Net Present Values and Internal Rate of Return

The project is viable under scenario 3 options 3B and 3A. Both options produce a good net cash flow surplus.

The cumulative cash flow for both options has increased through the operation life of the project. The net worth of the project has also raised steadily over the years and the net worth to total liability ratio is almost above 70% starting from the 9th (2018) of operation.

c) Sensitivity analysis for some parameters (fixed investment, sales, production costs)

Sensitivity test, which was applied, for adverse changes in fixed investment, sales, and production costs shows that the project is more sensitive to adverse changes in sales revenue. However, a 25% decrease in sales revenue will not make both options of scenario 3 unviable.

		SCENARIO 3			
		3A		3B	
	% change	NPV (mil. Birr)	IRR(%)	NPV (mil. Birr)	IRR(%)
Base case		395.51	15.56	403.74	15.54
Increase In Fixed Investment	10.0%	336.5	14.6	345.0	14.6
	15.0%	311.1	12.2	318.9	14.2
	25.0%	260.3	13.4	266.7	13.4
Increase In Production Cost	10.0%	345.7	15.0	355.8	15.0
	15.0%	324.9	14.8	335.1	14.8
	25.0%	203.3	14.3	293.6	14.3
Decrease In Cells Revenue	10.0%	264.6	14.1	272.8	14.1
	15.0%	203.4	13.3	210.5	13.4
	25.0%	78.5	11.7	82.8	11.7

Table 26: Sensitivity Analysis

6. FINANCING OPTIONS ASSESSMENT

6.1 African Development Bank (ADB):

African Development Bank:

c) Extended a loan to assist in financing the foreign exchange costs for preparation of detailed engineering design and tender document for similar sugar projects in Ethiopia..

d) Lent to Government of Ethiopia a principal loan in various convertible currencies to assist in financing part of the foreign exchange cost of similar sugar projects.

All these previous experiences in participation of financing sugar projects in Ethiopia may indicate that there would be a possibility of securing some financing support from the Bank for the implementation of the new sugar factory project at Wonji–Shoa.

6.2 African Development Fund:

ADF lent to Government of Ethiopia an amount in various convertible currencies to assist in financing part of the foreign exchange cost of some sugar projects. This option has to be further looked into for the expansion of sugar factory at Wonji-Shoa.

6.7.1 Original Sovereign Lenders to the New-Wonji Shoa

6.7.2 Sweden

Swedish Government through its Swedish Agency for International Technical & Economic Cooperation has the experience of making available credit facilities and grants to be utilized for the delivery of electrical erection and installation materials and transformers to some Sugar Project. Effort is needed to win the interest of Swedish Government to continue its support in financing the new sugar project at Wonji-shoa.

6.7.3 Australia

The Australian Trade Commission Trading as Export Finance & Insurance Corporation (EFIC) has the experience of extending credit facilities that utilized for financing contract price for the supply of sugar cane handling and mills equipment to be delivered for a sugar project in Ethiopia. The same may apply for the Sugar factory at Wonji-Shoa

6.7.4 The Kingdom of Spain

The Kingdom of Spain has the experience of guaranteeing a loan facility accounting for goods and services exported for a sugar project at Finchaa. Such loan facilities are "tied" loans utilized for the purchase of Spanish goods and services.

Although, Financing facilities from these / such Sovereign Lenders is often 'tied' to procurement of goods originating in the lender's home country, it is necessary to win their interest to continue financing support for expansion of Wonji-Shoa Sugar Factory.

6.7.5 Development Bank of Ethiopia

Development Bank of Ethiopia is engaged in extending investment loans to aid in the development of Ethiopia. The Bank financed housing and infrastructural civil works and erection of factory pump stations, electrical and telecommunications equipment, pre-operating costs as well as part of the working capital requirement for a sugar project at Finchaa. Here also it is necessary to approach the bank to extend investment loans to support financing the new expansion project of Wonji-Shoa Sugar Factory.

7. POLICY, INSTITUTIONAL/REGULATORY ASSESSMENT/

7.1 POLICY ASSESSMENT

94% of Ethiopia's energy requirement is covered by traditional energy source. The balance is covered by commercial energy i.e. electricity and petroleum. The supply of household fuel is associated with massive deforestation and land degradation. The high population growth rate in the country has the scarcity of fuel wood.

Committed to shaping the economic future of the country, the Government of Ethiopia adopted a strategy for sustainable economic development, which places agriculture as its driving force, namely, Agricultural Development Led Industrialization (ADLI).

Ethiopia has vast energy resources of 30,000 MW hydropower resources, 1387 million TOE biomasses resources, 17.5 million TOE agricultural residue over 100 billion cubic meter of natural gas 4000 MW of geothermal energy and 40.3 million tons of coal and oil shale energy resources. But, all these energy resources have not been developed, transformed and exploited for optimal economic development.

Therefore, GOE believes to provide the economy with the necessary energy inputs at the right time, place and affordable price. To speed up economic development objectives of the country, a comprehensive national energy policy directing and coordinating the development of energy sector, has been formulated.

The policy is included in the government's economic policy and is subject to review through time according to new developments.

General Energy Sector Policy

g) To enhance and expand the development and utilization of hydrological resources for power generation with emphasis on mini-hydropower development.
h) To take appropriate policy measures to achieve a gradual transition from traditional energy fuels to modern fuels.
i) To set, issue and publicize standards and codes which will ensure the energy is used efficiently and properly.
j) To develop human resources and establish competent institutions.
k) To provide the private sector with necessary support and incentives to participate in the development of the country's energy resource; and
l) To pay due and close attention to ecological and environmental issues during the development of energy projects.

MAIN POLICY ISSUES

Energy Resource development

Traditional fuels

c) A country wide forestation program will be undertaken to enhance the supply of fuel wood to consumers
d) To reduce the negative effects of agri-residue use for energy on soil fertility measures will be taken to modernize and increase the efficiency of the utilization of agri-residue as energy sources.

Modern Energy Resource Development

d) Hydropower will form the backbone of the country's energy sector development strategy, as it is the country's most abundant and sustainable energy resource.
e) Natural gas resources will be developed and utilized to meet as much of the country's demand as possible; and
f) Promising areas for oil and natural gas will be explored by providing incentives to oil companies to encourage them to take in exploration activities.

Alternative Energy Recourses Development Policy:

d) Solar and Geothermal energy will be used, wherever possible, for process heat and power generation;
e) Ethiopians wind energy resources will be developed to provide shaft power for water and irrigation.
f) Coal will be developed and introduced as an alternative fuel.

Energy Supply Policy

Household Energy

Government's Energy Policy to achieve a Balance Between the Supply and Demand for Household Fuels.

- Government will seek to stabilize their prices by increasing the supply of alternative fuels and relieving the pressure on wood resources.

Agriculture Energy Supply Policy

- Government's agriculture sector energy supply policy is to increase the supply of modern energy sources to the agriculture sector.

Industrial Sector Energy Supply Policy

Government's industrial sector supply policy is:

c) To ensure for industrial energy supply will be compatible with the industrial development of the country; and
d) To ensure that industrial energy use and supply will be based on economic and efficiency criteria.

7.2 INSTITUTIONAL ISSUES

The government of Ethiopia believes to create an institution which is entrusted with policy formulation, priority setting and coordination of all energy sector development activities in order to coordinate and ensure consistency in resource development and to avoid resources waste and duplication of efforts.

For facilitating conditions for expansion of electricity services, the Ethiopian Electricity Agency has been established under the Ministry of Mines & Energy as an autonomous federal organ to regulate the activities of electricity suppliers and the prescription of provisions required.

The objective of the Agency is to promote the development of efficient reliable high quality and economical electricity services.

Main powers and duties of the Agency are: -

h) Supervise and ensure the generation, transmission, distribution and sale of electricity are carried out in accordance with proclamation # 86/1997 as well as regulations and directives issued hereunder
i) Determine the quality and standard of electricity services and ensure the implementation thereof;
j) Issue certificates of professional competence to electrical contractors;
k) Issue, suspend and revoke license for the generation, transmission, distribution and sales of electricity in accordance with this proclamation and as well as regulations and directives issued hereunder
l) Study and recommend a tariff and up on approval supervises the implementation thereof.
m) Collect license fees in accordance with rates to be prescribed by regulations;
n) Cooperate with training institutions in the field of electricity.

Requirement and Condition of License

a) No person may generate, transmit, distribute or sell electricity for commercial purposes unless he is a holder of a license.
b) Any person desiring to generate, transmit or distribute electricity for non commercial purpose shall notify the Agency in advance and produce documents evidencing that he has fulfilled environmental protection and safety conditions as required by the Agency
c) Any person generating electricity by installing a standby generator may use the existing supply system of the area by entering into agreement with the concerned licensee.

Eligibility for License

d) Any person may be issued with a license where he satisfies the qualifying conditions specified in the proclamation, regulations and directives issued hereunder as well as in the investment law and upon conditions by the Agency that he is qualified to carry on trade under the commercial code and has the financial resources, technical competences, professional skill and experience required to fulfill license obligation.
e) Any person who has been engaged in the generation, transmission, distribution and sale of electricity prior to coming into force of the proclamation shall be required to submit an application, along with the necessary particulars and obtain a license.
f) Transfer of license

A license issued to the proclamation may be transferred to other person with the prior consent of the Agency, under conditions to be specified by regulations.

Any licensee shall:

iv. Carry out the generation, transmission, distribution and sale of electricity in accordance the Proclamation, regulation and directives issued here under as well as in compliance with environmental protection laws and quality standards determined by the Agency.
v. Keep relevant records of operation, submit reports and supporting documents to the Agency in accordance with directives to be issued by the Minister
vi. Make books and records of operation available for inspection by duly authorized official of the Agency

Suspension and Revocation of License

v. The agency may suspend or revoke a license where the license fails to comply with obligations specified to the proclamation, regulations and directives issued hereunder as well as in the license.
vi. Prior to revocation of the license, the agency shall allow the licensee such time, as it deems sufficient to rectify failure.
vii. Without prejudice to the rights of heirs, the license shall be revoked upon death of the licensee or upon liquidation or declaration of bankruptcy under the relevant law, in case of judicial person.
viii. No licensee may claim charges in case of the tariff.

7.3 REGULATORY ASSESSMENT

7.3.1 The electricity operation council of ministers of the federal government of Ethiopia issued an Electricity Operation Regulation #49/1999 on the 2nd may, 1999.

Part two of the electricity operation states the following general requirements for application of license:

7.3.2 Any application for a license of generating, transmitting, distribution importation or exportation of electricity shall be addressed to the Agency and shall contain:

f) Identity and address of the applicant
g) Feasibility study of the project
h) Environmental impact assessment
i) Documents showing the applicant's financial situation, technical competence and experience
j) Construction and installation design, and such other information the Agency may determine by directives

7.3.9 Feasibility steady shall consist of the following operation:

e) Social and economic input;
f) Estimated costs and returns of the equipment
g) Duration of the project.
h) Construction and installation programs and commencement date of operation.

7.3.10 The environmental impact assessment referred to shall consists of the following components:

c) All potential dangers to the environment along with mitigation or reclamation plan including resettlement program for displacement;
d) Estimated costs of implementation of the plan and program.

7.3.11 Application for generation license contain:

e) source of energy;
f) Map of the project site at the scale determined by the agency.
g) Total power capacity of the project
h) Power purchase contract where appropriate

7.3.12 Application for transmission license contain:

d) Preliminary route map of proposed main and alternative transmission line
e) Total length an maximum load of transmission line
f) Standard of voltage and frequency

7.3.13 Applications for distribution and sale of electricity license contains the following:

d) Source from which the distribution system draws electricity
e) Estimated number of customers to be benefited prom the project and proposed price of each unit of power to be sold;
f) Power purchase contract where appropriate

7.3.14 Application of importation or exportation license shall contain the following:

d) An agreement made with concerned automation of a country from which or to which electricity is imported or exported
e) Standard of voltage and frequency
f) Power purchase contract where appropriate

8. REFERENCES:

f) Feasibility Study of Wonj-Shoa Sugar factory Expansion Project, Final Feasibility Study Report Document submitted in October 2001.
g) Energy Policy of The Transitional Government Of Ethiopia, 1994
h) Federal Negarit Gazeta of the Federal Democratic Republic of Ethiopia, 7th July 1997, Proclamation No. 86/1997, Electricity Production
i) Hand Book of Cane Sugar Engineering, Completely Revised Edition, 1986, Hugot

SUGAR CORPORATION OF UGANDA LTD, UGANDA

1. **PROJECT DESCRIPTION AND BACKGROUND**

A) Name of Industry :- Sugar Corporation of Uganda Limited
Location : - Mukono District - Lugazi Town Council - 28 miles from the Capital City of Uganda - Kampala
Industry : - Sugar and Alcohol manufacture

B) Capacity & Others :-
a) Area under Cane : 9800 Ha
b) Current Milling capacity: 2000 tons of cane per day
c) Alcohol production:
d) Joint veture between Uganda Govt. owning 26% and Mehta Group holding the rest.
e) The Company is ISO 9001:2000 certified and its product meets the Uganda National Standard.
f) Employs over 5000 persons on average on regular roll and the total number of Managers is 190. It is the largest private sector employer in the country.
g) Community support - If we add all persons fully dependant on income from the Company and their families, over 50,000 persons depend on the Company.

C) Production records :

Year	**Annual Cane Crushed (Tonnes)**	**Annual Sugar Production (Tonnes)**
2001	321,135	24,528
2002	465,189	32,786
2003	475,691	35,578
2004	572,790	46,819

The following is the expected performance:

Year	Annual Cane Crushed	Annual Sugar Production
2006	560,000	47,900
2007	750,000	63,000
2008	800,000	68,000

2. **RESOURCE ASSESSMENT**

A) Estimated production of Bagasse -

Year	**Annual Bagasse Production (Tones)**
2001	128,454
2002	176,768
2003	191,996
2004	243,999

B) Description of the past & future trends of Bagasse production

These have been generally increasing as the crushing capacities increase. The variations are mainly due to the varying qualities of cane which is due to the climatic conditions of the areas which in turn affects the fiber in the cane. (see 2001 fiber figures). The future trends are as follows:-

Year	Annual Production (expected)
2006	224,000
2007	300,000
2008	320,000

C) ESTIMATION OF ENERGY POTENTIAL

The Net Calorific Value of Bagasse is 8033 kj/kg.

Year	**Tones bagasse**	**Energy kj (000,000)**
2006	224,000	1800
2007	300,000	2410
2008	320,000	2570

There are no costs in using this bagasse as it is a by product from the manufacturing process of sugar. The handling costs are negligible.

In the past the company faced a serious liquidity problem as nearly all assets were mortgaged to senior lenders after the company was restarted (after the Idi Amin era), so it could not borrow any funds.
Up to now all the senior lenders have been paid.
Operations of this Company have improved over the years as the output has nearly doubled (27800 tons during the year 2001 to 45000 tons for the year 2004). The Company has added a new boiler of 30 tons capacity in addition to the two boilers in order to increase the steam production. The company is in a good position to venture into a co-generation project.

3. ENERGY REQUIREMENT

A) The general electricity requirement for the sugar Factory is 3.00MW (calculated on peak crushing).

The daily load consumption :- 64 MW
The monthly load consumption :- 1914 MW
The Annual load consumption :- 574200 MW

B) Sources of steam

There are 3 boilers each of 30kg/sq.cm pressure and 32 tones/hr steam generation. Since one of the boilers is now inefficient and beyond economical repair, there are plans to install another boiler of 32kg/sq.cm capacity producing 60 tones of steam.
There is not sufficient information to assess the steam requirement pattern as well as the cost of steam.

Below are the boilers in place:-

Boiler No.	Year of Manufacture	Boiler capacity (T/hr)	Operating pressure	Operating condition
1.	1988	32	32	Beyond economic repair
2.	1988	32	32	Was overhauled and is operational
3.	1995	32	32	Same as 2 above
4.	**Proposed**	**60**	**32**	**New to be procured**

C) The cost of electricity per unit from the Grid is Ush 98.43 per kWh
The first 2000 kVA costs Ush 3300 per kVA
Above 2000kVA costs Ush 3000 per kVA

D) The average electricity requirement per month is 2,234,000 kWh (4700 kVA)

E) Current status :
There is a 2.5MW turbo alternator which is being refurbished and is expected to be operational by December 2005. There is a proposal to acquire a new turbo alternator of 6MW capacity for the cogeneration project.

4. TECHNICAL ASSESMENT

With the above data in mind, SCOUL has now repaired the old 2.8MW Turbo Alternator of 1954 model and the plan is to introduce one 6MW machine to cater for the sugar plant, molasses distillation plant as well as to supply power to the surrounding villages.
The Bagasse is enough to produce power for over 300 days every year. The Company's estate and Out growers are able to produce over 500,000 tons of cane per year. This figure is expected to go up to 1 million tons in the next 4 years. There is thus a good source of energy for power generation.

The expected sugar cane production activity in the coming years is as follows:

Year	**2005**	**2006**	**2007**	**2008**
Estate	450,000	525,000	575,000	675,000
Out Growers	250,000	250,000	275,000	300,000
Total (gross)	700,000	775,000	825,000	975,000
Total (Net)	**665,000**	**736,000**	**783,000**	**926,000**

A) The Combined Heat and Power Cycle using the Rankine cycle is currently in place for steam generation. (see diagram No. 1 Appendix). This involves heating pressurized water, with the resulting steam expanding to drive a turbine-generator and then the waste heat is used for industrial purposes and then condensed back to water for partial or full recycling to the boiler.

B) The best options available for a cogeneration project in this industry is that of using high pressure boilers, but this requires a high degree of operating skills and automation which may be expensive, bearing in mind that hydro electricity is a cheap source of electricity in the country. Also the following is proposed in order to increase the milling capacity (see diagram no 2 a & b)

- Commissioning the sling bar crane to offload more cane

- introducing the fiberizor for better cane preparation
- widening the cane carriers to increase the conveying capacity
- introducing rake elevators for positive feeding to mills
- rehabilitating the boilers for a trouble free operation of the plant
- installing a new clarifier to cope with the increased milling
- introducing super heated wash water to maintain the quality of sugar
- a 6 MW Power turbine to increase the power demand
- 1kg packaging machine to meet the demand of the customers
- Hyd/DC drives for mills to meet the steam balance

C) There are plans to generate 6.65 MW through cogeneration and this is expected to cost US$ 10.75 Million.
D) A capacity of 6.65 MW has been selected for the cogeneration project and is based on research on the existing plant capacities, available cane and bagasse. A steam and power balance has been done.
E) Specifications of major equipment (see app. No.2)
F) Bagasse required will be 1025 tones based on the proposed generation for 18 hrs per day taking into account load during peak and off peak hours.

Table 1 (Appendix) demonstrates the whole picture

5. ECONOMIC AND FINANCIAL ASSESSMENT OF CO-GENERATION

The project is viable with an expected payback period of only 4.33 years, considering that it is a basic infrastructure development project. The returns on investments are thus good.

The Project envisages generation of Power and distribution for the plant and villages around.
Nearly one MW of power will be distributed to 14 villages around the estate and this will benefit about 10,000 people in the following ways:

1. Provision of light points for each house.
2. Pumps for water distribution from nearby protected points.
3. Facilities for the nearby medical treatment points.
4. Street lighting.

Some of the facilities will be free of cost to the residents or subsidized to maintain consumption discipline. It is expected that communication and awareness (radios & televisions) will improve as well as education for those who will no longer have to go to towns for such facilities. In all the quality of life will improve

A) Cost of Co-generation technology and improvements (Estimates)

Capital expenditure US$ 10.43 million
Development Costs US$ 0.31 million
Operation & Maintenance US$ 1.19 million

B) Comparative cost of electricity generated from the Grid (Hydro) and Bagasse

Bagasse US Cents 4.3
Grid US Cents 5.3

C) Sources and amount of revenue in cogeneration

5. The Company intends to supply power to the Grid
6. It also intends to supply power to the surrounding areas where power is not accessible. The study on this is nearing completion.

D) Economic assessment of the co-generation option

SCOUL has considered a grant of US$ 5.00 million at an interest rate of 5% . Based on the above figures :-
NPV = US$ 2.442 million
IRR = 13.7%
Any changes in the grants and interest rates may affect the viability of the project.

E) Current Tariff structure
Eskom currently pays a generation capacity fee of Ushs. 12,056
The current transmission rates are :
Ushs81.5 per kWh at peak
Ushs 60.4 per kWh at the shoulder
Ushs 33.0 per kWh at off peak

6. FINANCING OPTIONS ASSESSMENT

A) SCOUL expects the following :-

- Grant: - US$ 5.00 million
- Internal Generation : - US$ 1.300 million
- Loan Finance : - US$ 4.435 million

B) Financing options :-

1. The Rural Electrification Agency (REA) for the Grant. Contacts have been made.
2. East African Development Bank _ for the loan
3. Terms and conditions for borrowing from Capital markets is being worked upon.

7. INFORMATION, TECHNICAL, FINANCIAL AND CAPACITY BUILDING SUPPORT NEEDS.

A) The preliminary Financial and Technical feasibility study has been completed and the Company is well prepared to take up the Project.

The Company is short of a trained work force to man this project effectively at the moment and may require training for :
1. Middle and lower management personnel to supervise the activities
2. Due to the expansion of the whole project, there is need for training in the administration, security and finance departments.

B) A grant is definitely required if the Project is to be viable as well as a separate consultant to carry out design and advise on the detailed engineering aspects.

GUNIED SUGAR FACTORY, SUDAN

1.0 PREAMBLE

The present situation of Sugar Industry worldwide is very volatile, with high sugar stocks and low sugar prices. The sugar price is lower than what it was ten years back, whereas the price of sugar cane has steadily increased. This situation has forced the sugar industry to operate with thinner profit margins. There is an urgent need to plan long-term strategies for survival of sugar industry, by exploiting by-product potential. Major by-products are molasses and bagasse. Molasses is used for production of ethanol and other products. Bagasse is used either as fuel for surplus power generation or raw material to paper industry. This kind of value addition to by-products will give much-needed additional revenue earnings for improved viability of sugar estates.

Co-generation of power is not new to cane sugar industry. Every cane sugar factory utilises bagasse for the purpose of generating steam with an objective of producing power and also utilises exhaust steam in the sugar making process. This type of power generation is called co-generation of power.

In the past, most of the sugar factories had been designed on balancing the bagasse consumption to the bagasse production, so as to minimise bagasse disposal costs. The steam requirement was in the range of 60 to 65 % on cane. Nowadays the trend has changed to optimise the energy consumption in the sugar factory so as to create sizable surplus bagasse for additional power generation for export.

Bagasse based co-generation plants are not only eco friendly but also have added advantages of relatively low capital cost as well as short gestation period. With the continuous depletion of fossil fuels, growing population pressures and renewed concern for environment, co-generation in sugar industry has become one of the most convenient and environment friendly way of generating electricity. The world over, co-generation has been recognised as a reliable way of producing additional electricity.

Fully aware of the benefits of the co-generation to the factory as well as to the country, Guneid Sugar factory management intends to use this surplus bagasse by setting up co-generation plant to produce surplus power.

2.0 CURRENT STATUS AT GUNEID SUGAR FACTORY

During the year 2002-03, Guneid Sugar Factory had processed about 825,000 tons of sugarcane and produced about 81,600 tons of very high pol (VHP) raw sugar for domestic consumption. Factory has undertaken extensive cane development programme to increase the area under cane cultivation which would result in increased cane availability to about 1,000,000 tons.

At present, for sugarcane crushing of about 825,000 tons, the factory has surplus bagasse of about 100,000 tons every year, which has no local market and hence no economic value. The surplus bagasse is not only costing lot of money for stock piling during season, fire protection etc, but also creating lot of concern on environmental protection. In order to mitigate this problem, factory has started generating electricity even during off-crop period by operating existing boilers and turbo-alternators (back pressure type). The exhaust steam is condensed at evaporators. This is not an efficient way of generating power, but factory is able to burn out surplus bagasse.

Hence, it is considered beneficial to have a co-generation power project at Guneid Sugar Factory, in order to have a financially productive use for the surplus bagasse produced. This will not only eliminate problems associated with bagasse disposal but also improve the overall profitability of Sugar Factory by exporting power to NEC grid after meeting the power demand of factory and also irrigation pump stations.

3.0 SUGAR FACTORY OPTIMISATION AT 200 TCH

At present factory steam demand is around 40 % on cane. This is due to low imbibition at mills and the factory steam demand will increase to about 45 % on cane when the imbibition at mills is increase to 220 %

fibre. At present, exhaust steam generated from the steam driven prime movers is slightly more than process steam demand. Hence it is essential to reduce exhaust steam generation to optimise process steam balance.

For improvement of overall thermo-dynamic efficiency and steam economy of the plant with existing boilers, it would be beneficial to consider phase wise replacement of single stage steam turbines driving mills with suitable electric drives.

Several technical options are available to lower specific energy consumption of sugar production while allowing better utilisation of bagasse as a fuel. Based on their viability, measures to lower steam demand of GSC are recommended in this report, to maximise bagasse savings, thus increase potential for power generation and export. Important measures include :

a) a)Improvement in cane preparation index with installation of fibrizor, thus improved quality of bagasse as fuel

b) b)Improved steam distribution system to reduce pressure drop between generation and consuming points and even load sharing of boilers for improved performance.

c) c)Measures on feed water management and control for improved performance and reliability of steam generation plant.

The budgetary cost of sugar factory optimisation is about US $ 3.76 million. The benefit of these optimisation measures is estimated to be about 0.783 million per annum (for 9,00,000 tons cane crushed per year) in addition to efficient consumption of bagasse.

4.0 BAGASSE AVAILABILTY

With the projected increase in sugar cane, the surplus bagasse is expected to increase to around 110,000 tons.

5.0 CO-GENERATION SCHEME

Co-generation scheme with various options have been evaluated from a detailed analysis of the requirement of sugar factory in respect of its expected operating characteristic, bagasse availability and energy demand for the plant capacity at 200 tch.

Out of four existing boilers of 25 tph capacity, three will be in operation and generate about 69 tph steam to meet steam demand of mill driven steam turbines and one turbo-alternator of 3.0 MW. Process steam demand will be about 92 tph. Steam generation from the new high pressure boiler will be about 60 tph. Exhaust steam requirement, after utilizing the steam from existing boilers shall be extracted from the condensing extraction turbine as per process steam demand.

During the intermediate stage, when all the existing steam driven mill drives are replaced with electrical drives, two or three out of existing four boilers will be in operation to meet steam demand of existing both turbo-alternators of about 57 tph and remaining shall be extracted from condensing extraction turbine from the co-generation plant.

At the final stage, when factory is expanded to 250 tch, all the existing boilers will be phased out and new 85 tph high pressure boiler similar to the one installed at the initial stage will be in operation.

Initially two existing turbo-alternators, 3.0 MW back pressure type will be in operation to meet factory power requirement and new 14.0 MW DEC set will be installed for power export. During the intermediate stage, both the existing 3.0 MW turbo-alternators along with 14.0 MW DEC set will be in operation. At the final stage, one more 14.0 MW similar to the existing DEC set will be installed and all the existing back pressure type turbo-alternators will be phased out.

New DEC type turbo-alternator will be in operation in extraction and condensing mode. Total steam requirement for process including de-aerator (at 1.7 kg/cm^2 (g) is estimated at an average 100 tph at saturated condition). Fluctuations in process steam demand after installation of the recommended stabilisation controls should reduce to ± 2.5 % on cane. Hence, whatever configuration is selected for the new turbo-alternator, the additional process steam demand (after utilising existing prime mover exhaust) will have to be met by extraction steam from the new turbo-alternator. While the factory operates in parallel with the grid, no process steam will be supplied through the pressure reducing valve.

Process steam at 3.0 kg/cm^2 (g) for sugar drying etc will be extracted from new turbo-alternator at 7 kg/cm^2 (g). As the extraction at pressure 3.0 kg/cm^2 (g) for process is not practicable, extraction at 7 kg/cm^2 (g) is considered. After deducting allowance for pressure loss, the pressure at consumer points is expected to be around 4 to 5 kg/cm^2 (g). In case required, this can be throttled and supplied at 3.0 kg/cm^2 (g).

The existing PRDS station will be operated during season only in case new DEC type turbo-alternator is out of operation. In order to supply steam from new boiler to existing steam distribution system, one PRDS station of 50 tph capacity, to reduce HP steam from 45 kg/cm^2 to 21 kg/cm^2, 370^0 C is considered.

During off-season, only new high pressure boiler will be in operation. New DEC type turbo-alternator will be in operation in extraction and condensing mode. The extraction steam quantity will only be limited to the requirement of de-aerator at 1.7 kg/cm^2 (g), to heat feed water to 103 ^{0}C. No steam is required at 7.0 kg/cm^2 (g). All the remaining quantity of steam supplied to turbo-alternator will be condensed and returned back to boiler.

6.0 EVALUATION OF CO-GENERATION SCHEME

Various options are evolved and assessed based on process steam consumption and maximum surplus bagasse available for generating co-generation electric power for the duration of 300 days i.e. usage of bagasse is spread over 300 days. Accordingly the size of turbo-alternator is considered for each option of different proposals.

After detailed analysis of all the options, recommendation of co-generation scheme for Phase-I and Phase-II shall be as follows.

7.0 CONFIGURATION OF CO-GENERATION POWER PROJECT

The major plant machinery and equipment of selected co-generation power plant include :

a) Addition of two new boilers, each of 85 t/hr capacity with steam condition 45 kg/cm^2 (g) and temperature 510^0 C. One boiler in Phase-I and another one in Phase-II.

b) Addition of two new Double extraction and condensing type turbo-alternator matching above boiler conditions each of 14 MWe capacity. One TA set in Phase-I and another TA set in Phase-II.

c) New boiler and power house building with EOT crane.

d) Cooling tower.

e) Water treatment plant.

f) Modification to HP steam piping in the plant.

g) Electrical system for power export and distribution.

h) Environmental aspects and pollution control measures such as particle emission controls from the gasses and Effluent treatment plant.

8.0 BAGASSE HANDLING SYSTEM

Bagasse handling system proposed utilises existing bagasse handling carriers. The system recommended also provides open storage yard and reclaim facility to operate co-generation plant during off-season.

The Summary of budgetary cost estimates for bagasse handling system is given below.

Proposal I	Cost US $ x 1000	5315.00
Proposal II	Cost US $ x 1000	5424.00

9.0 QUANTIFICATION OF POWER GENERATION AND EXPORT

Cane crushing rate	tch	200
Total cane crushed	t/year	9,07,200
Bagasse % cane		39.03
Bagasse produced per year	tons	3,54,000
Sugar factory operation	days	210
Co-generation power plant operation	per annum	300
Sugar factory time efficiency	percent	90
Co-generation plant time efficiency	percent	92
Factory steam generation - During season - During off-season	 t/h t/h	 127.00 51.00
Power generation during season from : - Existing 3.0 x 2 MW TA set - New co-generation turbo-alternator	 MW MW	 5.00 13.46
Power generation during off-season from : - Existing 3.0 x 2 MW TA set - New co-generation turbo-alternator	 MW MW	 --- 12.67
Power export - During season - During off-season - Total units exported	 MW MW MWh	 10.53 10.53 72415

10.0 BUDGETARY COST ESTIMATES

Summary of budgetary cost for the proposed co-generation plant and sugar factory optimisation is given below.

Sr. No.	Description	Cost in US $ x 1000
1)	Sugar factory optimisation cost	3762.00
2)	Co-generation plant	16841.00
3)	Bagasse handling	5424.00

10.1 The above cost estimates covers all the costs of equipment including transport to site, installation of mechanical, electrical and civil works. It may be noted that no provision is made for any escalation in the above estimates, as the project is expected to be implemented in the nearest future.

10.2 Provision of 5 % on the FOB cost of the equipment has been considered towards contingencies.

10.3 The total project cost is arrived after adding other costs such as pre-operating costs, capitalization of interest, etc. The estimates of these expenses are given below.

10.4 The total project costs required for cogeneration project for phase-I and phase-II are considered for financial analysis and is given below

Sl. No	**Description**	**Phase-I (US$x1000)**	**Phase-II (US$x1000)**	**Total (US$x1000)**
1	Plant and Machinery for cogeneration plant (Installed cost)	16,841.00	13,636.00	30477.00
2	Bagasse handling system (Installed cost)	5424.00	-	5424.00
3	Pre-operative expenses capitalised	172.00	172.00	344.00
4	Pre-operative interest capitalised	2031.53	1242.72	3274.25
5	Margin money for working capital	135.52	-	135.52
6	**Total project cost (Say)**	**24604.00**	**15051.00**	**39655.00**

11.0 FINANCIAL ANALYSIS

The key important financial ratios as calculated for the project completed in both phases are summarized below.

Particulars	
Debt Service Coverage Ratio (DSCR)	2.06
Average Break Even Point	43.37 %
Internal Rate of Return (IRR)	15.71 %
Composite cost of capital	5.45 %
Pay back period	5.37 years
Average ROI	57.86 %
Debt equity ratio	1.80

11.1 Comments

Based on the above findings, following observations can be made.

- Low Break Even Point (43.37 % as against 100 % where contribution is just enough to cover the fixed costs, with no profit no loss situation)

- Ideal Debt Service Coverage Ratio, DSCR (2.06 as against 1.5 to 2.5 generally expected by the bankers or Financial Institution, indicating the capacity of the borrower to meet the obligations of long term borrowing)

- Favourable Internal Rate of Return (15.71 % as against cost of capital available at 5.45 %)

- Ideal Debt Equity Ratio (1.8 as against 2.0 generally expected by the creditors indicating the cushion available on liquidation of the organization)

11.2 Sensitivity Analysis in case of Variation in Power Tariff

Sensitivity of financial indicators is worked out for co-generation project based on selling price of US $ 56.0 (80 % of base price) and US $ 63.0 (90 % of base price). Base price considered is US $ 70.00. The summary is given below.

Power tariff per MWh	IRR %	DSCR	BEP %	Payback period	D/E Ratio
US $ 56.0	10.02	1.63	54.20	6.76	2.66
US $ 63.0	12.92	1.84	48.18	6.00	2.15
US $ 70.0	15.71	2.06	43.37	5.37	1.80

12.0 FINANCIAL ANALYSIS EXCLUDING THE COST OF REPLACMENT OF EXISTING BOILERS AND POWER PLANT

In the above financial analysis, the total cost of steam generation plant and power plant is considered. The present condition of existing boilers and turbo-alternators is not good and have already outlived their life and are due to major rehabilitation/replacement at the earliest opportunity. This is an essential requirement to revitalise overall sugar factory operations.

The cost of replacement of existing boilers and turbo alternators is estimated as given below.

Sr. No	*Description*	*Installed cost in US $ x 1000*
1	***4 boilers, 20 kg/cm^2, 370^0 C, 25 t/hr capacity***	***4000.00***
2	***2 Turbo alternators, each 3 MW***	***1000.00***
	Total	*5000.00*

Financial analysis is worked out by deducting the above cost of US$ 5.0 million from the cogeneration project and the revised cost estimates and findings of key financial indicators with sensitivity analysis is presented below.

12.1 Revised Budgetary Cost Estimates

Sr. No	Description	Phase-I (US$x1000)	Phase-II (US$x1000)	Total (US$x1000)
1	Plant and Machinery for cogeneration plant (Installed cost) less: replacement cost	16,841.00 0.0	13,636.00 - 5000.00	25477.00
2	Bagasse handling system (Installed cost)	5424.00	0.00	5424.00
3	Pre-operative expenses capitalised	172.00	172.00	344.00
4	Pre-operative interest capitalised	2031.53	792.72	2824.25
5	Margin money for working capital	135.52	-	135.52
6	**Total project cost (Say)**	**24604.00**	**9601.00**	**34205.00**

12.2 Key Financial Indicators

Particulars	
Debt Service Coverage Ratio (DSCR)	2.56
Average Break Even Point	40.08 %

Internal Rate of Return (IRR)	19.56 %
Composite cost of capital	5.45 %
Pay back period	4.68 years
Average ROI	70.37 %
Debt equity ratio	1.63

12.3 Sensitive Analysis

Power tariff per MWh	**IRR %**	**DSCR**	**BEP %**	**Payback period**	**D/E Ratio**
US $ 56.0	13.32	2.03	50.09	5.89	2.35
US $ 63.0	16.49	2.30	44.53	5.22	1.92
US $ 70.0	19.56	2.56	40.08	4.68	2.56

13.0 **CONCLUSION**

Based on the key financial ratios, the project is not only viable but also attractive.

Also it may be noted that co-generation power plant improves overall viability of sugar estate because of productive use of surplus bagasse available with the sugar factory.

Considering the minimum life of cogeneration plant of about 25 years, the pay back period mentioned above is acceptable.

SENNAR SUGAR FACTORY, SUDAN

1.0 PREAMBLE

The present situation of Sugar Industry worldwide is very volatile, with high sugar stocks and low sugar prices. The sugar price is lower than what it was ten years back, whereas the price of sugar cane has steadily increased. This situation has forced the sugar industry to operate with thinner profit margins. There is an urgent need to plan long-term strategies for survival of sugar industry, by exploiting by-product potential. Major by-products are molasses and bagasse. Molasses is used for production of ethanol and other products. Bagasse is used either as fuel for surplus power generation or raw material to paper industry. This way of value addition to by-products will give much-needed additional revenue earnings for improved viability of sugar estates.

Co-generation of power is not new to cane sugar industry. Every cane sugar factory utilises bagasse for the purpose of generating steam with an objective of producing power and also utilises exhaust steam in the sugar making process. This type of power generation is called co-generation of power.

In the past, most of the sugar factories had been designed on balancing the bagasse consumption to the bagasse production, so as to minimise bagasse disposal costs. The steam requirement was in the range of 60 to 65 % on cane. Nowadays the trend has changed to optimise the energy consumption in the sugar factory so as to create sizable surplus bagasse for additional power generation for export.

Bagasse based co-generation plants are not only eco friendly but also have added advantages of relatively low capital cost as well as short gestation period. With the continuous depletion of fossil fuels, growing population pressures and renewed concern for environment, co-generation in sugar industry has become one of the most convenient and environment friendly way of generating electricity. The world over, co-generation has been recognised as a reliable way of producing additional electricity.

Fully aware of the benefits of the co-generation to the factory as well as to the country, Sennar Sugar factory management intends to use this surplus bagasse by setting up co-generation plant to produce surplus power.

2.0 CURRENT STATUS AT SENNAR SUGAR FACTORY

During the year 2002-03, Sennar Sugar Factory had processed about 880,000 tons of sugarcane and produced about 83,400 tons of very high pol (VHP) raw sugar for domestic consumption. Factory has undertaken extensive cane development activities to increase the cane availability. It is planned that the cane availability will be improved to 1,100,000 tons during the year 2004-05 and subsequently up to 1,400,000 tons.

At present, for sugarcane crushing of about 880,000 tons, the factory has surplus bagasse of about 90,000 tons every year, which has no local market and hence no economic value. However, factory is using this bagasse to produce about 3 to 4 MW of power during off-season for about 60 days, with the existing boilers and back pressure type turbo-alternators. The back pressure steam is condensed with the help of existing evaporator set. This is only an interim arrangement to dispose of stock pilled bagasse in the storage yard and is not a economically feasible solution.

Hence, it is considered beneficial to have a co-generation power project at Sennar Sugar Factory, in order to have a financially productive use for the surplus bagasse produced. This will not only eliminate problems associated with bagasse disposal but also improve the overall profitability of Sugar Factory by exporting power to NEC grid after meeting the power demand of factory.

3.0 SUGAR FACTORY OPTIMISATION AT 290 TCH

Several technical options are available to lower specific energy consumption of sugar production while allowing better utilisation of bagasse as a fuel. Based on their viability, measures to lower steam

demand of SSF are recommended in this report, to maximise bagasse savings, thus increase potential for power generation and export. Important measures include :

a. Improvement in cane preparation index with installation of fibrizor, thus improved quality of bagasse as fuel

b. Adoption of extensive vapour bleeding scheme at evaporators to reduce process steam demand. This is being implemented in the current off-season.

c. Waste heat recovery measures such as installation of economisers at boilers.

d. Improved steam distribution system to reduce pressure drop between generation and consuming points and even load sharing of boilers for improved performance.

e. Measures on feed water management and control for improved performance and reliability of steam generation plant.

The budgetary cost of sugar factory optimisation is about US $ 2.219 million. The benefit of these optimisation measures is estimated to be about 1.0 million per annum (for 1,242,360 tons cane crushed per year) in addition to increased saving of bagasse by about 50 %.

4.0 BAGASSE AVAILABILTY

With the projected increase in sugar cane, the surplus bagasse is expected to increase to around 115,000 tons. The bagasse savings can further be improved to 180,000 tons per year with implementation of some energy economy measures.

5.0 CO-GENERATION SCHEME

Following two major co-generation schemes are evolved from a detailed analysis of the requirement of sugar factory in respect of its expected operating characteristic, bagasse availability and energy demand depending upon the extent of implementation of measures recommended for optimisation of plant at 290 tch.

5.1 Alternative I

Install one DEC turbo-alternator operating with steam condition 23 kg/cm^2 (g); 360 ^{0}C and extraction at pressures at 7.0 kg/cm^2 (g) and 1.7 kg/cm^2 (g) and condensing to 0.1 kg/cm^2 (absolute). The extraction quantities at various pressure levels shall be to the extent required for factory process. This would allow following modes of operation.

During season, operate DEC type turbo-alternator for power supply to irrigation requirement and one 6.5 MW back pressure turbo-alternator exclusively to meet factory power demand. The extraction steam quantity at various pressure levels will be supplied to factory process house as per requirement (or) through existing PRDS whenever co-generation plant is not in operation.

During off-season, operate one of the existing boiler to supply steam to DEC type turbo alternator. The extraction steam supply will be for de-aerator only.

In this case factory can retain one of the 6.5 MW turbo-alternator as standby unit. Also an added advantage is that the process house steam requirement at 3.0 kg/cm^2 (g) and 1.7 kg/cm^2 (g) is extracted from DEC type turbo set which would otherwise have taken from pressure reducing and de-superheating station. Thus it will improve the power generation potential.

Sugar factory operations can be made independent of co-generation plant.

5.2 Alternative II

Install one new boiler operating with high pressure and temperature.

Install one new condensing extraction turbo-alternator, with steam condition matching with new boiler.

This would allow following modes of operation.

One new boiler and new turbo-alternator will be in operation during season as well as during off-season and supply power for captive consumption and surplus to State Grid.

Factory can draw process steam at various pressure levels during season (or) through existing PRDS whenever co-generation plant is not in operation.

Sugar factory operations can be made independent of co-generation plant.

Existing steam generation plant at Sennar is having 5 boilers, each of 58 t/h MCR capacity. Maximum 4 boilers will be in operation to meet steam demand of both sugar factory and co-generation power plant during season and one boiler still remain as standby. Hence, for 290 tch capacity, there is no need for installation of new boiler. Addition of new high pressure boiler even though gives higher surplus power but requires higher initial investment.

6.0 EVALUATION OF CO-GENERATION SCHEME

Various proposals are evolved and assessed based on process steam consumption and maximum surplus bagasse available for generating co-generation electric power for the duration of 300 days i.e. usage of bagasse is spread over 300 days. Accordingly the size of turbo-alternator is considered for each option of different proposals.

Out of 14 options evaluated and assessed for both alternatives, recommendation for co-generation scheme would be as follows. This has been selected considering future optimisation measures being planned for sugar factory.

7.0 CONFIGURATION OF CO-GENERATION POWER PROJECT

The major plant machinery and equipment of selected co-generation power plant include :

a. Double extraction and condensing type turbo-alternator, 13 MWe.

b. Extension to power house building with EOT crane.

c. Cooling tower.

d. Water treatment plant.

e. Modification to HP steam piping in the plant.

f. Electrical system for power export and distribution.

8.0 MODE OF OPERATION OF PROPOSED CO-GENERATION PLANT

8.1 Mode of operation during season

Four out of five existing boilers will be in operation to meet steam demand of about 190 t/h of sugar factory and co-generation plant.

One of the two existing turbo-alternators, 6.5 MW back pressure type will be in operation to meet factory power requirement of about 6.24 MW.

New DEC type turbo-alternator will be in operation in extraction and condensing mode. Total steam requirement for process including de-aerator (both at 1.7 kg/cm^2 (g) and 0.9 kg/cm^2 (g) is estimated at an average 150 t/h at saturated condition. Fluctuations in process steam demand after installation of the recommended stabilisation controls should reduce to ± 2.5 % on cane. Hence, whatever configuration is selected for the new turbo-alternator, the additional process steam demand (after utilising existing prime mover exhaust) will have to be met by extraction steam from the new turbo-alternator. While the factory operates in parallel with the grid, no process steam will be supplied through the pressure reducing valve.

Process steam at 3.0 kg/cm^2 (g) for sugar drying etc will be extracted from new turbo-alternator at 7 kg/cm^2 (g). As the extraction at pressure 1.7 kg/cm^2 (g) and 3.0 kg/cm^2 (g) is not practicable, extraction at 7 kg/cm^2 (g) is considered. After deducting allowance for pressure loss, the pressure at consumer points is expected to be around 4 to 5 kg/cm^2 (g). In case required, this can be throttled and supplied at 3.0 kg/cm^2 (g).

The existing PRDS station will be operated during season only in case new DEC type turbo-alternator is out of operation.

8.2 Mode of operation during off-season

One of the five existing boilers will be in operation. New DEC type turbo-alternator will be in operation in extraction and condensing mode. The extraction steam quantity will only be limited to the requirement of de-aerator, to heat feed water to 103 ^{0}C. All the remaining quantity of steam supplied to turbo-alternator will be condensed and returned back to boiler.

9.0 BAGASSE HANDLING SYSTEM

Bagasse handling system proposed utilises existing bagasse handling carriers and existing storage shed. The system recommended also provides open storage yard and reclaim facility to operate co-generation plant during off-season.

At present factory is having huge stockpile of bagasse in the proposed location of open storage area. In order to install proposed system, clearing of bagasse from this area is to be carried out. This is time consuming activity and also an expensive operation. It may be noted that the cost of site clearing is not considered in the budgetary costs. Most practical and economical way is to plan bagasse handling system in phase wise manner i.e. consider bare minimum requirement at initial stage with a provision for gradual expansion to final phase depending on availability of funds.

The Summary of budgetary cost of bagasse handling system is given below.

Phase I	Cost US $	4.127 million
Phase II	Cost US $	2.747 million
Total cost of bagasse handling	Cost US $	**6.873 million**

10.0 QUANTIFICATION OF POWER GENERATION AND EXPORT

Cane crushing rate	tch	290
Total cane crushed	t/year	1,242,360
Bagasse % cane		39.09
Bagasse produced per year	tons	485,638
Sugar factory operation	days	210
Co-generation power plant operation	per annum	300
Sugar factory time efficiency	percent	85
Co-generation plant time efficiency	percent	90
Factory steam generation		
- During season	t/h	188.23
- During off-season	t/h	64.66
Power generation during season from :		
- Existing 6.5 MW TA set	MW	6.24
- New co-generation turbo-alternator	MW	10.66
Power generation during off-season from :		
- Existing 6.5 MW TA set	MW	---
- New co-generation turbo-alternator	MW	12.64
Power export		
- During season	MW	10.72
- During off-season	MW	10.72
- Total units exported	MWh	64342

11.0 BUDGETARY COST ESTIMATES

Summary of budgetary cost for the proposed co-generation plant and sugar factory optimisation is given below.

Sr. No.	Description	Cost in US $ x 1000
1)	Sugar factory optimisation cost	2219.00
2)	Co-generation plant	11107.00
3)	Bagasse handling	6872.00

11.1 The above cost estimates covers all the costs of equipment including transport to site, installation of mechanical, electrical and civil works. It may be noted that no provision is made for any escalation in the above estimates, as the project is expected to be implemented in the nearest future.

11.2 Provision of 5 % on the FOB cost of the equipment has been considered towards contingencies.

11.3 The total project cost is arrived after adding other costs such as pre-operating costs, capitalization of interest, etc. The estimates of these expenses are given below.

11.4 The total project costs required for cogeneration project excluding sugar factory optimisation costs, are considered for financial analysis and is given below

Sl. No	Description	(US$x1000)
1	Plant and Machinery for cogeneration plant (Installed cost)	11,107.00
2	Bagasse handling system (Installed cost)	6873.00
3	Pre-operative expenses capitalised	172.00
4	Pre-operative interest capitalised	1648.17
5	Margin money for working capital	160.97
6	**Total project cost (Say)**	**19,961.00**

12.0 FINANCIAL ANALYSIS

The key important financial ratios as calculated for the project are summarized below.

Particulars	
Debt Service Coverage Ratio (DSCR)	2.12
Average Break Even Point	40.17 %
Internal Rate of Return (IRR)	25.02 %
Composite cost of capital	5.45 %
Pay back period	4.41 years
Average ROI	65.62 %
Debt equity ratio	1.22

12.1 COMMENTS

Based on the above findings, following observations can be made.

- Low Break Even Point (40.17 % as against 100 % where contribution is just enough to cover the fixed costs, with no profit no loss situation)

- Ideal Debt Service Coverage Ratio, DSCR (2.12 as against 1.5 to 2.5 generally expected by the bankers or Financial Institution, indicating the capacity of the borrower to meet the obligations of long term borrowing)

- Favourable Internal Rate of Return (25.02 % as against cost of capital available at 5.45 %)

- Ideal Debt Equity Ratio (1.22 as against 2.0 generally expected by the creditors indicating the cushion available on liquidation of the organization)

12.2 SENSITIVITY ANALYSIS IN CASE OF VARIATION IN POWER TARIFF

Sensitivity of financial indicators is worked out for co-generation project based on selling price of US $ 56.0 (80 % of base price) and US $ 63.0 (90 % of base price). Base price considered is US $ 70.00.

The summary is given below.

Power tariff per MWh	IRR %	DSCR	BEP %	Payback period	D/E Ratio
US $ 56.0	15.91	1.68	50.19	5.57	1.70
US $ 63.0	20.46	1.90	44.62	4.92	1.42
US $ 70.0	25.02	2.12	40.17	4.41	1.22

13.0 CONCLUSION

Based on the key financial ratios, the project is not only viable but also attractive.

Also it may be noted that co-generation power plant improves overall viability of sugar estate because of productive use of surplus bagasse available with the sugar factory.

Considering the minimum life of cogeneration plant of about 25 years, the pay back period mentioned above is acceptable.

NEW HALFA SUGAR FACTORY, SUDAN

1.0 PREAMBLE

The present situation of Sugar Industry worldwide is very volatile, with high sugar stocks and low sugar prices. The sugar price is lower than what it was ten years back, whereas the price of sugar cane has steadily increased. This situation has forced the sugar industry to operate with thinner profit margins. There is an urgent need to plan long-term strategies for survival of sugar industry, by exploiting by-product potential. Major by-products are molasses and bagasse. Molasses is used for production of ethanol and other products. Bagasse is used either as fuel for surplus power generation or raw material to paper industry. This kind of value addition to by-products will give much-needed additional revenue earnings for improved viability of sugar estates.

Co-generation of power is not new to cane sugar industry. Every cane sugar factory utilises bagasse for the purpose of generating steam with an objective of producing power and also utilises exhaust steam in the sugar making process. This type of power generation is called co-generation of power.

In the past, most of the sugar factories had been designed on balancing the bagasse consumption to the bagasse production, so as to minimise bagasse disposal costs. The steam requirement was in the range of 60 to 65 % on cane. Nowadays the trend has changed to optimise the energy consumption in the sugar factory so as to create sizable surplus bagasse for additional power generation for export.

Bagasse based co-generation plants are not only eco friendly but also have added advantages of relatively low capital cost as well as short gestation period. With the continuous depletion of fossil fuels, growing population pressures and renewed concern for environment, co-generation in sugar industry has become one of the most convenient and environment friendly way of generating electricity. The world over, co-generation has been recognised as a reliable way of producing additional electricity.

Fully aware of the benefits of the co-generation to the factory as well as to the country, New Halfa Sugar factory management intends to use this surplus bagasse by setting up co-generation plant to produce surplus power.

2.0 CURRENT STATUS AT NEW HALFA SUGAR FACTORY

During the year 2002-03, New Halfa Sugar Factory had processed about 835,000 tons of sugarcane and produced about 84,000 tons of very high pol (VHP) raw sugar for domestic consumption. Factory has undertaken extensive cane development programme to increase the area under cane cultivation, which would result in increased cane availability to about 1,000,000 tons.

At present, for sugarcane crushing of about 835,000 tons, the factory has surplus bagasse of about 107,000 tons every year, which has no local market and hence no economic value. The surplus bagasse is not only costing lot of money for stock piling during season, fire protection etc, but also creating lot of concern on environmental protection. In order to mitigate this problem, factory has started generating electricity even during off-crop period by operating existing boilers and turbo-alternators (back pressure type). The exhaust steam is condensed at evaporators. This is not an efficient way of generating power, but factory is able to burn out surplus bagasse.

Hence, it is considered beneficial to have a co-generation power project at New Halfa Sugar Factory, in order to have a financially productive use for the surplus bagasse produced. This will not only eliminate problems associated with bagasse disposal but also improve the overall profitability of Sugar Factory by exporting power to NEC grid after meeting the power demand of factory.

3.0 SUGAR FACTORY OPTIMISATION AT 230 TCH

At present factory steam demand is around 53 % on cane. The exhaust steam demand at NHSC is relatively high compared to other factories because of tail end refinery unit. At present, exhaust steam generated from the steam driven prime movers is less than process steam demand and on an average about 10 t/hr live steam is reduced and desuperheated to 1.5 kg/cm^2 (g) for process steam makeup. In order to process cane at the rate of 230 tch rate, with the existing configuration of evaporator set and vapour bleeding scheme, the average steam demand from boilers is estimated to be about 125 t/h. In order to meet this demand, all the five boilers shall be operated at 100 % load continuously which is most difficult situation. Hence, at present, factory is limiting its capacity to 200 tch and is producing raw sugar with tail end refinery unit. If factory plans to operate at 230 tch along with refinery unit, then it is essential to install additional evaporator bodies with modified vapour bleeding scheme so as to reduce overall steam demand so as to meet from the existing boilers.

For improvement of overall thermo-dynamic efficiency and steam economy of the plant with existing boilers, it would be beneficial to consider phase wise replacement of single stage steam turbines driving mills with suitable electric drives.

Several technical options are available to lower specific energy consumption of sugar production while allowing better utilisation of bagasse as a fuel. Based on their viability, measures to lower steam demand of NHSC are recommended in this report, to maximise bagasse savings, thus increase potential for power generation and export. Important measures include :

a. Improvement in cane preparation index with installation of fibrizor, thus improved quality of bagasse as fuel

b. Improved steam distribution system to reduce pressure drop between generation and consuming points and even load sharing of boilers for improved performance.

c. Measures on feed water management and control for improved performance and reliability of steam generation plant.

d. Additional heating surface area is provided at evaporator station and existing bleeding scheme is modified to reduce process steam consumption.

The budgetary cost of sugar factory optimisation is about US $ 5.94 million. The benefit of these optimisation measures is estimated to be about 0.913 million per annum (for 10,40,000 tons cane crushed per year) in addition to efficient consumption of bagasse and increased plant capacity.

4.0 BAGASSE AVAILABILTY

With the projected increase in sugar cane, the surplus bagasse is expected to increase to around 1,10,000 tons.

5.0 CO-GENERATION SCHEME

Co-generation scheme with various options have been evaluated from a detailed analysis of the requirement of sugar factory in respect of its expected operating characteristic, bagasse availability and energy demand for the plant capacity at 230 tch.

Out of five existing boilers each of 25 tph capacity, three or four boilers will be in operation and generate about 75 tph steam to meet steam demand of mill driven steam turbines and one turbo-alternator of 3.0 MW. Process steam demand will be about 123 tph. Steam generation from the new high pressure boiler of 85 tph capacity will be about 76 tph. Exhaust steam requirement, after utilizing the steam from existing boilers shall be extracted from the condensing extraction turbine as per process steam demand.

During the intermediate stage, when all the existing steam driven mill drives are replaced with electrical drives, two or three out of existing five boilers will be in operation to meet steam demand of existing both turbo-alternators of about 58 tph and remaining shall be extracted from condensing extraction turbine from the co-generation plant.

At the final stage, when factory is expanded to 250 tch, all the existing boilers will be phased out and new 85 tph high pressure boiler similar to the one installed at the initial stage will be in operation.

Initially two existing turbo-alternators, 3.0 MW back pressure type will be in operation to meet factory power requirement and new 15.0 MW DEC set will be installed for power export. During the intermediate stage, both the existing 3.0 MW turbo-alternators along with 15.0 MW DEC set will be in operation. At the final stage, one more 15.0 MW similar to the existing DEC set will be installed and all the existing back pressure type turbo-alternators will be phased out.

New DEC type turbo-alternator will be in operation in extraction and condensing mode. Total steam requirement for process including de-aerator (at 1.7 kg/cm^2 (g) is estimated at an average 123 tph at saturated condition). Fluctuations in process steam demand after installation of the recommended stabilisation controls should reduce to $\pm$ 2.5 % on cane. Hence, whatever configuration is selected for the new turbo-alternator, the additional process steam demand (after utilising existing prime mover exhaust) will have to be met by extraction steam from the new turbo-alternator. While the factory operates in parallel with the grid, no process steam will be supplied through the pressure reducing valve.

Process steam at 3.0 kg/cm^2 (g) for sugar drying etc will be extracted from new turbo-alternator at 7 kg/cm^2 (g). As the extraction at pressure 3.0 kg/cm^2 (g) for process is not practicable, extraction at 7 kg/cm^2 (g) is considered. After deducting allowance for pressure loss, the pressure at consumer points is expected to be around 4 to 5 kg/cm^2 (g). In case required, this can be throttled and supplied at 3.0 kg/cm^2 (g).

The existing PRDS station will be operated during season only in case new DEC type turbo-alternator is out of operation. In order to supply steam from new boiler to existing steam distribution system, one PRDS station of 50 tph capacity, to reduce HP steam from 45 kg/cm^2 to 21 kg/cm^2, 370^0 C is considered.

During off-season, only new high pressure boiler will be in operation. New DEC type turbo-alternator will be in operation in extraction and condensing mode. The extraction steam quantity will only be limited to the requirement of de-aerator at 1.7 kg/cm^2 (g), to heat feed water to 103 ^{0}C. No steam is required at 7.0 kg/cm^2 (g). All the remaining quantity of steam supplied to turbo-alternator will be condensed and returned back to boiler.

6.0 EVALUATION OF CO-GENERATION SCHEME

Various options are evolved and assessed based on process steam consumption and maximum surplus bagasse available for generating co-generation electric power for the duration of 300 days i.e. usage of bagasse is spread over 300 days. Accordingly the size of turbo-alternator is considered for each option of different proposals.

After detailed analysis of all the options, recommendation of co-generation scheme for phase-I and phase-II will be as follows.

7.0 CONFIGURATION OF CO-GENERATION POWER PROJECT

The major plant machinery and equipment of selected co-generation power plant include:

a) Addition of two new 85 t/hr boilers steam condition with pressure 45 kg/cm^2 (g) and temperature 510^0 C at SH outlet. One boiler in phase-I and another in phase-II.

b) Addition of two new Double extraction and condensing type turbo-alternator matching above boiler conditions, 15 MWe. One TA set in phase-I and another in phase-II.

c) New boiler and power house building with EOT crane.

d) Cooling tower.

e) Water treatment plant.

f) Modification to HP steam piping in the plant.

g) Electrical system for power export and distribution.

Environmental aspects and pollution control measures such as particle emission controls from the gasses and Effluent treatment plant.

8.0 BAGASSE HANDLING SYSTEM

Bagasse handling system proposed utilises existing bagasse handling carriers. The system recommended also provides open storage yard and reclaim facility to operate co-generation plant during off-season.

Summary of budgetary cost estimates for bagasse handling system is given below.

Proposal I	Cost US $ x 1000	5230.00
Proposal II	Cost US $ x 1000	5441.00

9.0 QUANTIFICATION OF POWER GENERATION AND EXPORT

Cane crushing rate	tch	230
Total cane crushed	t/year	1,043,280
Bagasse % cane		39.61
Bagasse produced per year	tons	413,000
Sugar factory operation	Days	210
Co-generation power plant operation	per annum	300
Sugar factory time efficiency	percent	90
Co-generation plant time efficiency	percent	92
Factory steam generation		
- During season	t/h	145.00
- During off-season	t/h	55.00
Power generation during season from :		
- Existing 3.0 x 2 MW TA set	MW	5.20
- New co-generation turbo-alternator	MW	14.72
Power generation during off-season from :		
- Existing 3.0 x 2 MW TA set	MW	---
- New co-generation turbo-alternator	MW	13.29
Power export		
- During season	MW	11.06
- During off-season	MW	11.06
- Total units exported	MWh	75672

10.0 BUDGETARY COST ESTIMATES

Summary of budgetary cost for the proposed co-generation plant and sugar factory optimisation is given below.

Sr. No.	Description	Cost in US $ x 1000
1.	Sugar factory optimisation	5,941
2.	Co-generation project	
	Phase-I	18,360
	Phase-II	10,209
3.	Bagasse handling	5,441
4.	**Total project cost**	**39,951**

10.1 The above cost estimates covers all the costs of equipment including transport to site, installation of mechanical, electrical and civil works. It may be noted that no provision is made for any escalation in the above estimates, as the project is expected to be implemented in the nearest future.

10.2 Provision of 5 % on the FOB cost of the equipment has been considered towards contingencies.

10.3 The total project cost is arrived after adding other costs such as pre-operating costs, capitalization of interest, etc. The estimates of these expenses are given below.

10.4 The total project costs required for cogeneration project excluding cost of optimisation of sugar factory, for phase-I and phase-II are considered for financial analysis and is given below

Sr. No	Description	Phase-I (US$x1000)	Phase-II (US$x1000)	Total (US$x1000)
1	Plant and Machinery for cogeneration plant (Installed cost)	18,360.00	10,209.00	28,569.00
2	Bagasse handling system (Installed cost)	5441.00	-	5441.00
3	Pre-operative expenses capitalised	172.00	172.00	344.00
4	Pre-operative interest capitalised	2170.19	934.29	3104.48
5	Margin money for working capital	140.20	-	140.20
6	**Total project cost (Say)**	**26283.00**	**11315.00**	**37598.00**

11.0 FINANCIAL ANALYSIS

The key important financial ratios as calculated for the project completed in both phases are summarized below.

Particulars	
Debt Service Coverage Ratio (DSCR)	***2.13***
Average Break Even Point	46.01 %
Internal Rate of Return (IRR)	15.00 %
Composite cost of capital	5.45 %
Pay back period	5.68 years
Average ROI	57.60 %
Debt equity ratio	1.85

11.1 Comments

Based on the above findings, following observations can be made.

- Low Break Even Point (46.01 % as against 100 % where contribution is just enough to cover the fixed costs, with no profit no loss situation)

- Ideal Debt Service Coverage Ratio, DSCR (2.13 as against 1.5 to 2.5 generally expected by the bankers or Financial Institution, indicating the capacity of the borrower to meet the obligations of long term borrowing)

- Favourable Internal Rate of Return (15.00 % as against cost of capital available at 5.45 %)

- Ideal Debt Equity Ratio (1.85 as against 2.0 generally expected by the creditors indicating the cushion available on liquidation of the organization)

11.2 Sensitivity Analysis in case of variation in Power Tariff

Sensitivity of financial indicators is worked out for co-generation project based on selling price of US $ 56.0 (80 % of base price) and US $ 63.0 (90 % of base price). Base price considered is US $ 70.00. The summary is given below.

Power tariff per MWh	**IRR %**	**DSCR**	**BEP %**	**Payback period**	**D/E Ratio**
US $ 56.0	9.27	1.69	57.50	7.16	2.77
US $ 63.0	12.18	1.91	51.11	6.33	2.21
US $ 70.0	15.00	2.13	46.01	5.68	1.85

12.0 FINANCIAL ANALYSIS EXCLUDING THE COST OF REPLACMENT OF EXISTING BOILERS AND POWER PLANT

In the above financial analysis, the total cost of new steam generation plant and new power plant is considered. The present condition of existing boilers and turbo-alternators is not good and have already outlived their life and are due to major rehabilitation/replacement at the earliest opportunity. This is an essential requirement to revitalise overall sugar factory operations.

The cost of replacement of existing boilers and turbo alternators is estimated as given below.

Sr. No	**Description**	**Installed cost in US $ x 1000**
1	5 boilers, 20 kg/cm^2, 370^0 C, 25 t/hr capacity	5000.00
2	2 Turbo alternators, each 3 MW	1000.00
	Total	6000.00

Financial analysis is worked out by deducting the above cost of US$ 6.0 million from the cogeneration project and the revised cost estimates and findings of key financial indicators with sensitivity analysis is presented below.

12.1 Revised Budgetary Cost Estimates

Sr. No	Description	Phase-I (US$x1000)	Phase-II (US$x1000)	Total (US$x1000)
1	Plant and Machinery for cogeneration plant (Installed cost) less: replacement cost	18,360.00	10,209.00 - 6000.00	22569.00
2	Bagasse handling system (Installed cost)	5441.00	0.00	5441.00
3	Pre-operative expenses capitalised	172.00	172.00	344.00
4	Pre-operative interest capitalised	2170.19	394.29	2564.48
5	Margin money for working capital	140.20	-	140.20
6	**Total project cost (Say)**	**24604.00**	**4775.00**	**31058.00**

12.2 Key Financial Indicators

Particulars	
Debt Service Coverage Ratio (DSCR)	3.37
Average Break Even Point	41.66 %
Internal Rate of Return (IRR)	20.02 %
Composite cost of capital	5.45 %
Pay back period	4.76 years
Average ROI	76.05 %
Debt equity ratio	1.62

12.3 Sensitive Analysis

Power tariff per MWh	IRR %	DSCR	BEP %	Payback period	D/E Ratio
US $ 56.0	13.55	2.68	52.06	6.00	2.35
US $ 63.0	16.83	3.02	46.28	5.31	1.91
US $ 70.0	20.02	3.37	41.66	4.76	1.62

13.0 CONCLUSION

Based on the key financial ratios, the project is not only viable but also attractive.

Also it may be noted that co-generation power plant improves overall viability of sugar estate because of productive use of surplus bagasse available with the sugar factory.

Considering the minimum life of cogeneration plant of about 25 years, the pay back period mentioned above is acceptable.

ANNEX L: SUMMARY OF THE POWER SECTOR IN PROJECT COUNTRIES

Kenya Power Sector

Historical Background

The decision by the Government of Kenya to liberalise the energy sector in 1994 marked an important turning point in Kenya's energy sector. The power sub-sector underwent significant and far-reaching changes in the process. Prior to liberalisation the power sub-sector was dominated by the *de facto* vertically integrated utility: Kenya Power and Lighting Company (KPLC) which owned some generation and transmission assets and the entire distribution network in Kenya. Other entities in the sub-sector which owned generation assets only or a combination of generation and transmission assets executed management contracts with KPLC for the management of these assets. Thus on the face of it KPLC appeared to own all the assets in the electricity supply industry in Kenya, however, there were other significant players in the background. Prior to liberalisation and subsequent restructuring there were five major players in the power sub-sector namely: Kenya Power and Lighting Company (KPLC), the Kenya Power Company (KPC) the Tana River Development Company (TRDC), the Tana and Athi River Development Authority (TARDA) and the Kerio Valley Development Authority (KVDA).

Table J1: Institutional set-up of the Kenyan Power Sector

Institution	Area of jurisdiction/Function
Ministry Of Energy	- Overseeing the energy sector - Policy formulation, monitoring and evaluation
Electricity Regulatory Board	- Regulation of the power sector
Kenya Power and Lighting Company (KPLC)	- Electricity transmission and distribution
Kenya Generating Company Ltd (KENGEN)	- Generation of electricity
Independent Power Producers (IPPs)	- Generation of electricity

Kenya Power and Lighting Company (KPLC), was a limited liability company quoted on the Nairobi Stock Exchange –where it is considered a blue chip company- with 51% shareholding by the government and government agencies, most significantly the National Social Security Fund (NSSF). The other 49% of KPLC stock was owned by various investors including individuals and institutional investors such as banks, private pension funds and insurance companies. KPLC was responsible for the transmission and distribution of electricity most of which it purchased in bulk from other generating companies. It also owned and operated a number of small hydro-power stations and all thermal power plants on the interconnected system. KPLC had two sister companies namely Kenya Power Company (KPC) and Tana River Development Corporation (TRDC): KPC was responsible for geothermal development at Olkaria, the operation of the Tana and Wanjii power stations on upper Tana River and the importation of electricity from Uganda. TRDC was responsible for the development of major hydro-power plants in the Seven Forks area of the Tana River. Both KPC and TRDC were wholly owned by the government, had a board of directors but no staff of their own and were entirely managed and operated by KPLC; which purchased bulk power from the two under an arrangement in which all operational, development and debt servicing costs of the two companies were met by KPLC as and when these were incurred ("*ascertained cost*" principle). The two companies did not pay corporate taxes, or any duties and taxes on imported material. They were not supposed to make any profit or loss or to hold any reserves for future developments as these were supposed to be taken care of by KPLC through the "ascertained costs" and a "development surcharge".

Two regional development authorities Tana and Athi River Development Authority (TARDA) and Kerio Valley Development Authority (KVDA) were set up to develop the Tana/Athi and Turkwell basins respectively. TARDA was mandated to develop the Masinga reservoir and power station as well as the Kiambere hydro-electric power project, both on the Tana river; while KVDA was mandated to develop the

Turkwell Gorge hydro-electric power project. TARDA and KVDA, which are fully owned by the government and each of which has a board of directors and staff, were set up as multi-purpose projects with a mandate to generate and sell electric power as well as to undertake other income generating activities including irrigated agriculture, fishing and tourism. Their power stations were however, operated and managed by KPLC under a lease agreement in which the power generated was sold in bulk to KPLC.

The Ministry of Energy had the oversight, co-ordination and management responsibility for all the sector entities in the power sub-sector including policy, regulatory, commercial transactions and the day-to-day operations of the entities. The Ministry was directly involved in the implementation of all the major projects in the sub-sector and the Minister approved all bulk and retail tariffs as well as all the financial transactions between and amongst the sector entities. Owing to its non-commercial orientation the Ministry set the bulk and retail tariffs at sub-economic levels with a view to promote the political and welfare agenda of the government without due regard to commercial and efficiency considerations. The power sub-sector was therefore unable to generate sufficient funding to meet its operational and developmental requirements and hence relied heavily on the exchequer for support. In this regard the power sub-sector operated like a department of the Ministry of Energy.

The Minister was also responsible for the Rural Electrification Programme (REP) which was set up in 1973, and managed this through an ad-hoc Rural Electrification Committee, while the implementation of the programme was contracted to KPLC which was required to contribute part of its earnings to support the programme. The government owned all the REP assets, and KPLC was required to maintain separate accounts for the REP projects implemented on behalf of the government.

Power sector reforms

There was therefore an urgent need to reform and restructure the sub-sector in order to prepare it to tackle the challenges facing it, in particular the need to attract adequate funding, especially from the private sector, for operations and development. The government’s strategy for creating enabling conditions for an efficient energy sector and for eliminating electricity supply deficits entailed the establishment of appropriate macroeconomic measures, reforming the sector’s institutional, legal and regulatory framework, and implementing a least-cost investment programme.

The macro economic measures that needed to be established included the creation of an enabling environment for attracting private sector investment, improvement of incentives for operational efficiency and the adjustment of electricity tariffs to economic levels to ensure the financial viability of the sub-sector and foster efficient use of electricity by the consumers.

The institutional, legal and regulatory reforms required entailed the restructuring of the electric power sub-sector to create arms-length commercial relationships between sector entities; facilitate establishment of an autonomous regulator to handle decisions on pricing, environmental and safety regulation objectively; and to facilitate private sector participation.

Finally, there was a need to implement a least-cost investment programme with a view to eliminate supply deficits; and by reviewing the programme on an annual rolling basis introduce dynamism and transparency in the planning and generation planting process with the aim of eliciting private sector participation.

By pursuing this three-pronged strategy the government essentially committed to:

a) Adjust the structure of electricity pricing to ultimately reflect the long run marginal cost of supply
b) Create more competitive market conditions in electricity generation
c) Separate commercial functions from policy setting, regulatory and co-ordinating functions
d) Restructure utilities in the power sub-sector to enable them operate on commercial principles and conduct business transactions with each other at arms length
e) Implement power projects on the basis of improved least cost investment planning
f) Improve demand and supply side efficiencies in the industry and sub-sector.

Therefore in 1996 the Government of Kenya (GoK) made a decision to carry out further reforms in the power sub-sector comprising a review of the legal and regulatory framework, pricing of electricity, sector management, and restructuring the industry, as well as the institutional framework.

A new legal framework comprising the *Electric Power Act, 1997* which was promulgated in 1998, facilitated the delineation of responsibilities amongst the various sector entities as well as the restructuring of the sub-sector and the creation of new institutions. Thus the industry was restructured and the generation function unbundled from the transmission and distribution functions transforming the de facto vertically integrated structure into a single buyer (*Purchasing Agency*) model in which KPLC as the single buyer, purchases bulk power from IPPs and the public sector generation company under long term bilateral Power Purchase Agreements (PPAs).

The enactment of the *Electric Power Act, 1997* enabled the separation of policy, regulatory and commercial functions. The policy formulation function was retained by the Minister for energy, who also retained high level co-ordination, oversight and management for the energy sector as a whole. Regulatory functions passed onto an autonomous regulator: Electricity Regulatory Board (ERB); and commercial functions in respect of generation, dispatch, transmission, distribution and supply to various commercial entities. The Electricity Regulatory Board was empowered to set retail tariffs, enforce competition, where feasible, in the sub-sector, enforce environmental and safety regulations, approve contracts and resolve disputes. Licensing responsibilities were shared between ERB and the Minister, with the former processing and recommending and the latter issuing the licenses.

Generation was liberalised thereby opening the way for Independent Power Producers (IPPs) to participate in generation. This move also facilitated regularisation of the operations of the two stop-gap IPPs – Iberafrica Power (EA) Ltd. (45 MW) and Westmont Power Ltd (43 MW) - which came into operation before the new Act was promulgated. In a bid to rationalise the institutional set-up in the sub-sector, public sector generation was consolidated under a new generation company: Kenya Electricity Generation Company (KenGen), which took over all the generation assets formerly owned by KPLC, KPC, TRDC, TARDA, and KVDA comprising hydro, wind and geothermal power plants altogether 900 MW of installed capacity.

Following the liberalisation of generation, other IPPs, namely: OrPower4 Inc. (12 MW), Tsavo Power Company (74 MW) were licensed to generate electrical energy for sale in bulk to KPLC, the single buyer in the sub-sector. All players in the industry – generators, transmitters, distributors and retailers - are licensed by the Minister for energy upon recommendation by the Electricity Regulatory Board, which processes the licenses. Each generator executes a long term Power Purchase Agreement with KPLC, the off-taker, which must be approved by the Board. The durations of the PPAs mirror the durations of the licenses and are typically fifteen years or more depending on the type of generation technology employed. Transmission and distribution licenses generally cover longer durations, typically thirty years.

The transmission and distribution functions, however, remained bundled under a new look KPLC responsible for dispatch, transmission, distribution and retailing of electrical energy in Kenya. KPLC took over 1,000 km of 220kV and nearly 2,000 km of 132 kV lines; nearly 5,000km of 33 kV and about 15,000 km of 11 kV lines as well as approximately 6,000 MVA of transformation capacity. In addition at the time it was created in 1999 it had 400,000 customers; about 70,000 of whom were on the REP.

Responsibility for the Rural Electrification Programme remained with the Minister for energy; however, REP was explicitly recognised in the *Electric Power Act, 1997*. The Act empowers the Minister to establish the Rural Electrification Programme to support electrification of rural areas and other areas considered economically unviable for electrification by public electricity suppliers. The Act also empowers the Minister to raise a 5% levy on electricity consumption to support the REP fund, in addition to annual exchequer budgetary support, as well as loans and donations from local and external institutions. The Minister for energy continued to contract the REP assets to KPLC (Lodwar, Mandera, Wajir, Moyale,Marsabit) and additionally to the newly established KenGen (Lamu and Garissa).

Status of the electricity sector in Kenya: statistics and data

Table J2: Country-wide Installed generating capacity by fuel

Fuel/Source	Capacity in MWe (Year 2000 – 2004)				
	2000	**2001**	**2002**	**2003**	**2004**
Fuel oil	120.5	150.5	150.5	120.5	
Diesel	96.9	184.5	184.2	184.2	
Coal	-	-	-	-	
Natural gas	73.5	73.5	73.5	73.5	
Geothermal	56.83	57.48	58.5	58.5	
Hydropower*	704.5	707.2	727.2	705.9	
Renewables (Wind)	0.4	0.4	0.4	0.4	
TOTAL	1052.4	1173.1	1194.6	1143.1	

Source: World Bank Data Collection; Reforming the Power Sector Book
* Includes imports from Uganda

Table J3: Power generation mix by fuel

Fuel/Source	Power generated in MWh (Year 2000 – 2004)				
	2000	**2001**	**2002**	**2003**	**2004**
Fuel oil	592	575	362		
Diesel	483	1245	1069		
Coal	-	-	-		
Natural gas	414	309	78		
Geothermal	383	429	480		
Hydropower	2590	1523	2574		
Renewables (Wind)					

Source:

Table J4: Installed generating capacity by plant type and owner, 1996 – 2000 (MW)

Owner and plant type	1996	1997	2000	2001	2002
Hydro					
TRDC					
Kenya Power Company	276.5				
KPLC	21.8	298.3			
KenGen	6.2	6.2			
TARDA			674.5	677.2	677.2
KVDA	106.0	106.0			
UEB (Imports)	30.0	30.0	30.0	30.0	50.0
Total hydro	624.5	624.5	704.5	707.2	727.2
Geothermal					
KPC	45.0	45.0			
KenGen			45.0	45.0	45.0
IPP			8.0	12.0	13.0
Total geothermal	45.0	45.0	53.0	57.0	58.0
Thermal					
KPLC	144.3	124.3			
Gok/REP	3.8	5.4	5.1	5.1	5.1
KenGen			197.9	227.9	227.9
IPPs		11.4	87.5	175.5	176.0
Total thermal	148.1	141.1	290.5	405.5	409.0
Wind					
KPLC	0.4	0.4			
KenGen			0.4	0.4	0.4
Total Wind	0.4	0.4	0.4	0.4	0.4
Grand Total	**818.0**	**811.0**	**894.4**	**1,173.1**	**1,194.6**

Source: Marandu, E., and Kayo, D., 2004

Table J5: Independent power producers

Summary of IPP Investment

Company Name	**Project Location**	**Project type**	**Project capacity (MW)**	**Investment (US$ million)**	**Completion Date**
IberAfrica	Nairobi	Diesel plant	44	N/a	1997
IberAfrica	Nairobi	Diesel plant	12	13	October 2000
Westmont Power	Mombasa	Diesel plant, barge-mounted	43.5	N/a	1997
Ormat International	Olkaria	Geothermal Plant	64	210	12 MW by Nov. 2000, 52 MW by July 2003
BWSC (in full)	Lanet	Diesel Plant	55	65	July 2001
BWSC (in full)	Eldoret	Diesel Plant	55	65	July 2001
		Diesel Plant	75	85	July 2001

Source: Marandu, E., and Kayo, D., 2004

Table J6: Electricity demand/consumption

Type of customer	Electricity demand in GWh (Year 2000 – 2004)				
	2000	**2001**	**2002**	**2003**	**2004**
Residential	748	679	768		
Commercial	724	609	696		
Industrial	1398	1361	1513		
Others	634	563	651		
TOTAL	3504	3212	3628		

Source: AFREPREN, 2003;

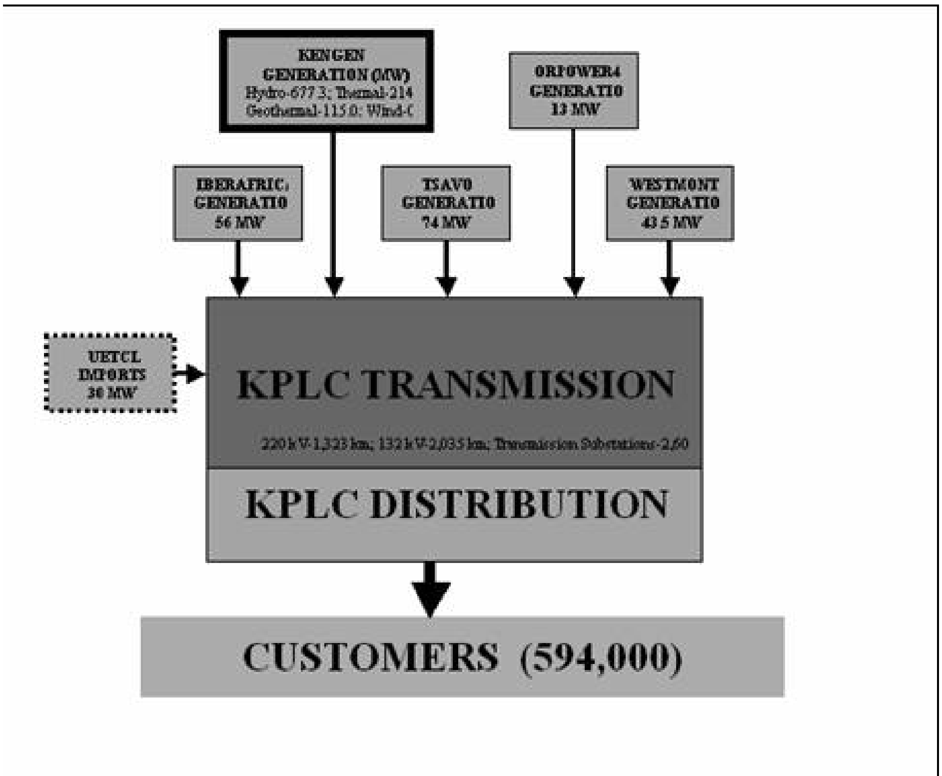
Electricity tariff and prices

Table J7: Electricity selling price by utility

Category	US cents/kWh
Residential	5.8
Commercial	6.8
Industrial	5.2
Others	

Source: Marandu, E., and Kayo, D., 2004

Figure J1: The Current Structure of the Electric Power Sub-Sector in Kenya

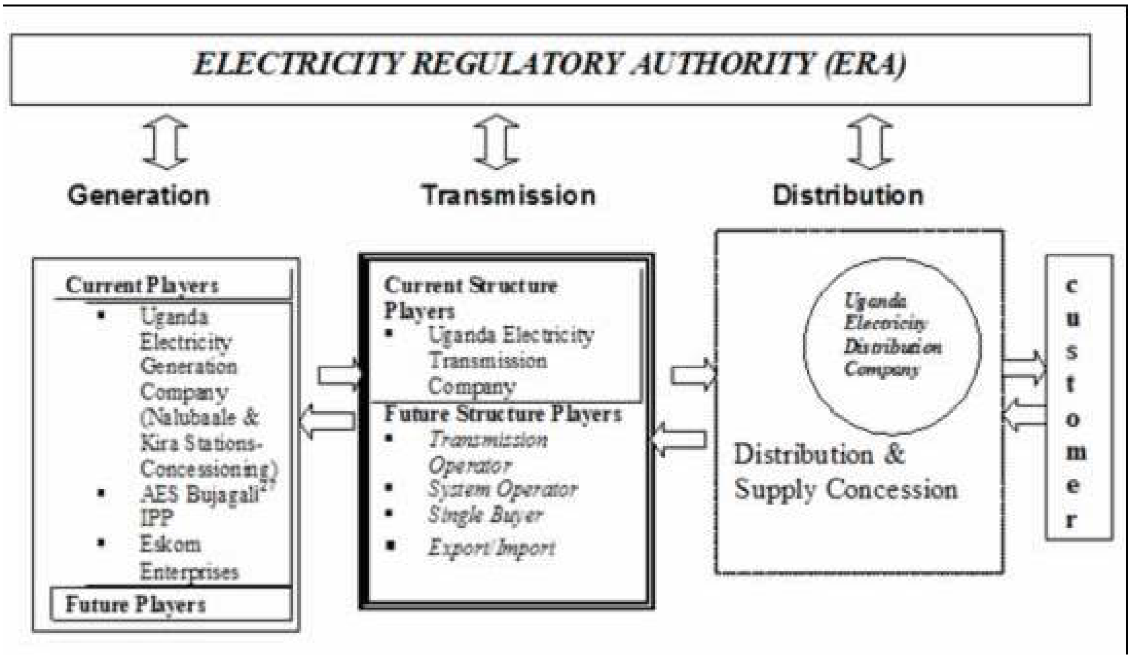


Source: F. Nyang, UNECA Report 2005.

Uganda Power Sector

The Ugandan power sector was previously dominated by a state-owned, vertically integrated Uganda Electricity Board, UEB, which has since been unbundled into three limited liability companies, namely, the Uganda Electricity Generation Company, the Uganda Electricity Transmission Company and the Uganda Electricity Distribution Company responsible for generation, transmission and distribution, respectively. The Ugandan government has been actively pursuing active negotiations with various investors, to increase in the level of private investment in the sector. So far, a concession for generation was awarded to Eskom Enterprises in 2002.

Figure J2: Structure of the Power Sector in Uganda



The Electricity Act of 1999 that outlines the Government's policy on electricity production, makes specific provisions for rural electrification and empowers the Minister of Energy to plan and initiate strategies that promote electricity use in the rural areas. The Rural Electrification Fund recently established in line with provisions of the Electricity Act is expected to be instrumental in achieving equitable access to electricity throughout the country.

In 1997, the Government of Uganda developed a Strategic Plan for transforming the Ugandan power sector into a financially viable electricity industry, in order to enable it to supply reasonably priced and reliable power. This new Strategic Plan placed special emphasis on the role of competition in promoting efficiency within the power sector and on private sector participation as a key driver for enhancing the performance of the country's electricity industry.

One of the aims of the reforms was to transform the sector into a profitable and financially viable industry with priority attention given to reducing system losses. Over the last five years the systems losses have averaged 34%
The bulk of the systems losses (on average over 60%) are due to technical losses resulting from the long distances between points of production and consumption and the need for network rehabilitation. As a result of the refurbishment and rehabilitation programs and the construction of new lines, the losses are expected to decline to about 10-15% by 2010.

In 1999, a new electricity legislation was enacted, providing for the liberalisation of the power sector, the introduction of new private sector electricity infrastructure providers and the privatisation of existing assets. The legislation also provided for the establishment of an autonomous authority to regulate the electricity industry and a Rural Electrification Trust Fund (RETF) to promote increased access to electricity, particularly for the poor. In 2001 the Uganda Electricity Board (UEB) is unbundled and three companies created and registered, namely: The Uganda Electricity Generation Company Ltd; The Uganda Electricity Transmission Company Ltd; and, The Uganda Electricity Distribution Company Ltd (UEDCL).
Prior to the reform process, the institutional structure of the power sector in Uganda was dominated by the UEB, the sole electricity utility that also doubled as a regulator. After the reforms, the entire institutional structure has been transformed.

Source: AFREPREN 2004.

Tanzania Power Sector

The Ministry of Energy and Minerals (MEM) is in charge of the Minerals, Power and Petroleum development in the Tanzania. Three parastatals exist under this ministry, namely, State Mining Corporation (STAMICO) – responsible for mineral exploration and production activities, Tanzania Petroleum Development Corporation (TPDC) – currently responsible for exploration and production of petroleum products, and Tanzania Electric Supply Company Limited (TANESCO) – responsible for generation, transmission, distribution and sale of electricity. All of these were by law monopolies in their respective sectors. To date the monopoly has been abolished and private players have joined the sector, especially in the most attractive areas like mining and distribution of petroleum products. The role of the Ministry spans from policy formulation to regulation and control, including (a) overseeing activities of the utility, (b) appointing board members, (c) defining social policies, and (d) issuing licenses to IPPs and IPDs. The private sector, of course co-existed, but with generation for own use.

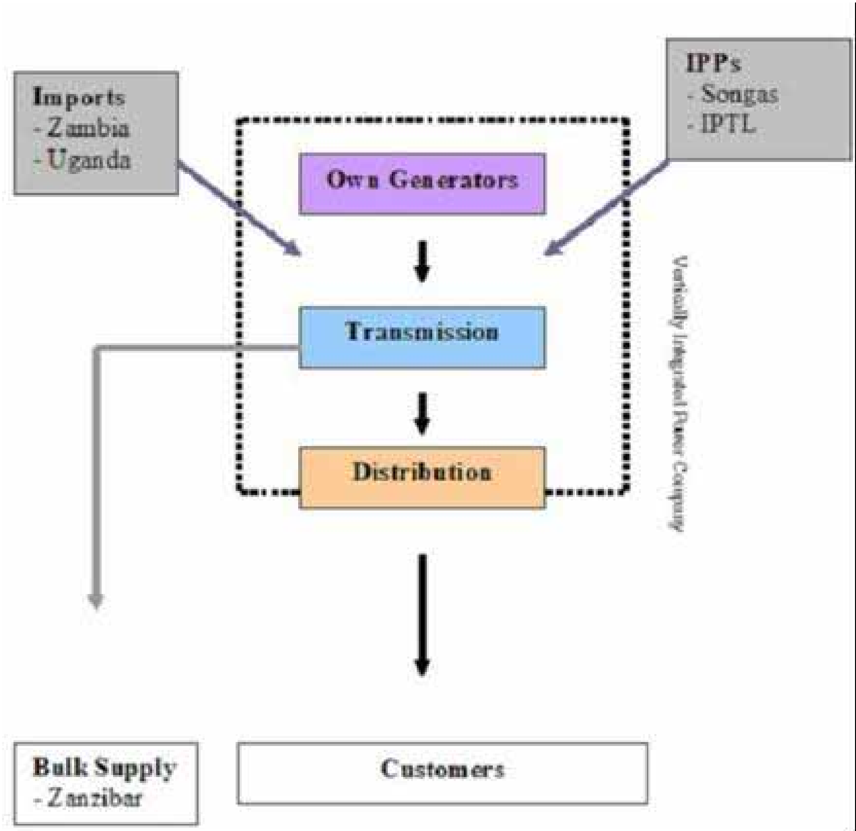
Table J8: Institutional set-up of the power sector

Institution	Area of jurisdiction/Function
TANESCO	Country wide (Generate, transmit and distribute power)
IPP	Isolated regions (generate electricity)
Ministry of Energy and Mines	Policy formulation to regulation and control, including (a) overseeing activities of the utility, (b) appointing board members, (c) defining social policies, and (d) issuing licenses to IPPs and IPDs
REA	Rural Areas (The act to establish the authority is pass but the authority is not yet operational)
Tanzania Investment Centre (TIC).	Reviews proposals and Issues certificate of acceptance to the private investors

Source: Marandu, E. and Kayo, D., 2004; Kayonza, N., 2005.

TANESCO, the only power utility in Tanzania, is wholly owned by the State, was established under the Company Ordinance Act of 1931 in 1964 after nationalization of the power supply industry by then under two private electricity distribution companies. It has been operating since then as a vertically integrated public utility responsible for generation, transmission, distribution and commercial services of electricity in the country. Following the 1992 policy change to abandon monopoly by TANESCO, dedicated IPP have joined the generation segment of the sector and sell electricity to TANESCO through the Power Purchase Agreements. Two major contracts have been signed, one in 1994, for a diesel-fired 100 MW capacity, and in 2001 for a gas-fired 115 MW capacity.

Figure J3: Structure of the Power Sector



The reform process in Tanzania were driven by the need to create enabling environment for an efficient and sustainable power sector. Amongst the reform efforts by the government include:
Passing a declaration on policy change to abandon monopoly (1992) which provided for an individual, a cooperative or any private agency to engage in generation, distribution and selling of electricity to consumers (Kahyoza, 1994). Enactment of an Electricity Law (2004)-still in a draft form- which is to facilitate the development and promotion of, and increased private sector participation, in the expansion of electricity services; to promote enhanced efficiency in and to maintain the safe operation of the electricity sector; to facilitate the reorganization and restructuring of and to provide for a framework for the effective regulation of the electricity sector; and to provide for related matters.

In April 2000 the Government made the decision to create two independent multi-sectoral regulatory agencies, one (to be known as EWURA) to regulate the utilities including electricity, the other (known as SUMATRA) to regulate all forms of transportation covering rail, land and maritime. In October 1999 the Government of Tanzania approved a new electricity industry policy and restructuring framework with the aim of unbundling the generation, transmission and distribution of electricity.
In order to increase power generation through attracting investment in the energy sector, the Government in 1992, changed its policy stand to allow private participation in generation. Following the policy change two independent power producers (IPPs) have been licensed, namely, Independent Power Tanzania Limited (IPTL) and Songas Limited. The former has constructed and operates a 100MW diesel-fired power plant near Dar es Salaam, while the latter has developed and operates the natural gas infrastructure with a throughput of 70 MMscf/d, generating 180MW and supplying 8 industrial customers in Dar es Salaam.

It is estimated that about 39% of the urban population has access to electricity, and only about 2% of the rural population (Esmap, 2005; HBS, 2000) do access electricity in Tanzania. Information from TANESCO indicates that normally TANESCO connects 20,000 to 30,000 customers per year. The Management Contractor has an ambitious plan to connect up to 100,000 customers per year (TANESCO, 2004). However, a much more aggressive connection strategy may be required to cope with the current population growth.

With the commissioning of the IPTL plant in 1999, and subsequent switching to the gas generation of the Ubungo turbines, per capita consumption of electricity picked up a steady increase to above 90 kWh in 2004. The number of customers in Tanzania has increased from about 221,000 in 1992 to 550,000 in 2004, an average of about 27,800 new connections per annum. The corresponding electricity access has increased from 5.1% in 1992 to 9.0% in 2004.

Source: N. Kahyoza, UNECA Report 2005.

Status of the Electricity Sector in Tanzania: Statistics and Data

Table J9: Country-wide Installed generating capacity by fuel

Fuel/Source	**Capacity in MWe (Year 2000 – 2004)**				
	2000	**2001**	**2002**	**2003**	**2004**
Fuel oil					
Diesel	302	302	302	302	182
Coal	6	6	6	6	6
Natural gas	0	0	0	0	160
Geothermal	-	-	-	-	-
Hydropower	561	561	561	561	561
Biomass	2	2	2	2	2
Renewables	-	-	-	-	-
TOTAL	871	871	871	871	911

Source: AFREPREN, 2005 (UNECA DATA)

Table J10: Power generation mix by fuel

Fuel/Source	**Power generated in MWh (Year 2000 – 2004)**				
	2000	**2001**	**2002**	**2003**	**2004**
Fuel oil					
Diesel	76	108	145	568	857
Coal	23	19	16	17	13
Natural gas	267	65	24	57	461
Geothermal					
Hydropower	2,145	2,557	2,668	2,491	2,011
Renewables					
Biomass	4.5	4.4	4.4	3.7	6.3
Internal Total Generation	2,516	2,753	2,858	3,138	3,347
Imports	6	28	34	41	46
Total Electricity (Gen + Imports) - GWh	2,522	2,782	2,892	3,179	3,393

Source: AFREPREN, 2005 (UNECA DATA)

Table J11: National grid power plant & breakdown of individual installed capacity

Name of power plant	Type of power plant	Fuel	Capacity (MWe)
Nyumba ya Mungu (NYM) Power Plant	Hydro	Hydro	8
Hale Power Plant	Hydro	Hydro	21
New Pangani Falls	Hydro	Hydro	68
Mtera and Kidatu hydro power plants	Hydro	Hydro	284

Table J12: Independent power producers

Name of power plant	Type of power plant	Owner	Fuel	Installed capacity (MWe)	Contracted capacity (MWe)	Tern of contract (Years)
Ubungo	Gas Turbine	Asea Brown Boveri (ABB)	Natural Gas	160		
IPTL	Diesel-fired power plant	IPTL	Diesel	100		1994 -
Songas	Gas turbine	Songas	Natural Gas	150		October 2001*-

Source: Marandu, E. and Kayo, D., 2004; AFREPREN, 2005 (UNECA DATA); Karekezi, S., and Kithyoma, W., 2005

* Contract negotiations, which had started in 1994, stalled for about two years between 1997 and 1999 pending investigation into the IPTL controversy

Table J13: Regulations for independent power generation and distribution

Regulations	Requirements	Responsible authority
Licensing (generation)	Per size of systems	Ministry of Energy and Mines
	Fees	Ministry of Energy and Mines
	Valid time period	Ministry of Energy and Mines
Licensing (distribution)	Fees	Ministry of Energy and Mines
	Subsidies available	Ministry of Energy and Mines
	Valid time period	Ministry of Energy and Mines
PPA	Standard offer/ negotiation by project	Tanzania Investment Centre and TANESCO
Taxes and Levies	Customs on imported equipment	Ministry of Energy and Mines
	Taxes on construction contracts, income taxes	Ministry of Energy and Mines
	Royalty fees for use of site	Ministry of Energy and Mines
Environmental Regulations	EIA (documentation, public hearing)	
	Particulates CO2, NOx, Sox, etc.	

Source: Kayonza, N., 2005; Marandu, E. and Kayo, D., 2004

Malawi Power Sector

Status Of The Electricity Industry

In electricity production, hydropower is the dominant source of power production. In fact, over 95% of the electricity produced by ESCOM is hydro-based. Poor policy, infrastructure development and poor planning have made electricity very expensive. At present only 6% of the population have access to electricity. The limited affordability of electricity is clearly illustrated by the fact that although about 56% of the urban population are electrified, only 27.5% use it for lighting whilst a mere13.3% use it for cooking (Malawi Census, 1998). Overdependence on hydropower also makes the system highly susceptible to varying rainfalls, which is common in the country. This calls for a diversification of energy sources, a factor that further substantiates the argument for allowing private participation in the Malawi Power Sector.

The Electricity Supply Corporation of Malawi, a predecessor of the Electricity Supply Commission of Malawi, dominates the Malawi Power sector. The commission was established in 1965 by an Act of Parliament to undertake all functions of electricity supply. Thus the commission was a vertically integrated monopoly. In its three-decade existence, poor performance and massive socio-political interference became a “trademark” of the utility. Supply services deteriorated and its work force was unnecessarily inflated.

Institutional Set-up and Reforms in Power Sector

The department of Energy, under the Ministry of Natural Resources and Environmental Affairs carries out the administrative and coordinating functions of all energy issues in Malawi. The ministry undertakes all policy issues and developing strategies that ensure energy efficiency in the country. The Ministry of Finance and the Department of Economic Planning are responsible for the budget allocations and broader planning of the energy sector, whilst the Forestry Department oversees biomass sub-sector issues. Another government department that has a stake in the energy sector is the Department of Statutory Co-operations, which is the mother body for the power utility, ESCOM. Currently, ESCOM is the only power utility in the energy market.

A new player in the energy sector is the National Electricity Council (NECO). NECO is an independent regulator, set up to undertake issues pertaining to licensing and regulating power producers. This is in line with the new Electricity Act, which allows private investors in the electricity market. Prior to the establishment of the electricity regulator, Department of Energy was responsible for some of the regulatory functions.

Table J14: Institutional set-up of the Power Sector in Malawi

Institution	Area of jurisdiction/Function
Ministry of Natural Resources and Environmental Affairs	Carries out Energy-related administrative and coordinating functions in Malawi. Undertakes all Policy issues and develops strategies that ensure energy efficiency in the country.
Ministry of Finance and the Department of Economic Planning	Budget allocations and broader planning of the energy sector.
ESCOM	National Utility (Generation, transmission and distribution)
National Electricity Council (NECO)	Deals with issues pertaining to licensing and regulating power producers

Source: Energy Policy 2002, Marandu, E., and Kayo, D., 2004

Status of the Reforms in Malawi

As discussed above, the Malawi power sector was performing poorly, and so with the urging of the World Bank, power sector reforms were instituted in Malawi, as a part of the on-going economic reforms. The power sector reforms started in 1998 and a new act, the Electricity Act (1998) was enacted to replace the Electricity Act (1965). The New Electricity Act among other things allows the participation of other players (apart from ESCOM), in the Malawi Power sector. It also establishes a corporate body, the National Electricity Council, as a regulator of the electricity industry. In the same year, the ESCOM Act (1998) was enacted affirming ESCOM's existence as a public entity. The Act was an ephemeral Act, awaiting amendment and so later in the year the ESCOM Amendment Act was enacted. This Act allows for the transfer of ESCOM assets and liabilities from the commission (i.e. the public ESCOM) to the corporation (i.e. the commercialised ESCOM).

Following the enacting of these Acts, the national power utility was unbundled. The functions of generation, transmission and distribution are however not completely ring-fenced. The supply sector also underwent a structural change and three supply units were established based on the three administrative regions of the country. Thus the Northern Electricity Supply, the Central Electricity Supply and the Southern Electricity Supply were established.

Apart from these legal framework and structural changes, ESCOM has engaged the services of its South African counterpart, Eskom to assist in building managerial, technical and financial capacity. The utility has therefore negotiated a two-year management contract.

The results of the PSR that the Malawi power sector has undertaken are not currently evident. Aside from the private generation by big commercial customers, who generate a total of 30MW for their own use, there are no IPPs in Malawi. Frequent blackouts and frequency and voltage fluctuations still characterise the Malawi electricity sector. The employment base of the power utility also remains artificially blotted and government interference has not really abated. Nevertheless the power sector reforms are in infancy, still incomplete and have been going on for four years only. Concluding that PSR in Malawi have been a failure or not would be unfair at this point and other developments such as the intention to amend the Electricity Act (1998) also indicate that the power sector in Malawi is still very much in a state of flux.

Source: AFREPREN 2004.

Ethiopia Power Sector

The Ethiopian Power Sector is dominated by the vertically integrated utility, the Ethiopian Electric Power Corporation (EEPCo). EEPCo owns, manages and develops electricity generation, transmission and distribution facilities and retail to customers. The power sector falls under the Ministry of Infrastructure, which is responsible for the development of all infrastructures in the country including the power sector. The Ethiopian Electricity Agency (EEA) is a federal organ that regulates the activities of electricity suppliers for the supply of efficient, reliable and affordable electricity to the public.

Table J15: Institutional Set-up of the Ethiopian Power Sector

Institution	Area of jurisdiction/Function
Ministry of Mines and Energy	Directs the Management Board and EEPCO on matters of Policy in the Power Sector; Approves major Investments on power projects in cooperation with Ministry of Finance and Economic Development
Management Board	Provides Overall and key Management Directions for the Public Utility; Approves Investments exceeding 30 million Birr; Gives Final Approvals or Claims settlements brought coming from Projects
Executive Management of Ethiopian Electric Power Corporation (EEPCO) With an Executive Management Team, and With a Senior Management Body	Headed General Manager (or Managing Director) Plus Four Deputy Managers for Four Sectors, namely: Operations; Engineering; Human Resources and Finance;
	Under each Sector, Department Heads act as Senior Managers for the following key areas: – Operations Sector: Power Systems and Regions; – Engineering Sector: Engineering Design, Projects & Contract Administration and Planning; – Finance Sector: Treasury and Comptroller; Human Resources: Personnel Administration, General Services and Auxiliary services.
EECO Regional Directors	Mostly Equivalent to Senior Managers, Regional Directors serve and act as EEPCO's managers for Operations, Electricity Transmission & Distribution Systems. as well as Sales and Collections in eight Regions – Addis Ababa (the largest Region and accounting for over 45 percent of total sales), Central Region, Eastern Region, Southern Region, North Eastern Region, Northern Region, North Western Region, and Western Region.
Ethiopian Electricity Agency (EEA)	Under the Minister of Mines and Energy, the EEA regulates and monitors the operations of EEPCO, and in the immediate future will regulate and monitor the operations of other independent power producers (IPPs) like the Sugar Factories that will export excess electricity to the interconnected system (ICS) national grid.
Small and Future Independent Power Producers (IPPs)	Strictly Outside the Public Utility System Providing Electricity to Urban and Semi-Rural Consumers.

Source: Ethiopian Electric Power Corporation (EEPCO).

EEPCo, being the sole power producer, maintains two different power supply systems, namely, the Inter-connected system (ICS) and Self - Contained System (SCS). ICS is mainly supplied from hydro - power plants as wells as geothermal (steam) and thermal (diesel) sources. Where as, SCS consist of mini hydro - power plants and a number of isolated diesel generating units widely spread all over the country.
EEPCo is responsible for ensuring adequate transmission capacity to maintain supply and quality of electricity to the currently more than 777,007 customers.

Demand for electricity in Ethiopia stands at more than 370 MW. At present EEPCo has an installed generating capacity of 521 MW. The installed generating capacity is estimated to be 1110 MW by the year 2010. And 1745 MW by the year 2015. Over 98% of the total generation in the country comes from the hydropower sources.

The Ethiopian Power sector reforms have so far focused on better regulation, corporatisation and commercialisation. These reform measures, as observed from the experiences of other countries, can be considered merely as preparatory steps to further reforms. Therefore, further reform measures are expected henceforth in Ethiopia to improve the performance of the power sector and to introduce private sector participation in the sector.

Status of the Electricity Sector in Ethiopia: statistics and data

Table J16: Country-wide Installed generating capacity by fuel

Fuel/Source	**Capacity in MWe (Year 1999/2000 – 2003/2004)**				
	1999/2000	**2000/2001**	**2001/2002**	**2002/2003**	**2003/2004**
Fuel oil	-------	-------	-------	------	-------
Diesel	35.86	35.52	36.54	34.46	115.23
Coal	-------	-------	-------	------	-------
Natural gas	-------	-------	-------	------	-------
Geothermal	7..30	7.30	7.30	7.30	7.30
Hydropower	377.50	450.75	450.75	484.75	668.75
Renewables	-------	-------	-------	------	-------
TOTAL	42.0.91	493.57	494.59	526.36	791.28

Source: Central Statistics Agency (CSA) Statistical Bulletin 349, November 2005, Addis Ababa, Ethiopia

Table J17: Power generation mix by fuel

Fuel/Source	**Power generated in MWh (Year 1999/2000 – 2003/2004)**				
	1999/2000	**2000/2001**	**2001/2002**	**2002/2003**	**2003/2004**
Fuel oil	-----	-----	-----	-----	-----
Diesel	40,009	20,030	45,869	40,055	38,000
Coal	-----	-----	-----	-----	-----
Natural gas	-----	-----	-----	-----	-----
Geothermal	4,300	2,135	1,025	------	
Hydropower	1,645,820	1,789,829	1,606,167	2,023,635	
Renewables	-----	-----	-----	-----	-----
TOTAL	1,688,829	1,811,994	1,653,088	2,063,689	2,311,332

Source: Central Statistics Agency (CSA) Statistical Bulletin 349, November 2005, Addis Ababa, Ethiopia

Table J18: National grid power plant & breakdown of individual installed capacity (December 2005)

Name of power plant	**Type of power plant**	**Fuel**	**Capacity (MWe)**
Gilgel Gibe	Hydroelectric Power (HEP)	Water Power	180
Finchaa	HEP	″ ″	134
Melka Wakena	HEP	″ ″	150
Tis Abbay I and II	HEP	″ ″	73 + 12 = 75
Koka (Awash I)	HEP	″ ″	42
Awash II	HEP	″ ″	30
Awash III	HEP	″ ″	30
Dire Dawa Thermal Plant TP	Thermal Plant (TP)	Diesel fuel (light)	80
Aluto-Langano	Geothermal	Geoth. energy	7
Self-contained Isolated Units TP	TP	Diesel fuel (light)	~50
Independent Diesel Plants	TP	Diesel fuel (light)	~22
Total (December 2005)	Hydropower + Diesel	Hydro + Diesel	~800

Source: Ethiopian Electric Power Corporation (EEPCO)

Table J19: Independent power producers

Name of power plant	Type of power plant	Owner	Fuel	Installed capacity (MWe)	Contracted capacity (MWe)	Tern of contract (Years)
Small Diesel; Plants	Diesel	Urban Associations and Private Investors	Diesel (light fuel)	~ 22	As per Trade laws, Regulations & Agreements	Private, Informal & Non-binding in favour of Supplier

Source: Estimates from previous studies and Central statistics Agency, Statistical Bulletin No.349., Nov. 2005

Table J20: Electricity demand/consumption

Type of customer	Electricity demand in MWh (Year 2000 – 2004)				
	1999/2000	**2000/2001**	**2001/2002**	**2002/2003**	**2003/2004**
Residential	506,008	520,635	581,354	599,779	654,100
Commercial	328,331	338,736	391,257	401,671	455,300
Industrial	532,005	542.043	835,820	688,103	715,700
Others (Street Lighting)	93,333	10,716	13,3309	17,193	21,700
TOTAL	1,4375,750	1,412,130	1,621,740	1,706,746	1,846,800

Source: The Federal Democratic Republic of Ethiopia, (FDRE), Central Statistical Agency (CSA), Report on Large and Medium Scale: Manufacturing and Electricity Industries Survey, No. 349 Statistical Bulletin, Addis Ababa, November 2005

Table J21: Demand-supply forecast

Forecast	Capacity in MWe (Year 2006 – 2010) in %				
	2006	**2007**	**2008**	**2009**	**2010**
Peak demand	800	810	1300	1650	1850
Supply	930	945	1300	1720	2100
- Fuel oil	-------	-------	-------	-------	-------
- Diesel	130	130	150	150	100
- Coal	-------	-------	30	30	30
- Natural gas	-------	-------	-------	-------	???
- Geothermal	-------	-------	7	7	15
- Hydropower	800	800	1220	1520	1955
- Renewables(Wind)	-------	15	30	50	50

Source: EEPCO with additional reasonable estimates, but subject to further refinements.

Table J22: Electricity selling price by utility

Category	US cents/kWh
Residential	4.08 US cents/kWh @ 1US$ = 8.48 Birr, average Exchange rate from 1999/200 to 2003/2004
Commercial	7,43
Industrial	5,37
Others	5,11

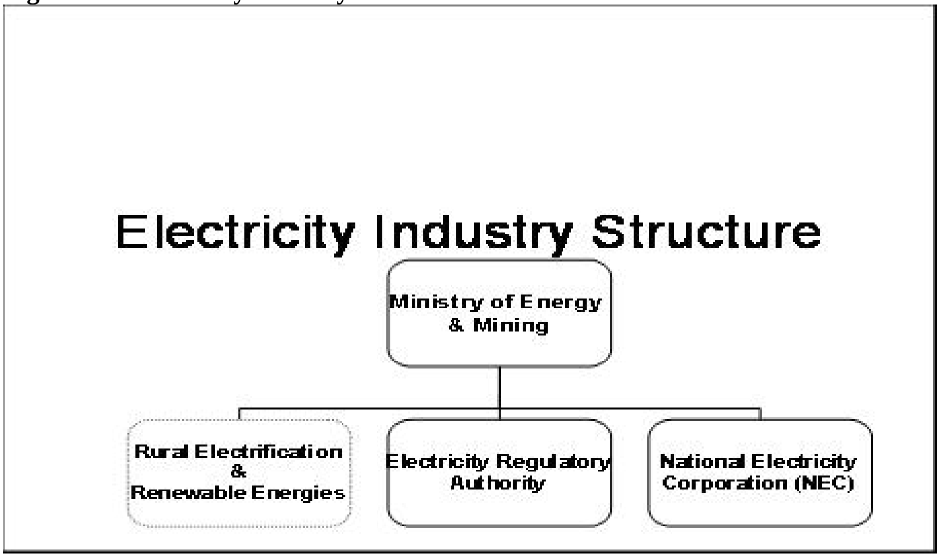
Source: Average tariffs calculated from five-year consumptions from data published by the Central Statistics Agency, Bulletin 349, Nov. 2005, Addis Ababa, Ethiopia.

Sudan Power Sector

Sudan 's electricity sector is plagued by poor infrastructure and frequent outages. Sudan has 728 megawatts (MW) of electricity generation capacity, and the country's total electricity generation was 2.4 billion kilowatthours (kwh) in 2002. The country's main generating facility is the 280-MW Roseires dam located on the Blue Nile river basin, approximately 315 miles southeast of Khartoum . The facility comes under frequent attack by rebel groups, and low water levels often cause its output to fall to 100 MW.

Electricity is transmitted through two interconnected electrical grids -- the Blue Nile Grid and the Western grid -- which cover only a small portion of the country. Regions not covered by the grid rely on small diesel-fired generators and wood fuel for power, although blackouts and brownouts are common. Only 30% of Sudanese currently have access to electricity, but the government hopes to increase that figure to 90% in coming years. In June 2004, Sudanese Electricity Minister Ali Tamim Fartak said that Sudan has secured more than $2 billion of the estimated $3 billion necessary to meet that goal.

Figure J 4: Electricity Industry Structure in Sudan



N.B: Rural Electrification & Renewable Energies Department is Proposed within the new Ministry Structure but not yet finalized.

Several projects are underway to increase Sudanese generating capacity. The largest include the proposed 2,500-MW Merowe and 300-MW Kajbar hydroelectric facilities in northern Sudan. France's Alstom, China's Harbin Power, and several Arab investors have contributed funding to construction of the Merowe facility, which is scheduled for completion in July 2008. China is financing 75% of the $200 million Kajbar dam construction, with Sudan providing the remaining 25%. Environmental groups have expressed concern about the Kajbar project, citing potential damage to the Nile ecosystem and the culture of displaced Nubian residents of the area.

In addition to the Merowe and Kajbar facilities, in June 2004, Sudan inaugurated two electric power stations located north of Khartoum, estimated to have a combined capacity of 330 MW. In November 2004, Sudan's first independent power production (IPP) project also went onstream. Located near Khartoum, the 257-MW diesel plant sells output to the state-owned Sudan Electricity Corporation (SEC). Several additional power stations with a total capacity of 700 MW are scheduled for completion before 2008.

Foreign investment in the Sudanese power sector is expected to increase with the cessation of the recently-ended civil war. In June 2004, for example, the United Arab Emirates (UAE) pledged to invest in the Sudanese power sector following the signing of a peace accord.

Source: Mbendi, http://www.mbendi.co.za/indy/powr/af/su/p0005.htm

Status of the Electricity Sector in Sudan: Statistics and Data

Table J23: Country-wide Installed generating capacity by fuel

Fuel/Source	Capacity in MWe (Year 2000 – 2004)				
	2000	2001	2002	2003	2004
Fuel oil Diesel	436	436	436	830	
Coal	-	-	-	-	
Natural gas	-	-	-	143	
Geothermal	-	-	-	-	
Hydropower	307	307	307	307	
Renewables	-	-	-	-	
TOTAL	743	743	743	1380	

Source:NEC2004

Table J24: Power generation mix by fuel

Fuel/Source	Power generated in MWh (Year 2000 – 2004)				
	2000	2001	2002	2003	2004
Fuel oil Diesel Coal	1386.3	1572.4	1806.3	2190.8	
Natural gas					
Geothermal					
Hydropower	1183	1267.6	1287.2	1163.2	
Renewables					
TOTAL					

Source: NEC/GDEA2004

Table J25: National grid power plant & breakdown of individual installed capacity

Name of power plant	Type of power plant	Fuel	Capacity (MWe)
National Grid	NEC Owned	Hydro	309.60
National Grid	NEC Owned	Diesel/Fuel Oil	455.5
Isolated Power Plants	NEC Owned	Diesel/Fuel Oil	112.00

Source:NEC/GDEA2005

Table J26: Electricity demand/consumption

Type of customer	Electricity demand in MWh (Year 2000 – 2004)				
	2000	**2001**	**2002**	**2003**	**2004**
Residential	761000	1057000	1200000	1134000	
Commercial	194000	99000	113000	313000	
Industrial	343000	508000	577000	514000	
Others(Agriculture)	30000	48000	54000	18000	
Others(Government)	237000	138000	157000	341000	
TOTAL	1565000	1850000	2100000	2320000	

Source:NEC&GDEA2005

Table J27: Demand-supply forecast

Forecast	Forecast 2005	Capacity in MWe (Year 2006 – 2010)				
		2006	**2007**	**2008**	**2009**	**2010**
Peak demand		1135	1772	2372	2800	2800
Supply						
- Fuel oil		300	642	350	300	-
- Diesel						
- Coal		-	-	-	-	-
- Natural gas		142	160	500	-	-
- Geothermal		-				-
- Hydropower		-	300	750	250	-
- Renewables						
Total	1211.4	1653.4	2815.4	4415.4	4965.4	4965.4

Source:NEC2004

Table J28: Electricity selling price by utility

Category	US cents/kWh
Residential	7.20
Commercial	10.80
Industrial	5.04
Others	8.00

Source:NEC2004

Table J29: Electricity purchase tariff by utility

Category	US cents/kWh
IPP	n/a
Others	n/a

Swaziland Power Sector

Power in Swaziland is supplied and distributed by SEB (Swaziland Electricity Board.
SEB is responsible to the Ministry of Works, Power and Communications. Installed capacity is mostly hydro powered. There is also a link with ESKOM in South Africa. Swaziland currently imports 90% of its electricity from South Africa.
Swaziland has in place coal reserves of 2 020 million metric tonnes.

Table J30: Institutional set-up of the power sector

Institution	Area of jurisdiction/Function
Swaziland Electricity Board (SEB)	National Utility. It is responsible for Generation, importation, transmission and distribution of electricity. Grant licenses to other electricity producers.
The Ministry of Natural Resources and Energy	Overall policy guidance and price controls
Ministry of Finance	The Public Enterprise Unit (PEU) of the Ministry of Finance is presently regulating and monitoring the activities and financial performance of SEB as a Government enterprise
Swaziland Environmental Authority (SEA)	SEA is also responsible for the issuance of Environmental Compliance Certificates for any projects, both small and large
Independent Power Producers	Produce electricity for use in their production process and for adjacent company towns
Tertiary institutions and NGOs	There is a long history of collaboration and co-operation between Government and the tertiary institutions and NGOs on energy projects and energy research.

Construction began in August 1998 on the Maguga dam. This R343.5 million dam, which is the country's largest public works project, was recently awarded to a Swazi consortium in a joint venture with Group Five of Swaziland, LTA, Grinaker and WBH Swaziland. This dam will bring Swaziland, which currently imports 90% of its electricity from South Africa, closer to self-sufficiency. The dam will take about 31 months to complete.

The European Investment Bank (EIB) in conjunction with government and the Swaziland Electricity Board (SEB) are to finance a 400 kV line project. The 400kv lines are being established by MOTRACO, a joint venture between Electricidade de Mozambique, ESKOM and SEB, which will supply the Mozal Aluminium Smelter in Maputo. The line stretches across Swaziland from Camden in South Africa to a new substation in Maputo, Mozambique

Source: The International Small Hydro Atlas, http://www.small-hydro.com/index.cfm?Fuseaction=countries.country&Country_ID=134

ANNEX M: SUMMARY OF AGRICULTURAL PRODUCTION IN PROJECT COUNTRIES

A. Ethiopia

Agricultural product	Production in (1000 tons) (Year 2000 – 2004)				
	2000	2001	2002	2003	2004
Sugarcane	2177	2232	2232	2456	2454
Rice Paddy	0	15	16	16	16

Source: FAOSTAT data 2005

B. Kenya

Agricultural product	Production in (1000 tons) (Year 2000 – 2004)				
	2000	2001	2002	2003	2004
Sugarcane	3942	3551	4501	4204	4661
Rice paddy	52	45	45	41	49

Source: FAOSTAT data 2005.

C. Malawi

Agricultural product	Production in (1000 tons) (Year 2000 – 2004)				
	2000	2001	2002	2003	2004
Sugarcane	2000	1900	1900	2100	2100
Rice paddy	71	93	92	88	50

Source: FAOSTAT data 2005.

D. Sudan

Agricultural product	Production in (1000 tons) (Year 2000 – 2004)				
	2000	2001	2002	2003	2004
Sugarcane	4981	5503	5500	5500	5500
Rice Paddy	8	11	8	16	16

Source: FAOSTAT data 2005

E. Swaziland

Agricultural product	Production in (1000 tons) (Year 2000 – 2004)				
	2000	2001	2002	2003	2004
Sugarcane	3885	4000	4300	4500	4500
Rice paddy	0.17	0.17	0.17	0.17	0.17

Source: FAOSTAT data 2005.

F. Tanzania

Agricultural product	Production in (1000 tons) (Year 2000 – 2004)				
	2000	2001	2002	2003	2004
Sugarcane	1355	1500	1750	2000	2000
Rice paddy	782	514	640	650	680

Source: FAOSTAT data 2005.

G. Uganda

Agricultural product	Production in (1000 tons) (Year 2000 – 2004)				
	2000	2001	2002	2003	2004
Sugarcane	1550	1600	1600	1600	1600
Rice	109	114	120	109	140

Source: Uganda Bureau of Statistics, FAOSTAT data 2005.

ANNEX N: LIST OF INSTITUTIONS AND PERSONS CONTACTED DURING PDF-B

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ANNEX O: BRIEF ON AFREPREN

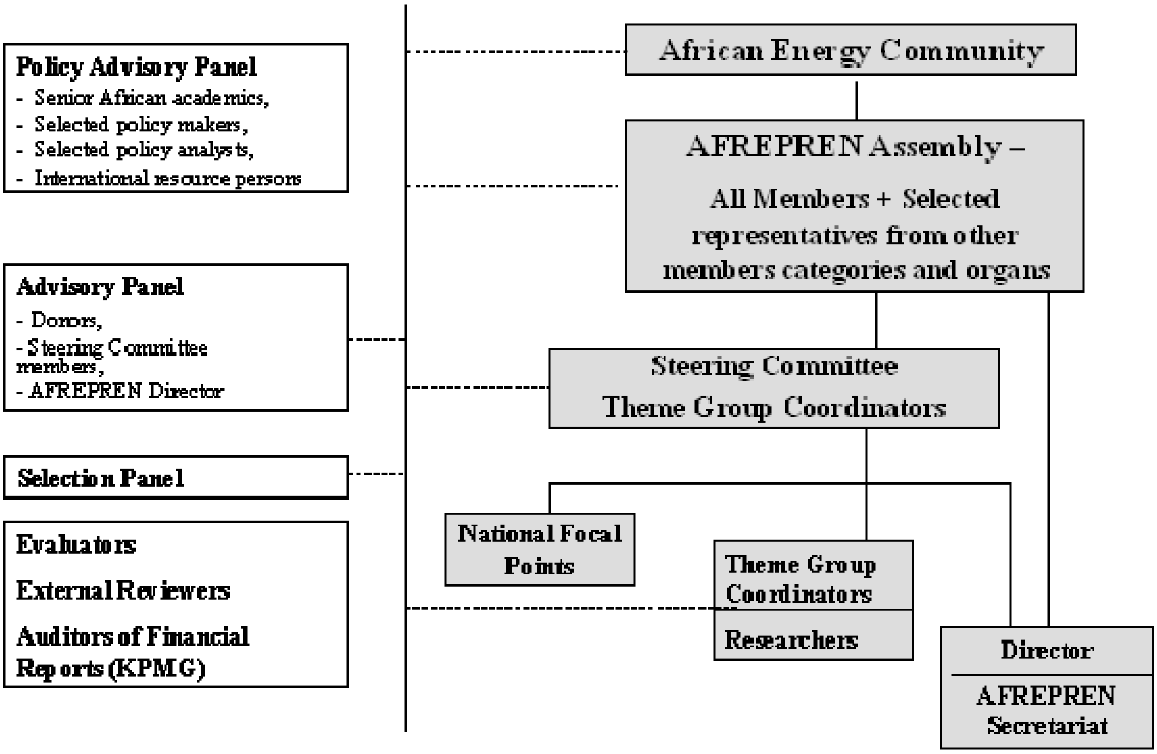
BRIEF ON AFREPREN/FWD - The Energy, Environment and Development Network for Africa

Introduction

Launched in 1989, AFREPREN/FWD brings together African energy researchers and policy makers who have a long-term interest in energy research and the attendant policy-making process. The key objective of AFREPREN/FWD is to strengthen local research capacity and to harness it in the service of energy policy making and planning. Since its initiation in 1989, AFREPREN/FWD has successfully implemented 90 research projects involving about 200 African researchers and policy makers from 19 countries of Eastern and Southern Africa and forged close collaborative links with several West African energy researchers and policy makers.

AFREPREN/FWD members decide on the structure, direction and mode of operation of the Network. The AFREPREN/FWD Secretariat shares offices with another international network, the Foundation for Woodstove Dissemination (FWD) in Nairobi, Kenya. The AFREPREN/FWD/FWD Secretariat coordinates the research program of AFREPREN/FWD and provides the requisite administrative and technical support. The structure of the network is shown below:

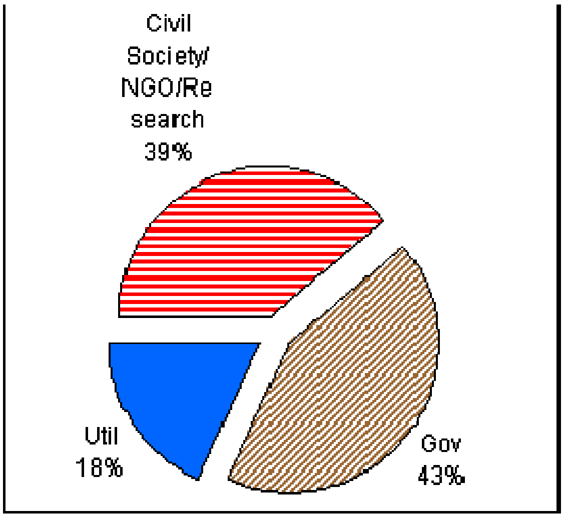
Figure N1: AFREPREN/FWD Organization Structure

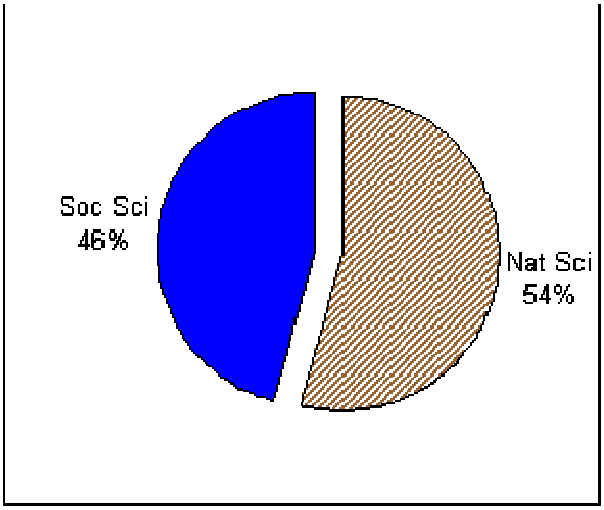


AFREPREN/FWD's Impact – A Brief Review

With 97 active African energy policy makers and researchers during any given research phase, the AFREPREN/FWD research program has a direct link to a critical mass of influential energy analysts in Africa. As shown in the following graphs, the distribution of the AFREPREN/FWD membership provides multiple entry points for influencing energy policy in the region. About 50 % of AFREPREN/FWD members are in Government or energy utilities and in a position to directly influence and/or formulate energy policy in the region. In addition, the broad specialization and qualifications of AFREPREN/FWD members assists in ensuring that AFREPREN/FWD's impact is felt across various disciplinary boundaries.

Figure N2: AFREPREN/FWD Membership: Institutional Affiliation & Discipline





Current and former AFREPREN/FWD members occupy (or occupied) senior positions in utilities and Ministries of Energy in the region. Notable examples include a Permanent Secretary in the Ministry of Energy in Kenya, Zambia and Tanzania; an Assistant Minister of Energy in Uganda; Directors of Energy in Ethiopia, Eritrea, Uganda and Zambia; Principal Economist in the Ministry of Finance and Ministry of Energy in Kenya; and, national utility director in Ethiopia. In addition, AFREPREN/FWD counts among its members, eminent researchers and scientific advisers. Notable examples include the late Pro-Vice Chancellor of the University of Mauritius and a former Member of the Scientific and Technical Advisory Panel (STAP) of the US$ 2 billion Global Environment Facility managed by the World Bank, UNDP and UNEP.

AFREPREN/FWD members are highly qualified individuals with vast experience in energy policy issues, as well as field project implementation. The participation of senior African energy policy makers and researchers in AFREPREN/FWD has been an important avenue for increasing AFREPREN/FWD's impact on energy policy formulation and implementation in the region. In a number of cases (notably Kenya, Ethiopia, Uganda and Zambia), senior AFREPREN/FWD members have used AFREPREN/FWD research reports to generate substantial portions of their country's energy policy documents and policy guidelines.

The Network has expertise in the following areas that are of relevance to this proposal – power sector reforms, electricity tariff setting, power sector planning, regulation and financing, power engineering, sugar/energy technology, hands-on operation of cogeneration-based IPPs and power utilities.

The engineering expertise in AFREPREN/FWD covers the following areas:
System load forecasting; construction and maintenance of cogeneration-based IPPs; management of energy efficiency systems; power sector planning; power systems design; construction and maintenance of power transmission lines; and power sector regulation. The network also has members who are senior lecturers in the faculties of engineering and technology in universities in the region with extensive experience in engineering design.

AFREPREN/FWD members have been involved in the execution of biomass-based cogeneration projects both at field and policy level. For instance, two of the largest IPPs in Mauritius are run and managed by AFREPREN/FWD members. At policy level, one of the AFREPREN/FWD members in Mauritius was instrumental in the setting up and implementation of the cogeneration policy.

Specifically, AFREPREN/FWD members have been involved in the following cogeneration projects:

- Kakira Sugar Works, Uganda
- Tanzania Wattle Company (TANWAT), Tanzania
- Hippo Valley, Zimbabwe
- Triangle Sugar Factories, Zimbabwe

The network members, through their respective institutions, have been involved in a variety of major energy projects ranging from grid extension and tariff negotiations to training of policy makers and technocrats.

AFREPREN/FWD has also been involved in implementation of energy policy research projects, training programs, and field surveys in the East and Southern Africa.

The AFREPREN/FWD Secretariat, which is based in Nairobi, Kenya, is staffed by a highly competent, well-qualified group of professionals (Independent Evaluation of AFREPREN/FWD, 2002). Staffed by engineers, economists, social scientists and expert on agriculture accounting, project finance and business administration, the AFREPREN/FWD Secretariat brings together a wide range of experience, knowledge and expertise on energy technology and policy issues in the East and Southern Africa region, as well as other African regions, Asia, Europe and the United States. The Secretariat also runs an internship program with local universities where continuing student work as interns/research assistants and are involved in various research projects.

AFREPREN/FWD has made a substantial contribution to the limited literature on energy in Africa. Findings of the research undertaken by AFREPREN/FWD have been published in 13 major books, a special issue of the International Energy Policy journal, 24 Occasional Papers, 37 journal articles, 23 book chapters and over 315 Working Papers. The publications are available in print and electronically on CD ROMs and on the AFREPREN/FWD website (www.AFREPREN/FWD.org). The various forms of AFREPREN/FWD's publications address the question of target and time. Some publications are lengthy and detailed, suitable for academia, the wider energy community and AFREPREN/FWD network members. Others are succinct, tailored mainly for busy readers such as policy makers and energy policy analysts.

AFREPREN/FWD has over the years developed a substantial African Energy Database, which is a compilation of data on energy and socio-economic indicators. The database covers mainly sub-Saharan Africa, but also includes other regions in Africa such as Central Africa, West Africa and North Africa. The database is updated and crosschecked regularly, to ensure that it is current and that the data is accurate.

To date, the Secretariat has produced nine (9) data handbooks. In order to avail the data to the wider public, the Secretariat has published two Occasional papers on African Energy Data and Terminologies (AFREPREN/FWD Occasional Papers 13 and 23). In addition to energy data and socio-economic indicators, these published volumes also include definitions of terminologies that are commonly used in the African energy sector. The published volumes are available on the AFREPREN/FWD website.

AFREPREN/FWD/FWD also has a library and documentation unit, which is dedicated to energy and energy related issues, and covers cogeneration issues in Africa in some depth. It contains more than 36,000 documents and has been growing at an annual rate of 11 % since 1990. All AFREPREN/FWD/FWD library documents are entered on a state-of-the-art computerized bibliographic system and are searchable.

The AFREPREN/FWD Website (www.AFREPREN/FWD.org) has been designed to enhance the exchange and sharing of energy information, and to increase access to information available within the AFREPREN/FWD Network and the energy community in general. The website has become popular as evidenced by the monthly average hits that have increased from less than thirty thousand in 1997 to more than forty thousand per month in 2004. The daily average hits currently stand at 1,441 hits per day.

Most research reports are available on the AFREPREN/FWD website as downloadable documents. AFREPREN/FWD publications occupy the largest section of the website. The publications on the website include published AFREPREN/FWD books such as forthcoming volumes, journal articles, conference proceedings, publication chapters, Occasional Papers and Working Papers as well as the African Energy Handbook. Plans are underway to upload the AFREPREN/FWD/FWD library on the website.

AFREPREN/FWD - Ideal host for the Cogeneration Center?

Since its initiation, AFREPREN/FWD has successfully implemented over 90 research projects involving 234 African researchers and policy makers in 19 countries of Eastern and Southern Africa and forged collaborative links with West, Central and North African energy researchers and policy makers. Through its network of members, publications, data and documentation resources, AFREPREN/FWD is uniquely placed to host the proposed Co-generation Center. AFREPREN/FWD has over the years built a significant amount of expertise on cogeneration, and is one of the few institutions in the region that has assessed cogeneration.

In particular, AFREPREN/FWD has undertaken a number of projects on biomass-based cogeneration in Eastern and Southern Africa. One of AFREPREN/FWD's research theme groups on 'Special Studies of Strategic Significance' has undertaken a number of studies on biomass-based cogeneration in the region. In addition, AFREPREN/FWD is currently coordinating a project on the potential of cogeneration in East and Horn of Africa.

The main projects and activities on biomass-based cogeneration undertaken by AFREPREN/FWD are summarized below:

- Commissioned studies on the cogeneration industry in Mauritius, factors leading to the successful implementation and lessons for other countries in the region. The studies were undertaken in conjunction with researchers from the Mauritius Sugar Authority and the Central Electricity Board in Mauritius, and have been published as an AFREPREN/FWD Occasional Papers, Journal Articles and AFREPREN/FWD Working Papers;

- Organized an Energy Training Workshop on Cogeneration for stakeholders from Eastern and Southern Africa, in conjunction with the Mauritius Sugar Authority. About 20 participants from the various energy sub-sectors in East and Southern Africa participated in the week-long Training Course, which debated the identified opportunities for cogeneration in a reforming African Power sector. The proceedings of the workshop are available as AFREPREN/FWD Occasional Paper number 21;

- Commissioned 7 short studies on the potential of cogeneration in Uganda, Tanzania and Zimbabwe;

- Sponsored a Masters Degree Thesis on Cogeneration in Kenya;

- Currently undertaking 4 national level and 1 regional level study (currently ongoing) on the contribution of cogeneration to the region's electricity sector. This study assesses the actual and potential contribution of cogeneration to total electricity supply in each of the countries, and the macro-economic benefits that would accrue from cogeneration development. The national studies are being undertaken in Kenya, Uganda, Tanzania and Ethiopia.

The research studies and projects on cogeneration have been published as various publications, which are listed below:

Journal Articles:

"Sugar cane bagasse for Electricity Generation in Africa" Kassiap Deepchand in ESI Africa Issue, 2, 2004

"Electricity from Bagasse in Zimbabwe". Charles Mbohwa and Shuichi Fukuda. In Biomass and Bioenergy Journal, Vol. 25, No. 2 Published by Elsevier Science Limited, Oxford, United Kingdom, December 2002.

"Bagasse Energy Cogeneration Potential in the Zimbabwean Sugar Industry". Charles Mbohwa. In Renewable Energy, Vol. 28 Published by Elsevier Science Limited, Oxford, United Kingdom, 2002.
"Bagasse Energy Cogeneration in Zimbabwe: The Technology, Possible Improvements and Setting the Right Environment." Charles Mbohwa and Shuichi Fukuda. In The Proceedings of the Zimbabwe Institution of Engineers. Published by the Zimbabwe Institution of Engineers, 2002.

"Promoting Equity in Large-Scale Renewable Energy Development: The Case of Mauritius". Kassiap Deepchand. In Energy Policy, Volume 30, Nos. 11-12. Published by Elsevier Science Limited, Oxford, United Kingdom, 2002.

"Commercial Scale Cogeneration of Bagasse Energy in Mauritius". Kassiap Deepchand. In Energy for Sustainable Development, Vol. V, No. 1. Published by International Energy Initiative Inc., Bangalore, India, March, 2001.

AFREPREN/FWD Occasional Papers:

"The Potential Contribution of Renewables to Africa's Energy Sector – The Case of Cogeneration and Geothermal: Summary for Policy Makers". Published by AFREPREN/FWD and HBF Regional Office for East and Horn of Africa.

"The Potential Contribution of Renewables in Ethiopia's Energy Sector –An Analysis of Geothermal and Cogeneration Technologies". Edited by Prof. Woldermariam Wollde-ghiorgis. Occasional Paper No.24, AFREPREN/FWD/FWD, Nairobi, 2004.39pp.

"Opportunities for Cogeneration in a Reforming African Power Sector – Proceedings of an Energy Training Course." Edited by Kassiap Deepchand. Occasional Paper No. 21, AFREPREN/FWD/FWD, Nairobi, 2003. 74pp.

"Cogeneration in Zimbabwe - A Utility Perspective". Bothwell Batidzirai. Occasional Paper No.19, AFREPREN/FWD/FWD, Nairobi, 2002. 48pp.

"Bagasse-Based Cogeneration in Mauritius - A Model for Eastern and Southern Africa". Kassiap Deepchand. Occasional Paper No. 2, AFREPREN/FWD/FWD, Nairobi, 2001. 37pp.

"AFREPREN/FWD Regional Policy Seminar on Renewables - Focus: Cogeneration". Edited by Stephen Karekezi, John Kimani and Jennifer Wangeci. Occasional Paper No.1, AFREPREN/FWD/FWD, Nairobi, 2001. 66pp.

Research Reports:

1. **Status of Renewable Energy in Kenya – A study into the Status and Potential of Power Generation from Biomass Waste in Kenya** by Eng. David Yuko
2. **Renewable Energy Technologies in Tanzania Biomass-Based Cogeneration** by Eng. Florence Gwang'ombe

3. **Cogeneration in Uganda** by Mr. Simon Peter Engorait

4. **Pre-feasibility Study on the Potential of Cogeneration in Zimbabwe** by Eng. Charles Mbohwa

5. **Assessment of the Potential of Cogeneration in Zimbabwe** by Mrs. Elizabeth Mugu

6. **Potential of Using Cogeneration for Power Supply by District Local Government in Tanzania** by James Ngeleja

7. **Establishment of Cogeneration Potential and Identification of Barriers to its Development in Uganda** by J. Baanabe

8. **Assessment of Policy Options for Promoting the Use of Forestry Wood Waste in Cogeneration Plants in Zimbabwe** by Alois Mhlanga

ANNEX P: PRELIMINARY ASSESSMENT OF COGENERATION POTENTIAL IN SELECTED SUGAR FACTORIES

Chemelil Sugar Factory, Kenya

i. The Chemelil Sugar Company is a Limited liability company, 97% shares of which is owned by the Government. Its catchments area for cane is in the Nyanza in the western part of Kenya. It started operation in 1968 and over the years its cane crushing capacity has reached 3000TCD.

   It produces 38000 tonnes of sugar and its average cane production for the period 1993 to 2003 was 595000 tonnes of cane. The average bagasse production has been around 232000 tonnes of cane. The bagasse to cane is thus 39%.

ii. The sugar factory is planning to increase its cane processing capacity to 4000 TCD and to process 1 million tonnes of cane annually. In addition, it is projecting to Invest in a Cogen plant with an installed capacity of 15MW.

iii. An appraisal was carried out by AFREPREN and its findings in terms of current cane and bagasse production using design parameters adopted under Mauritian condition is as follows.

   <u>The Chemelil Cogen Project (2750 TCD)</u>

   Factory crushing rate = 2750 TCD or 125TCH
   Bagasse % cane = 39%
   Bagasse output (t/h) = 48.75
   Less start-up losses @ 5% = 46.3
   Steam production per hour = 46.3* 2.2 Kg steam /Kg bag
   = 101.88 t/h
   Steam required for cane processing= 56.3 tonnes
   @ 450 Kg/tonnes

   Hence this amount of steam (56.3t) has to be extracted from the condensing-extraction (CE) turboalternator.

	Steam at 44 bar 440^{0}C	**Steam at 83 bar 525^{0}C**
Kg st/Kwh at CE	6.5	5.5
Kwh from 56.3 t steam	8661	10236
Kg St/Kwh at condensation	4.5	3.7
Kwh from 45.5 t steam	10111	12162
Total Kwh generated	18772	22398
Accounting for electricity consumption by auxiliaries @ 6%	17646	21054
Power consumption and cane milling @ 30Kwh/ tc	3750	3750
Exported to grid Kwh	13896	17304
@ Kwh/ TC	111	138
Export from 595000 TC	66 Gwh	82 Gwh

iv. Chemelil Sugar Company has the potential to export between 66 GWh and 82 GWh of electricity to the grid from installed capacity varying between 20MW for a steam pressure of 44 bar and 25MW for a steam pressure of 83 bars.

v. The estimated investment cost for the 2 pressure options proposed are as follows:
   a.) 20MW (44 bar) – US $ 20 million
   b.) 25MW (83 bar) – US $ 35 million.

vi. Using the data for the projected increase of cane crushing capacity to 4000 TCD and to handle one million tonnes of cane annually the detailed results will be as follows.

The Chemelil Cogen Project (4000 TCD)

Factory crushing rate = 4000 TCD or 180TCH
Bagasse % cane = 39%
Bagasse output (t/h) = 70.2
Less start-up losses @ 5% = 66.7
Steam production per hour = 66.7* 2.2 Kg steam /Kg bag
= 146.74 t/h
Steam required for cane processing= 81.0 tonnes
@ 450 Kg/tonnes

Hence this amount of steam (81.0t) has to be extracted from the condensing-extraction (CE) turboalternator.

	Steam at 44 bar 440^{0}C	**Steam at 83 bar 525^{0}C**
Kg ST/Kwh at CE	6.5	5.5
Kwh from 81.0 t steam	12461	14727
Kg ST/Kwh at condensation	4.5	3.7
Kwh from 65.74 t steam	14609	17768
Total Kwh generated	27070	32495
Accounting for electricity consumption by auxiliaries @ 6%	25446	30545
Power consumption and cane milling @ 30Kwh/ TC	5400	5400
Exported to grid Kwh	20046	25145
@ Kwh/ TC	111	140
Export from 595000 TC	111 Gwh	140 Gwh

vii. Chemelil Sugar Company has the potential to export between 111 GWh and 140 GWh of electricity to the grid from installed capacity varying between 30MW for a steam pressure of 44 bar and 35MW for a steam pressure of 83 bars.

The estimated investment cost for the 2 pressure options prepared are as follows:
i.) 30MW (44 bar) – US $ 30 million
ii) 35MW (83 bar) – US $ 49 million.

Busia Sugar Factory, Kenya

i. This company, controlled by the Government of Kenya as the majority shareholder, is currently ensuring agricultural management through funding, developing and successfully operating around 5700 ha of land belonging to farmers (outgrowers) for cane production.

ii. It is projecting to increase its area under cane production by an additional 20000ha and at the same time to invest in the construction of a new factory (4200 TCD) and a cogeneration plant next to it.

iii. The land is located within a radius of around 24 km of the site identified for the erection of the sugar factory. The land currently under cane is generally at 2nd , 3rd an d 4th ratoon stage and the yield has been around 75t/ha. The area has potential for cane production and, if properly managed and in particular if coupled with application of chemical fertilizer, cane yield may reach 90t/ha or higher. The current yield is only 50t/ha, a low yield by the world standards.

iv. The potential of cogeneration of electricity for sale to the grid has been worked out and the details are given below:

New cogeneration project proposal

1. Development of some 18000ha of land for cane production

2. Construction of a 4200 TCD factory to produce 115000 tonnes of sugar per year
3. Construction of a cogen facility 20MW capacity

Evaluation of the Cogen Potential

Factory crushing rate = 4200 tcd or 190TCH
Fiber % cane = 17.8%
Baggase % cane = 17.8* 100/50 = 35.6%
Bagasse output = 190*35.6
= 67.6
Less start-up losses @ 5% = 64.0
Steam production per hour = 64.0 * 2.2 Kg steam /t bag
=141 t/h
Steam required for cane processing =85.5 tonnes
@ 450 Kg/tonnes
Hence this amount of steam (85.5t) has to be extracted from the condensing-extraction (CE) turboalternator.

	Steam at 44 bar 440^{0}c	Steam at 83 bar 525^{0}c
Kg st/Kwh at CE	6.5	5.5
Kwh from 85.5 t steam	13153	15455
Kg St/Kwh at Condensation	4.5	3.7
Kwh from 54.5 t steam	12111	14729
Total Kwh generated	25264	30184
Accounting for electricity consumption by auxiliaries @ 6% Kwh	23748	28373
Power consumption in cane milling @ 30Kwh/ t c	5700	5700
Exported to grid Kwh	18048	23673
@ Kwh/ t c	95	125
Export from 1 million t c	95 Gwh	125 Gwh

v. The Busia Sugar Company has the potential to export between 95 Gwh and 125 Gwh of electricity to the grid from installed capacity varying between 25 Mw for a steam pressure of 44 bar and 30 Mw for a steam pressure of 83 bars.

vi. The estimated investment costs for the project on the basis of the 2 conditions of operating pressure are as follows:
a. 25 Mw (44 bar) – US $ 25 million
b. 30 Mw (83 bar)(preferably 35 Mw) – US $ 42 million

Nchalo Sugar Mill, Malawi

Nchalo sugar mill cane production currently amounts to around 1.3 million tonnes and sugar recovery of 160,000 tonnes.

Nchalo mill operated for 203 days in the year 2005 at 315 TCH and the average bagasse percentage cane was 28.6. The totality of the bagasse is currently burnt in 3 boilers to generate steam and power as shown in the following table.

NCHALO PLANT DESCRIPTION, STEAM AND POWER SYSTEM. (Installed kW ratings)
BOILERS

	No. 1	No. 2	No. 3	No. 4	No. 5
Maker	JT	JT	JT	JT	B&W
MCR, t/h	27.0	18.0	27.0	40.0	85.0
Pressure, kPa	1700	1700	1700	3000	3000
Temperature, °C	300	300	300	400	400

B&W=Babcock and Wilcox

TURBO-ALTERNATORS

	No. 1	No. 2	No. 3	No. 4
Maker, turbine	Allen	Allen	AEI	AEG
Maker, alt.	Parsons	AEG	AEI	AEG
MCR, MW	3.5	2.5	4	1.7
Type	B/P,LP	B/P,LP	B/P,HP	B/P, HP

HP= 3100 kPa
LP= 1700kPa
BP=Back Pressure

MILL TURBINES

	No. 1	No. 2	No. 3
Maker, turbine	FCB	FCB	FCB
MCR, kW	600	600	600

SHREDDER

Maker, turbine	ABB
MCR, kW	4000

SUNDRY TURBINES

Boiler Feed water Pump

Maker, turbine-CORPUS	Not Known
MCR, kW (LP Boiler)	220
MCR, kW (HP Boilers)	220

The potential of Nchalo mill using technically and commercially proven figures to export power to the grid is worked out below.

Design Data Used

TCH – 315 TCH
F% Cane = 14.5
H20% = 49.5%
Bagasse % Cane = 29%
Weight of bagasse = 91.4 t/h
Less 5% start-up losses = 86.8
Tonnes steam/hr = 190t/h

Process steam consumption @ 450kg/tc = 142t/hr
Steam to condense = 190-142 = 48t/hr

	44bar	83bar
C/E Kg steam/Kwh	6.5	5.5
Kwh generated	21846	21818
Condensing Kg steam/Kwh	4.5	3.7
Kwh generated	10666	12973
Total Generated	**32512**	**38791**
Less Auxiliaries (6%)	30561	36463
Less power consumed in milling @ 30Kwh/tc	9450	9450
Net Kwh from 315tc	21,111	27013
Kwh/tc	67.02	85.75
Total export from 1339455tonnes (GWh)	89.8	114.9
Investment cost	**US$32.5m**	**US$56m**

It is seen that Nchalo sugar mill can after meeting the totality of its energy (process steam and electricity) requirement has the potential to export 90 to 115Gwh of energy with excess power capacity ranging between 32.5 to 40MW

Dwanga Sugar Mill, Malawi

At Dwanga sugar mill, cane production in the year 2005 was 795,000 tonnes. The mill operates to around 30 weeks per year during the period: April to the end of November/early December limited due to, inter alia, the rainy season and field muddy conditions and in addition to issues linked to maturity of the cane.

Dwanga sugar mill has a cane processing capacity of 178TCH and its bagasse percentage cane is 33. The mill operated in 213 days in the year 2005. The bagasse is burnt in 2 boilers and the steam generated is used to drive the turbine of 2 alternators, the mills and shredders; Details are given in the following table.

DWANGWA PLANT DESCRIPTION, STEAM AND POWER SYSTEM. (Installed kW ratings)

BOILERS

	No. 1	No. 2
Maker	John Thompson	John Thompson
MCR, t/h	50.0	50.0
Pressure, kPa	3100	3100
Temperature, °C	385	385

TURBO-ALTERNATORS

	No. 1	No. 2
Maker, turbine	Shinko	Shinko
Maker, alt.	Allis	Allis
MCR, MW	3.5	3.5
Type	B/P,HP	B/P,HP

HP=High Pressure
(1700kPA)

MILL TURBINES

	No. 1	No. 2	No. 3
Maker, turbine	Mirlees Watson	Mirlees Watson	Mirlees Watson
MCR, kW	350	225	225

SHREDDERS

Maker, turbine	Peter Brotherhood
MCR, kW	1500

SUNDRY TURBINES

Boiler Feed water Pump

Maker, turbine	Shinko
MCR, kW	220

The potential of Dwanga mill using technically and commercially proven figures to export power to the grid is worked out below.
Design Data Used

TCH – 178 TCH
F% Cane = 16.5%
H20% = 49.5%

Bagasse % Cane = 33%
Weight of bagasse = 58.74 t/h
Less 5% start-up losses = 55.80 t/h
Tonnes steam/hr = 123t/h

Process steam consumption @ 450kg/tc = 80t/hr
Steam to condense = 123 - 80 = 43t/hr

		44bar		83bar
C/E Kg steam/Kwh		6.5		5.5
Kwh generated		12308		14545
Condensing Kg steam/Kwh		4.5		3.7
Kwh generated		9555		11622
Total Generated		**21863**		**26179**
Less Auxiliaries (6%)	20551		24608	
Less power consumed in milling @ 30Kwh/tc		5340		5340
Net Kwh from 178tc	15211		19268	
Kwh/tc		85		108
Total export from 795000 tonnes (GWh)		68		86
Investment cost		**US$22m**		**US$37m**

Dwanga Sugar Mill has the potential for a Cogen plant with installed capacity between 22 and 25MW depending on steam pressure of 44bar and 83bar.

ANNEX Q: COGEN PROGRAM IN ASEAN

COGEN PROGRAM IN ASEAN

Reference is made to the successful program implementation of the EC-supported Cogen phase 1, 2 and 3 for the ASEAN countries located at the Asian Institute of Technology (AIT) in Bangkok. The Association of South East Asian Nations (ASEAN) is an inter-governmental organization composed of Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam. A 4-year preliminary Cogen phase started in 1991 with the detailed formulation of a Cogen program, identifying needs, and preparing demonstration projects. In the second phase (1995-1998) 16 biomass based demonstration projects were realized while numerous additional parties received professional advice. The achievements of Cogen 2 in a nutshell: Increased awareness concerning possibilities and limitations of Cogeneration; Investments of € 60 mio realized in the Cogen sector of ASEAN; contributing a total of 354 MW_{th} and 74 MW_e while avoiding the emission of 250,000 tons of carbon equivalent per year. The ongoing 3rd phase (2002 – 2004) aims to promote Cogen in additional (new) ASEAN member countries and create new business opportunities for biomass, coal and gas based cogeneration in all other ASEAN member states. With the Cogen 3 phase officially terminating at the end of 2004, the Cogen Program realized an accumulated 110 MW_e in Full Scale Demonstration Projects while the program, through its expert advice on techno-economic issues, supported the creation of an additional estimated 500 MW_e of Cogen capacity in the ASEAN region.

During the first and second phase of the Cogen Program, the AIT housed 2 international experts, 4 regionally hired experts and 4 support staff. The annual operating cost amounted to € 750,000 per annum. For Full Scale Demonstration Projects (FSDPs) another € 2.5 mio was reserved and utilized. With the cost of approx. € 5 mio, the Cogen 2 phase realized € 60 mio of directly related investments in these Full Scale Demonstration Projects, a leverage effect of 1:12. As meanwhile the FSDPs themselves have been replicated, the indirect impact is understood to be even substantially larger. The leverage effect of Cogen 3 is estimated to be about 1:10 as in this last phase more international experts were deployed in the region, as per EC requirement.

The Full Scale Demonstration Projects were used to push the concept of cogeneration using only proven technologies. For some sectors (e.g. sugar industry, palm oil industry) cogeneration was already -partly- accepted; for other sectors (e.g. introducing step grate combustion for Cogen in rice mills) cogeneration was an entirely new concept. Showcasing the techno-economic feasibility and environmental advantages in actual projects has proven an effective way in promoting the cogeneration concept. The FSDPs were financially supported by the Cogen Program but never to a level that would alter the economic feasibility of a project: If a project was awarded FSDP status (based on a range of criteria such as reliability, technical soundness, efficiency, IRR, bankability, global/local impact, replicability) a grant of 15 % of the hardware cost but up to a limit of € 400,000 per project would be made available. It turned out that for smaller scale Cogen projects (up to some 3 MW) the 15 % support would be paid out; for projects over 3 MW the ceiling of € 400,000 was enforced. For a large 40 MW bagasse-fired Cogen system in Thailand, the € 400,000 grant was equal to 1 % of the total investment cost. However, the sugar company valued the expertise provided by the Cogen center (in this case technical advise, monitoring and confidence building were attractive points) while the FSDP status allowed free access to interested parties and government representatives. Cogen kWh prices: In a Full Scale Demonstration Project in the Philippines with a 1.0 mw rice husk Cogent plant, the kWh price amounts to Philippine Peso 3.50 or USD 0.06. In a 41 MW sugar Cogen facility the kWh is said to be USD 0.04/kwh.

A complete presentation covering the EC-ASEAN Cogen Program is available at website www.cogen3.net

ANNEX R: COGENERATION IN MAURITIUS

COGENERATION IN MAURITIUS

Mauritius, as a small island developing state forming part of the African continent, is devoid of any fossil fuel and depends heavily on imported energy for use in the various sectors of the economy. Hydro power and sugar cane bagasse are the two renewable resources that potentially can be used for electricity generation. Hydro power is limited by the availability of rain water and is seasonal in nature, and this resource is fully exploited in Mauritius. Interest in the use of bagasse for electricity generation and export to the grid started in Mauritius in 1957, but the most significant developments occurred in the early 1980s with the commissioning of a 10 MW continuous power plant and shortly thereafter a 21.7 MW firm power plant

Factory	Tonnes cane per hour	Power	Start date	Units from bagasse (GWh)	Units from coal (GWh)	Total units from bagasse & Coal (GWh)
Fuel	270	F	Oct. 1998	60	115	175
Deep River Beau Champ	270	F	April 1998	70	85	155
Belle Vue	210	F	April 2000	105	220	325
Medine	190	C	1980	20	-	20
Mon Tresor Mon Desert	105	C	July 1998	14	-	14
Union St. Austin	150	C	July 1997	16	-	16
Riche en Eau	130	C	July 1998	17	-	17
Savannah	135	C	July 1998	20	-	20
Mon Loisir	165	C	July 1998	20	-	20
Mon Desert Almo	170	C	Nov 1997	18	-	18
Total		3F		360 GWh	420 GWh	780 GWh
		7C		235 GWh F		
				125 GWh C		

** F = Firm (bagasse during crop and coal during intercrop)*
** C = Continuous (bagasse during crop season only)*

The success of these plants and events in the Gulf area in the early 1990s led the government to develop a bagasse energy development program. This included incentives to entrepreneurs to invest in power plants as independent power producers, as well as financial spin-offs, through a sugar investment trust, for the small cane growers and workers. This resulted in the following decade in an increase in capacity of sugar industry plants from 43 MW in 1993 up to 242 MW in 2002, with a concomitant increase in electricity exported to the grid in the same period from 111 GWh (12.8% of Mauritius' total) to 746 GWh (43.5% of the total).
At the same time the efficiency increased from 12 kWh/ton cane processed in 1991 to 61 kWh/ton cane in 2002. However, this is well below the 110 kWh/ton cane obtained in Réunion where only two factories are in operation, each processing around 900,000 tons of cane annually. Each factory is equipped with 2 x 30 - 35 MW power plants operating at around 82 bars. Only the Belle Vue plant is operating with this efficiency in Mauritius.

African Countries	Sugar (x10)	Sugar cane	Cogeneration potential (GWh)	
			44 bars	82 bars
Angola	31	282	20	31
Benin	5	45	3	5
Burkina Faso	40	364	25	40
Burundi	21	191	13	21
Cameroun	113	1,027	72	113
Chad	33	300	21	33
Congo	55	500	35	55
Cote d'Ivoire	158	1,436	101	158
Egypt	1,397	12,700	889	1,397
Ethiopia	294	2,672	187	294
Gabon	18	164	11	18
Guinea	26	236	17	26
Kenya	423	3,845	269	423
Madagascar	32	291	20	32
Malawi	257	2,336	164	257
Mali	34	309	22	34
Mauritius	552	5,018	351	552
Morocco	156	1,418	99	156
Mozambique	242	2,200	154	242
Nigeria	20	182	13	20
Reunion	210	1,909	134	210
Senegal	93	845	59	93
Sierra Leone	6	55	4	6
Somalia	21	191	13	21
South Africa	2,755	25,045	1,753	2,755
Sudan	792	7,200	504	792
Swaziland	520	4,727	331	520
Tanzania	190	1,727	121	190
Togo	3	27	2	3
Uganda	244	2,218	155	244
Zaire	75	682	48	75
Zambia	231	2,100	147	231
Zimbabwe	565	5,136	360	565
Total	**9,612**	**87,378**	**6,117**	**9,612**

(a) Estimated at sugar recovered % cane of 11%
(b) Based on 70 kWh/tonne cane
(c) Based on 110 kWh/tonne cane Sugar statistics from World Sugar Statistics (65th Edition), by FO Lichts (2004). Production of sugar and sugar cane and potential for cogeneration in Africa.

Further bagasse energy projects are also planned. A 35 MW coal fired power plant is being erected and will be commissioned within the next two years and it is anticipated that two firm power plants will follow immediately thereafter. With the implementation of these plants the electricity export to the grid from bagasse is likely to reach 550 GWh.
With further centralization of cane milling activities, improvement in exhaust steam in cane processing, upgrading of power plant efficiency to operating pressures of 82 bars and the use of cane field residues as supplementary fuel it can be safely said that 800 GWh of electricity could be exported to the grid from sugar cane biomass. This could be increased even further if current research and development efforts on a biomass gasifier/gas turbine combined cycle become a commercial reality.

POTENTIAL FOR REPLICATION ON THE AFRICA CONTINENT
The success achieved in bagasse energy cogeneration in Mauritius can be replicated in almost all the cane sugar producing countries on the African continent.
The table below gives the statistics on sugar and cane production in Africa and the potential amount of electricity that can be exported to the grid using the two commercially proven technologies (steam pressures of 44 and 82 bars), based on the results obtained in Mauritius. It must be noted that such plants require a minimum cane crushing capacity of 200 to 300 tons of cane per hour and many of the African countries have cane production well below these capacities. However, the cane sugar industries in a number of these countries are being rehabilitated and modernized and there is merit in coupling these plants with a cogeneration facility.

The total potential for sugar cane energy production in the countries in Africa is around 9,600 GWh on the basis of present cane production. Currently only Mauritius and Réunion are exploiting such bagasse in a significant manner.

PROSPECTS FOR COGENERATION
From the sugar industry's perspective the implementation of cogeneration would bring additional revenue to the industry, which is facing threats of price and quota reduction in the preferential markets in the context of trade liberalization. Besides, cogeneration is a climate-friendly technology that can attract GEF funding as well as financing schemes such as Activities Implemented Jointly and the Prototype Carbon Fund. Most of the cane producing countries in the African continent could benefit from such funding or schemes.
The on-going power sector reforms in the region have enhanced the prospects of cogeneration in the continent. However the cogeneration industry has to face a number of policy and institutional challenges in a reformed power sector. The national utility generally operates in a monopolistic situation in that generation, transmission and distribution are undertaken as a bundle of activities. In the reform, it has been envisaged that generation can also be undertaken by independent power producers but the issue of open access to the grid has to be properly addressed in power purchase agreements.

The price of cogenerated electricity is around 6-7 US cents/kWh and in many cases this price is not competitive with that of hydro electricity, which is priced at around 3 US cents/kWh. Furthermore bagasse energy cogeneration is only possible during the cane harvest season which lasts between 6-9 months and there is need for a complementary fuel such as coal for 3-6 months.
Another issue likely to pose significant challenges to cogeneration development is the deterioration in the management of the sugar industry which has led to its near collapse in many countries and led to closure of a number of sugar factories. This implies that if a sugar factory is not able to produce sugar - its primary output - it is unlikely to be a good cogenerator.

Unless there is an integrated policy of cogeneration linking sugar and electricity exports to the grid as a significant source of income to the industry, it is unlikely that cogeneration can be realized. In addition, most of the sugar factories need to be completely overhauled and modernized and these activities have to link with energy cogeneration which will enhance the financial viability of the facilities. The Mauritian sugar industry has faced such a situation and sharing of experience gathered on these issues will prove beneficial to the cane sugar industries in the region.
SOURCE: http://www.esi.co.za/archive/esi_2_2004/44_1.php

ANNEX S: NEWSPAPER ARTICLES RELEVANT TO THE PROJECT

Kenya: Electricity set to cost more By: BERNARD NAMUNANE

Kenyans will soon start paying higher power bills as the Government fights to meet electricity needs.

Power deficits, caused by inadequate water in electricity generating dams, have been projected to increase in the year, climaxing in December, said the Government yesterday.

The water level at Masinga Dam - the main storage reservoir for the Seven Forks - has dropped and will be worse by June, said Energy minister Kiraitu Murungi.

"Unless alternative arrangements are made promptly to supply electricity, there could be massive power rationing," he warned.

In a statement, Mr Murungi said the Government had decided to install new emergency power generators, which will provide 180 megawatts.

Measures to start depending mainly on oil-fired thermal power would now be intensified, increasing power rates.

Said he: "To give relief to the consumer, the Treasury will absorb the capacity rental charge, while the fuel cost will be passed on to the consumer."

Although the new measures were meant to last until April this year, the ministry has provided for an extension of 12 months, said the minister.

Mr Murungi said the cost of one unit of electricity now stood at Sh36 and was likely to block the Government from realising its growth target of five per cent. The minister has appointed the Emergency Power Supply committee to implement the new measures. The committee, which starts work immediately, will ensure availability of power at an affordable cost. It was also directed to ensure that the new generators start operating on May 1.

The public has also been urged to use power sparingly by switching off lights during the day, buying energy saving bulbs and using power during off-peak hours.

The country last experienced power rationing in 2000 due to low levels of water in the country's seven power generation dams following poor rainfall.

The country largely depends on water-generated electricity in the seven dams and is yet to tap wind and thermal power.

Although the country's power stations supply 1,050 megawatts against a demand of 930 megawatts, the minister said the expected growth in the economy and unpredictable weather have resulted in a projected deficit of 117 megawatts in May this year, which will rise to 174 megawatts in December.

Various essential services in Nairobi are preparing to deal with the water rationing.

Kenyatta National Hospital will be doing internal rationing, to store a week's supply of water, said spokesman Herman Wabwoba.

But he said the Nairobi Water Company should find a way to continue piping water to hospitals.

Mr Wycliffe Baraza, maintenance manager at the Mater Hospital, agreed that hospitals should be spared, but

conceded that Mater could sustain the rationing if it is not too prolonged.

Nairobi's fire brigade will also continue to work as usual, said station officer Evans Akado.

The United Nations compound in Gigiri began cutting down on water even before the rationing was announced.
The Daily Nation, Published: 2/11/2006

Kenya: Sugar industry's potential is yet to be fully utilised

By Prof Henry Bwisa

The on-going debate in the sugar industry makes it important for us to reflect again on the importance of this sector.

Today industrialisation and poverty eradication are two key Government objectives. Being an agro-based country our problem seems to be to select the most beneficial sector in terms of resource requirements, comparative advantage and creation of complementarities and linking with other sectors in the economy.

I want to propose that considering the present level of development, agro-based resource-based industries appear to be the best alternative for attaining the country's most appealing objective of poverty alleviation. The sugar industry is in my opinion a good candidate.

In order to comprehend the investment opportunities in the sugar industry I invite you to walk with me down the road of the sugar industry value chain.

Station one: The biotechnologist researches on the best cane seed for the farmer to plant.

Station two: Suppliers provide inputs to the farmer.

Station three: The farmer plants and manages the cane. Station four: The miller and refiner receive the cane from the farmer and processes it.

If it has been one road all through then at this station we get two branches off the main road.

Branch one: The by-product dealer uses by-products such as molasses and bagasse to produce useful products. Branch two: The millers and refiners send their sugar to the export market to earn forex.

Back to our main road and onto station five where the local dealer markets the sugar to both the industrial consumer for manufacturing foodstuffs and to the direct consumer. This is done via wholesalers and retailers.

It is evident that a well-managed sugar industry is pregnant with what economists call multiplier effects and linkages. One such a linkage is to academic institutions that do research and produce experts. Another linkage is to the by-products manufacturing sector.

There are other linkages. The multiplier effect is reflected in the many benefits generated at every station mentioned. Employment creation is accomplished and many participants in the chain get incomes. Industrialisation is effected even via the by-products of the millers.

Thus bagasse can be turned into steam for boilers as well as produce electricity which can be fed into the national grid. Bagasse is also used as raw material by the paper industry for production of fine quality paper. We would save our forests by using bagasse to produce paper. Bagasse and wood fibre are made into building particleboard by a process analogous to paper making.

Another by-product called molasses can be used in the manufacture of ethyl alcohol and as a table syrup and food flavourant. It is also used as feed for farm animals and in the manufacture of several processed tobaccos. Molasses can further be used to manufacture Ethanol which can be mixed with petrol to save foreign exchange on one hand and save precious conventional energy source of Petrol on the other hand. The same ethanol can be manufactured using cane juice.

Something called press mud is obtained in sugar factories to a tune of 2 per cent of the weight of sugar cane crushed. Press mud contains sizable quantity of macro and micronutrients, besides 20-25 per cent of organic carbon and can be used as organic manure by farmers and save importation of fertilisers.
Other by-products of the sugar cane industry would include synthetic alcohol and spirit (combined with benzene) as a fuel, bakers' and fodder yeast, chemical products such as acetic and citric acids etc.

With these potentially explosive investment opportunities it does not add too much to progress in the industry that as debate on it goes on efficiency of production is still a major problem both in the farming and processing spheres. For the farmers, the problem manifests in lower yield and lower sucrose content of the cane than in competing countries. More important is the fluctuation in annual cane output, mainly because most cane areas are rain-fed. All these factors collectively affect income stability of the growers as well as the efficiency in utilising mill capacity.

There are also problems that arise from improper cane harvesting and transportation, for example, cane burning and long queues and waiting periods during cane delivery.

The simple message here is that any action that retards the growth of the sector is tantamount to throwing the child out with the path water or killing the goose that lays the golden egg.

Bwisa is the Chairman, Kenya Investment Authority, and professor of entrepreneurship at JKUAT bwihem@yahoo.com

The Saturday Standard, January 21, 2006

Tanzania: Power cuts to bite more
2006-02-15 07:57:05
By Juma Thomas, Dodoma

The government announced yesterday a major load shedding schedule to save the power supply system from total collapse.

The revised schedule comes into effect today and will cover the entire country.

The new schedule comes at a time when some parts of the country are said to be already experiencing rationing for more than 12 hours.

The Minister for Energy and Mineral, Dr Ibrahim Msabaha, told the House that the purpose of the new power-rationing timetable was to save an average of 120 megawatts on the national grid.

Dr Msabaha, who was clarifying the government's position on power generation, said the water level at the Mtera Dam had reached 687.35 metres and to save the power system from total collapse, the government had decided to increase power-rationing hours on the recommendations of Tanesco.

Under the major power rationing schedule, domestic consumers, businesses and offices located in residential areas would go without power for 12 hours from 7am to 7pm daily, except on Fridays, Saturdays and Sundays.

On these days power will be rationed from 2pm to 7pm.
The minister said major industries, sensitive areas, major hospitals, banks and TRA offices will not be affected by new load shedding schedule.

The intention, the minister said, was to allow production to continue in these areas.

Kahama Gold Mine and Mwadui Resolute will not be affected.

The minister said that other gold mines such as Geita, generate their own power, hence they are not affected by rationing.

He said that offices and industries get low power voltage in downtown Dar es Salaam because of defective transformers at Ilala and would continue to suffer until a new transformer being installed becomes operational.

The minister said the transformer was bought in India and installation work had already started.

'We hope it will be ready by next month,' he said.The minister said the government had directed every region to reduce power consumption by 50 per cent.

He said that leading industries that contribute significantly to national income would not be affected by the power rationing.

Tanzania Starts Rationing Electricity Due To Drought

Thursday, 2 February 2006

By AND Network

Tanzanian authorities on Thursday began rationing electricity because of water shortages at hydroelectric plants caused by a drought that has placed millions at risk of famine across east Africa.

Energy and Minerals Minister Ibrahim Msabaha said power would be cut during the day from 8:00 am (0500 GMT) to about 5:00 pm (1400 GMT). "We are now forced to use water at (the main) Mtera Dam frugally until mid-March, when an additional 60-megawatt gas turbine will be installed at Ubungo Power Station in Dar es Salaam," he told AFP by phone. Tanzania Electric Supply Company (TANESCO) will provide power during the night. "It is important to have light at night to curb crime," he said. On Tuesday, President Jakaya Kikwete said most of the hydro power plants would be shut due to water shortages. "We are now approaching a point where we must shut down the hydropower generation plants," he said. Kikwete said the water level at Mtera Dam, which feeds the major hydroelectric plants in central Tanzania, was below the permitted power-generation level of 690 metres. "The government in January permitted TANESCO to continue with production until the level reached 687 metres," he said. "The level has since dropped to 687.59 metres, meaning we have only 59 centimetres remaining, beyond which power production will have to stop. Under such circumstances, power rationing is now inevitable," he warned. He said the 447 megawatts currently produced by TANESCO's hydro and thermal stations and firms contracted by the state fell short of national demand, which is said to be double the amount being generated. TENASCO chief Adrian Van Der Merwe said power rationing would not affect institutions such as hospitals, key government facilities and strategic industries. Electricity has for the last five months been erratic in Tanzania's commercial capital Dar es Salaam for various reasons including drought and a breakdown of facilities. Many traders and industrialists were forced to resort to noisy and costly generators. Tanzania's total generation capacity is 953 megawatts, more than two-thirds of which is hydroelectric.

Source: Sapa
http://www.andnetwork.com/app?service=direct/1/Home/$StorySummary$0.$DirectLink$2&sp=l15600

Uganda: Power shortage: Firms die

MONITOR TEAM, 9 February, 2006

KAMPALA

DAYLONG power outages are beginning to claim their first victims. The once bustling downtown industrial centers of Katwe and Kisenyi are slowly slipping into inactivity.

When Daily Monitor reporters visited Katwe yesterday morning, welders were not inside their workshops fixing window and door frames - they were seated outside talking politics. "You can see we are like idlers," one man said. "The power comes back at night when we are asleep. We don't have business now because the power is on and off ."

Many entrepreneurs expressed disappointment at the increased load shedding.
Last week, Umeme announced it had increased load shedding to 12 hours from the usual 4 hours on the advice of the Uganda Electricity Transmission Company Ltd. UETCL in turn blames power generation capacity which has declined because of the low water level of Lake Victoria. The hydropower generation capacity which was 265 MW two years ago has declined to 140 MW.

Mr Shafik Nsambu of Bivamuntuyo General Metal Works in Katwe complained of their inability to finish clients' work: "A number of our customers who made orders for window and door frames have come here complaining, calling us thieves. We actually look like thieves and idlers," he adds.

In Kisenyi, where a number of maize mills are operated, the situation is not any better. Mr Mutumba Grace who operates Westland Maize Millers said they are only producing two sacks of 50kg maize instead of the 30 sacks they are supposed to produce daily.

"We cannot afford a generator. When things get worse we shall go back to our villages," Mutumba said.

Kampala Siti Cable Ltd, an Internet service provider, in Kamwokya, is using a generator. "We don't have our own generator. We spend Shs 150,000 to hire and buy fuel for a generator on a daily basis," says the company's Marketing Manger Mr Shaban Lukooya.

"Since January, our power has been on and off. This has affected our machines, with many of them blowing up," Lukooya said, addning that their subscribers sometimes pay as little as $ 20 monthly instead of the required $50 because of load shedding.

Nasser Road
It's a sad affair too on Nasser Road, the home of the printing and publishing business. Although it was business as usual when Daily Monitor visited, businessmen were lamenting. "Our industry depends entirely on power. We cannot work without power. We have no generators since it is so expensive to run such heavy machinery on generators.

But if the situation continues, we shall have no option but to buy generators, which will mean increasing our printing charges," says Mr Fredrick Kamya, the Manager of Horizon Lines Ltd. a printing company for magazines, books, brochures and posters along Nasser road. Printers have a lot of orders because of the campaigns.

Mr Goodwill Aloysius of Toner World, a computer servicing company was frustrated too. "Most of the work is computer based so without power we cannot do anything developmental," Aloysious said.

Mukalazi Metal, specialists in building vehicle body parts said they would soon fold if the situation doesn't improve. It takes them now a month to build one body instead of a week, reported the Director Mr Mukalazi Muhamood.
Ms Ruth Namusoke, the proprietor of Katwe Fresh Diaries said that the milk used to go bad whenever power went off; now they now use a generator but it also consumes a lot of fuel.

"We can't wait for power to come back," Namusoke says.
Supermarkets have not been spared the brunt either. At Shoprite supermarket, there was no power when Daily Monitor visited.

"The problem is very serious here," an officer who preferred anonymity said. He did not elaborate.

The government has said it will procure thermo plants to generate 150 MW as an emergency measure to address the current power shortageuntil the commissioning of the Bujagali power project expected to be ready by 2009.

EMMA MASUMBUKO, EVELYN LIRRI, SARAH KIBISI, & ASHAH NTABADDE

Uganda: Who let the waters out?

MUHEREZA KYAMUTETERA , 7 February, 2006

L.Victoria water level drops by 2.5 metres. Electricity generation cut from installed capacity of 380MW to 140MW. Load shedding extended to 12 hours daily. Kiira dam to shut down

KAMPALA

EFFECTIVE yesterday, Ugandans plunged into an even worse power crisis when Uganda Electricity Generation Company Ltd, sliced by a sixth, the amount of power it produces at the country's two major dams.

In an exclusive interview with Daily Monitor, Electricity Regulatory Authority, Chief Executive Officer, Eng Francis X. Ssebowa, said: "Effective Monday 6, in order to save the lake, generation is going to fall from the current 170 MW to 140 MW."
The reduction, he said, is to save the falling waters of the Lake Victoria.

This means that including the 50 MW produced at the Aggreko thermal plant at Lugogo, Uganda will now be producing 190 MW, further escalating the nation's power deficit from 130 MW to 160 MW.

Now, Daily Monitor has learnt from reliable sources that the 30 MW will mean Ugandans will have to go for twelve hours everyday without electricity up from eight hours.
"The load shedding will be so bad. Between you and me, I can tell you that it will now be a 6 to 6 rationing schedule. If you are switched off at 6:00 p.m. you will get back power the next day at 6:00 a.m. and if you are switched off at 6:00 a.m., you will get the power at 6:00 p.m.," said a source from the Uganda Electricity Transmission Company Ltd (UETCL).

Uganda has an installed capacity at her two major dams combined, of 380 MW (Nalubaale 180 MW and Kiira 200 MW).

Uganda's energy demands are estimated at 350 MW.
Just over a week ago Umeme announced an extension of the daily load shedding hours to 2:00 a.m. from 7:00 p.m. to 'allow the water levels to be regained to usable levels.'

Umeme added that from now on, Ugandans would from time to time, other than the stipulated load shedding schedules, experience emergency or non-scheduled load shedding, something the company referred to as 'the best solution available' given the current power supply situation.

Once completely submerged, these metal beams are now a reminder of the receding level of Lake Victoria water. The water level has dropped by 2.5 meters. While the solution remains delicately elusive even to engineers, electricity supply is short endangering all sectors of the economy.

Umeme Communications Manager Robert Kisubi said that it was true that the amount of power available from UETCL for Umeme to distribute would reduce, beginning today, but declined to comment on the 12-hour load shedding schedule.
"Yes, it is true we shall be getting reduced supply from UETCL but the details I am yet to know," he said on phone.

Asked about the increased load shedding hours, he said: "we will shortly be sending a new load shedding schedule to the press," he said.

dam to be used more.

“For the little water that we discharge, it is best that we use the new Kiira dam because for every cubic meter of water, we pass through Kiira, we get more output because the machines are new and more efficient. I believe that both dams will be used but it is up to the engineers to use the most efficient turbines,” he said.

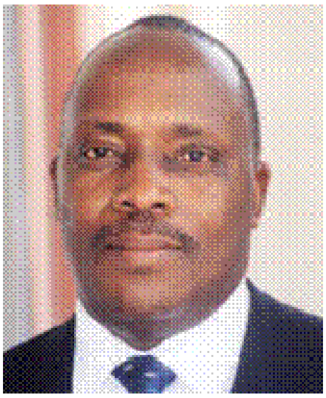
He appealed to electricity users to be more carefully in using electricity and advised those who can afford alternative energy sources to do it.

Mitigation measures
Ssebowa said that the government is in different stages of generating up to 150 MW of thermal power. One plant will be installed at Mutundwe, another at Namanve while a third one at Lugogo.

All the three plants are to use heavy fuel oil, which is cheaper than diesel currently being used at the Lugogo plant.
Bids for the first 50 MW plant at Mutundwe, were opened on January 25. Three companies bid for the multi-billion-shilling project.

African Power Initiatives from Virginia USA bid $42.9 million (Shs77.5 billion) and will produce the power at $17 cents (Shs309) per Kilo Watt hour (KWh) and will deliver it in 90 days.

UMEME BOSS: Mr Mare



ERA BOSS: Sebowa

Electromaxx bid $34.1 million (Shs61.6 billion) and will deliver it at $14 cents (Shs260) per KWh and will deliver in 12 months while Norway’s Jacobsen Electro AS bid $52.4 million (Shs114 billion) at $11 cents (Shs 249) per KWh and will deliver between 9-12 months.

The Aggreko Lugogo produces at $24 cents (Shs434). This was, however, subsidised by the government to 13 cents (Shs235).
“We have put together a team of engineers, economists and representatives of UEGCL and UETCL and ministry of Energy to evaluate the bids,” he said.

He said the bids would be evaluated for technical competence and experience, financial competence, intended price of the power and the period within which the power can be delivered.

“We hope recommendations will be available for the authority to make decisions within two weeks,” he said.
Evaluation started yesterday.

He said that given the falling levels of the lake, the government was now considering increasing the output at Namanve to 100MW.
“Namanve is being speeded up but you should realise that more thermal power will mean more expensive power,” he said.

Ssebowa said that ERA is also at different stages of licensing a 5 MW mini hydro at Ishasha on the Uganda Congo Border and 10 MW at Kikagati near the Tanzanian border.
But with the erratic rains and a demand growing at 30 MW annually and expected to grow even bigger as the country develops and as politicians implement their promises, these initiatives cannot do much.

Expensive power
As if load shedding is not bad enough, Umeme’s Managing Director Paul Mare says that as the power goes on reducing, the company will be forced to increase tariffs something expected to be greeted with protests from the consumers.

"Load shedding has two impacts," he says. "Other than the fact that there is no power, to us it means that the costs of the entire electricity sector goes up because we are now distributing our costs over reduced production. Unless there can be some subsidy obtained, the price will go up because the sector has to make up for the rising cost of production,"

Who let the water out?
Right from the commissioning of Kiira dam, a lot of finger pointing has been going on with mainly the environmentalists on the offensive.
The environmentalists blamed the government, World Bank and Acres International - the hydrologists who okayed Kiira dam saying that the existence and location of Kiira jeopardises water flow of the lake.

There have also been unconfirmed reports that Egypt bribed engineers at Eskom-run Uganda Electricity Generation Company (UEGCL) to free more water to Egypt at night.
The government and the co-accused have, however, said that all is well and have blamed the excessive water loss on the long drought that has hit Lake Victoria basin.

One hydrologist at the National Water and Sewerage Corporation who prefers to remain anonymous referred to the question of who let the water out as being more of a political question than anything else, partially put the blame on the drought which he blamed for causing more than 40 percent of the excessive water loss.

“As you may know, drought affects the lake in two ways. Other that reducing on the water collected in the catchment areas of the Victoria basin, it also takes out the water directly from the lake through evaporation and this accounts for about 40 percent of the water loss from the lake," he says.

He adds that if nothing is done about the restoration of the vegetation cover, even the expected production at Bujagali would be affected.
"The power production at Bujagali was estimated when the water levels were healthy and now that they have taken a plunge, you should also expect a plunge in what will be produced there," he warned.

Engineer Hillary Onek, a one time MD of NWSC and a respected hydrologist also at one time blamed the drop in the water levels on the two dams which are almost adjacent to each other, an idea that UEGCL engineers quashed as views from 'Person(s) with no knowledge, let alone experience, to categorically state that Owen Falls Extension design/selection was in error.'

Ssebowa says that though the existence of Kiira in a way has contributed to the drastic drop in lake levels, the dam is not the problem. He explains that the problem is that the policy makers have failed to stick to the agreed technical plans.

“If you remember well, Nalubaale dam was built between 1954 and 1969 when the last turbines were put in place. The life span of a dam is 50 years and accordingly the 1954 turbines should have been closed last year and 2019 should be the end of the last turbine at Nalubale," he explains.

Onek adds: "From the engineering point of view, Kiira should have been a replacement for Nalubale because it was expected that as we gradually decommissioned Nalubale, the closed-off water would be channelled to Kiira enabling it to produce at full capacity when Nalubaale is finally closed in 2019," he said.

He says that if everything had stuck to plan, there would not be much of a problem.
“When later, the two dams were completed, the politicians either because they were misled or because they expected political mileage out of it thought that since Nalubaale's installed capacity was 180 MW and Kiira 200 MW, the two dams could co-exist, producing up to a combined 350 Mw or so. Little were they told that the two dams would affect each other's capacities and with time both capacities would reduce," he says.

“Well, somebody is afraid of taking this decision but soon the decision to close Nalubale will have to be taken. Whether people like it or not, Nalubale will have to be closed,” Onek says.

Tough times ahead
With the erratic climate not about to change, Mare says that the future of power sector only depends on Bujagali.

“I see the tough times going on till the time when Bujagali is completed, in the mean time, we are going to have a heavier reliance on thermal power, which is more expensive, but once Bujagali bounces on, then everything will be normal again,” he prophesies.

Uganda: Uganda Develops Rural Energy Master Plan

The East African (Nairobi)
January 25, 2006
Posted to the web January 25, 2006

Bamuturaki Musinguzi
Nairobi

Uganda is developing an energy resources database to prospective investors easy access to information on the sector.

The database is expected to act attraction for and serve private investment in the underdeveloped sector.

The data base will include information, major hydro sites with their potential, status of development and location. The country is endowed with a variety of renewable energy resources such as biomass; geothermal; mini/micro/pico hydro, wind, peat and solar energy resources.

In order to facilitate investment in the energy sector, the Ministry of Energy and Mineral Development says a number of small sites such as mini-hydro stations with a generation capacity of 2MW each and micro-hydro stations capable of producing 150KW have been identified.

Evaluation of large sites has also been accomplished, and a Hydropower Master Plan produced.

The Ministry of Energy said recently in a statement that rural electrification master plan is being developed that will determine potentially viable distribution concession areas and what other technological options can be applied to serve the varied settlement patterns and demand centres in the country.

The objective of the master plan is to provide grants to support rural electrification projects and co-finance feasibility studies for minor grid extension and isolated grid projects through the private sector.

"The master plan will establish the least cost options for development and minimise the time and expenses investors have to spend before deciding on the choice of investment," the ministry said in the statement.

The Ministry has adopted a private public partnership (PPP) approach in line with the government policy of private-sector participation by establishing a rural electrification fund that provides subsides to private entities engaged in generating and distributing energy to rural areas.

This will bring down the capital costs involved in rural electrification and renewable energy projects.

"The major policy goal is to meet the energy needs of Uganda's population for social and economic development in an environmentally sustainable manner."

Owing to the increased electricity demand in the mid-1990s and the government's privatisation policy, the Uganda Electricity Board was unbundled to allow private sector participation and give opportunity for investment in small-scale renewable energy and also carry out rural electrification.

The government is therefore promoting priority rural electrification projects or PREPS; locally initiated rural electrification projects or LIREPS and community initiated rural electrification projects or CIREPS to reduce the country's dependence on biomass for energy.

The Ministry of Energy in conjunction with the Rural Electrification Agency (REA) and other Energy for Rural Transformation Programme (ERT) implementing components has embarked on a path of expanding and transforming the energy sector from one that is heavily dependent on biomass, to one emphasising the development and utilisation of modern energy.

The REA has so far identified five distribution concessions, that the private sector can concentrate on. These are Masaka, Rakai and Kalangala for the central-south region, Mbarara and Ntungamo for the south west,

Mubende, Kibaale and Kyenjojo for the central west, Soroti, Kaberamaido, Katakwi and Moroto for the eastern region, and Gulu, Adjumani and Moyo for the northern region.

Uganda's energy sector is dependent on low-grade forms of energy, especially biomass-based fuels.

The overall goal of the REA's 10-year strategic plan is to achieve the national target of 10 per cent rural electrification by 2010 set in the Rural Electrification Strategy and Plan.

The growth of Uganda's econ-omy has created additional demands for various forms of energy. Currently, the demand for electricity supply, and continues to grow at a rate of about 24MW per year.

Through ERT, the ministry is optimistic that the demand will be met in the long run. Since the inception of the ERT programme, electricity access has increased from 1 per cent to 3 per cent. The programme is multisectoral, with emphasis on providing strategic energy services to rural Uganda through the provision of electricity for schools, health centers, agro-processing plants and ICT and water schemes.

Kenya: Bagasse Burning at Chemelil Sugar Company

FIRE SCARE

Photo/Sylvester Onyango

Guards at Chemelil Sugar Company of Kisumu District fight a bagasse (sugarcane remains) fire near the factory on Wednesday evening. The cause of the blaze that lasted eight hours was not known, but it caused panic at the plant before it was subdued. No one was injured.

ANNEX T: QUALIFICATIONS AND RESPONSIBILITIES OF AFRICA COGEN CENTER PERSONNEL

The major qualifications and responsibilities of the proposed personnel of the Africa Cogen Centre are described below. After the approval of the project and before the recruitment process is started, a more elaborate and detailed Terms of Reference for each personnel may be delineated.

Regional/Local Personnel
A. Short Term

1. Africa Cogen Centre Director
Qualifications:

- Minimum of university degree in Engineering or equivalent
- Minimum 10 years experience in the energy sector; minimum 5 years in managing an energy-related organization/agency or energy department of a company
- Demonstrated ability in managing a multi-disciplinary, multi-cultural team
- Experience in regional cooperation and networking/cooperation with government officials and private sector executives in Africa

Responsibilities:

- Provides direction and overall leadership to the Africa Cogen Centre, its staff and the Country Offices
- Takes overall responsibility for the organization and execution of the project
- Ensures that the activities are carried out according to the project design and the outcomes and outputs/deliverables are achieved within the approved timeframe and budget
- Reports to the Steering Committee on the progress and plans of the project

Project Development/Commercial Unit
2. Project Development Unit Head
Qualifications:

- Minimum university degree in a relevant field
- Minimum 5 years relevant experience, particularly in the areas of power plant/cogeneration project development, business structuring and analysis, etc.
- Demonstrated managerial experience and ability
- Excellent command of the spoken and written English, ability to write reports and good presentation skills

Responsibilities:

- Coordinates the activities of the Project Development/Commercial Unit
- Responsible for the preparation of the Cogeneration Investment Packages (CIPs), with assistance from Project Development/Commercial Unit staff and inputs from International Experts and other units
- Coordinates the selection and implementation of the FSPPs
- Any other tasks assigned by the Africa Cogen Centre Director

Financing Unit
3. Financing Unit Head
Qualifications:

- Minimum university degree in finance, banking and investment, economics or management
- Minimum 5 years relevant experience, particularly in the areas of project financing, investment banking, financial analysis, funds mobilization and financial packaging
- Demonstrated managerial experience and ability
- Excellent command of the spoken and written English, ability to write reports and good presentation skills

Responsibilities:

- Coordinates the activities of the Financing Unit
- Responsible for the conduct of training and capacity building activities to the projects developers/owners related to financing of projects and to financial institutions
- Responsible for providing financial advice and services to project developers on funds mobilization and financial packaging

- Coordinates the financial feasibility analysis and financial portion of the Pre-Investment/Feasibility Studies
- Any other tasks assigned by the Africa Cogen Centre Director

Policy Unit
4. Policy Unit Head
Qualifications:
- Minimum university degree in a relevant field
- Minimum 5 years relevant experience, particularly in areas related to power sector policy, regulation and reform; additional experience in legal and contractual arrangements and promotional/communication activities desired
- Familiarity and/or experience in the features and formulation of the Power Purchase Agreement (PPA) preferred
- Demonstrated managerial experience and ability
- Excellent command of the spoken and written English, ability to write reports and good presentation skills

Responsibilities:
- Coordinates the activities of the Policy Unit
- Responsible for the design and implementation of the advocacy activities
- With guidance and inputs from the International Experts on policy aspects and assistance from the Policy Unit staff, provides support to the policy makers and other relevant agencies on formulation/enhancements of policies and regulations that will encourage the widespread implementation of cogeneration
- Coordinates the preparation of the promotional and dissemination strategy and its execution
- Any other tasks assigned by the Africa Cogen Centre Director

Technical Unit
5. Technical Unit Head (Mechanical Engineer)
Qualifications:
- Minimum university degree in Mechanical Engineering
- Minimum 5 years relevant experience, particularly in the areas of power plant and/or cogeneration systems
- Experience in biomass fuels preferred
- Demonstrated managerial experience and ability
- Excellent command of the spoken and written English, ability to write reports and good presentation skills

Responsibilities:
- Coordinates the activities of the Technical Unit
- Responsible for the conduct of training and capacity building activities to the projects developers/owners and other stakeholders on the technical aspects of cogeneration projects
- Responsible for providing technical advice and services to project developers and potential owners of cogeneration projects
- Coordinates the conduct of Pre-Investment/Feasibility Studies
- Designs and coordinates the implementation of matchmaking activities between foreign equipment suppliers and local manufacturers
- Coordinates the visits and study tours to successful cogeneration installations
- Any other tasks assigned by the Africa Cogen Centre Director

6. Power/Electrical Engineer
Qualifications:
- Minimum university degree in Electrical Engineering
- Minimum 3 years relevant experience, particularly in the areas of power systems, grid interconnection, electricity generation, operation and maintenance of power/cogeneration projects
- Good command of the spoken and written English and ability to write reports

Responsibilities:
- Assists in the technical tasks of the Africa Cogen Centre, particularly in matters related to power systems and electrical generation aspects
- Conducts survey of fuel resources and assessments their potential
- Identify relevant technologies and their suppliers

- Assist in the implementation of matchmaking activities between foreign and local manufacturers
- With inputs from the International Experts and other staff, develops the Project Development Guide for reference and training purposes
- Assists in the conduct of Pre-Investment/Feasibility Studies
- Assists International Expert in developing and/or adapting software tools for technical analysis to be used for analysis of projects and training purposes
- Any other tasks assigned by the Africa Cogen Centre Director and the Head of the Technical Unit

Finance and Administrative Support
7. Finance/Administrative Manager
Qualifications:
- Minimum university degree in administration, management, finance, accounting or equivalent
- Minimum 5 years relevant experience, particularly in the areas of administration, office management, financial management, or accounting
- Demonstrated managerial experience and ability
- Excellent command of the spoken and written English and ability to write reports

Responsibilities:
- Coordinates the administration, financial management, accounting and secretarial services
- Manages the pool of secretaries and allocates secretarial services to the different units of the Africa Cogen Centre
- With the assistance of the administrative staff, organizes supporting activities such as: meetings, seminars/workshops, travels, printing and production of reports, and procurement of supplies and services
- Implements and reports on the M&E activities of the Africa Cogen Centre
- Any other tasks assigned by the Africa Cogen Centre Director

8. Information Technology Specialist
Qualifications:
- Minimum university degree in computer science, information technology or equivalent
- Minimum 3 years in computer network administration, database design and management, web design and development and computer hardware and software troubleshooting
- Familiarity with various operating systems
- Good understanding of the spoken and written English

Responsibilities:
- Installs and maintains the LAN system of the Africa Cogen Centre and provides support to the staff on computer hardware and software usage.
- Provides recommendations on the IT solutions for the Africa Cogen Centre and the personnel
- Designs, develops and manages the Database of the Africa Cogen Centre
- Designs, develops and manages the website (internet and intranet) of the Africa Cogen Centre and continually updates it
- Any other tasks assigned by the Africa Cogen Centre Director and the Head of the Administrative Unit

9. Secretary/Administrative Assistant
Qualifications:
- Minimum secretarial degree or equivalent
- Minimum 2 years secretarial experience
- Good command of the spoken and written English, ability to draft correspondence, and with reasonable typing speed

Responsibilities:
- Provides secretarial services to the personnel of the Africa Cogen Centre
- Assists in administrative matters such as organization of meetings, travel arrangements, processing of purchases, reimbursements, production of reports, etc.
- Any other tasks assigned by the Africa Cogen Centre Director and the Head of the Administrative Unit

B. Short Term

10. Regional Cogeneration Expert

Qualifications:

- Minimum university degree in Engineering or equivalent
- Minimum 5 years experience in the development, implementation or operation of cogeneration systems in the African region
- Good command of the spoken and written English and ability to write reports

Responsibilities:

- Provides expertise and advice on developing and implementing cogeneration systems in the region
- Supports the Africa Cogen Centre in promoting cogeneration to relevant industries and convincing them to implement highly efficient systems
- Acts as a Resource Person in the conduct of training and capacity building activities
- Assists in identifying relevant technologies, foreign equipment suppliers and local manufacturers
- Assists in identifying (biomass) fuel resources relevant for cogeneration and in assessing their potential for energy generation
- Provides inputs to the preparation of the Project Development Guide
- Any other tasks assigned by the Africa Cogen Centre Director

11. Regional Policy Expert

Qualifications:

- Minimum university degree in a relevant field
- Minimum 5 years relevant experience, particularly in areas related to power sector policy, regulation and reform in a regional basis within the African region
- Familiarity and/or experience in the features and formulation of the Power Purchase Agreement (PPA) in one or more countries in the region
- Possesses good and valuable contacts in the relevant government agencies responsible for policy matters in the region
- Good command of the spoken and written English and ability to write reports

Responsibilities:

- Provides advice on the design and implementation of the advocacy activities for the region
- Assists in providing support to the policy makers and other relevant agencies on formulation/enhancements of policies and regulations that will encourage the widespread implementation of cogeneration
- Supports and advises personnel in the Policy Unit on issues related to tariff setting principles, standard formula for buyback rates and supporting measures such as incentives, among others
- Acts as a Resource Person on policy matters
- Provides relevant contacts in the relevant government agencies responsible for policies in the different countries of the region
- Any other tasks assigned by the Africa Cogen Centre Director

12. Regional Environmental Expert

Qualifications:

- Minimum university degree in Environmental Engineering or equivalent
- Minimum 5 years relevant experience, particularly in the areas of environmental systems, environmental impact assessments, and Greenhouse Gas (GHG) mitigation activities
- Good command of the spoken and written English and ability to write reports

Responsibilities:

- Assists in the technical tasks of the Africa Cogen Centre, particularly in environmental matters
- Provides guidance and advice on the environmental compliance of cogeneration projects
- Provides information on the environmental standards in the different participating countries in the region
- Assesses the environmental and socio-economic benefits of the projects
- Acts as a Resource Person on policy matters
- Calculates the GHG emission mitigation of cogeneration projects
- Takes charge of the Clean Development Mechanism aspects of the projects
- Any other tasks assigned by the Africa Cogen Centre Director

International Experts
A. Part Time
1. Chief International Consultant
Qualifications:
- Minimum of university degree in Engineering or equivalent
- Minimum 10 years experience in the energy sector
- Professional experience in the field of cogeneration/power generation
- Experience in cooperation programs and networking, preferably with a similar design and concept as the Cogen for Africa Project
- Demonstrated ability in managing a multi-disciplinary, multi-cultural team

Responsibilities:
- Provides general advice to the Africa Cogen Centre Director on the operation and execution of the project based on successful experiences in other programs and regions
- Provides overall leadership to the team of International Experts
- Plans for, and organizes, the time and trips of the short term International Experts according to the overall Work Plan
- Performs the function of one of the short term International Experts relevant to his/her expertise

B. Short Term
Project Development/Commercial Unit
2. Business Adviser
Qualifications:
- Minimum university degree in a relevant field
- Minimum 5 years relevant experience, particularly in the areas of business development, business structuring and analysis of cogeneration projects
- Previous experience in a similar cooperation or regional program on cogeneration preferred
- Excellent command of the spoken and written English, ability to write reports and good presentation skills

Responsibilities:
- Supports and provides expert advice/inputs to the Africa Cogen Centre and to other stakeholders on matters related to cogeneration business development and investment decisions
- Provides training to, and develops capacity of, the regional/local personnel of the Africa Cogen Centre on business/commercial aspects of cogeneration projects
- Acts as a Resource Person on the external training and capacity building activities of the Africa Cogen Centre
- Any other tasks assigned by the Africa Cogen Centre Director and the International Team Leader

Financing Unit
3. Financing Expert
Qualifications:
- Minimum university degree in finance, business, management or equivalent
- Minimum 5 years relevant experience, particularly in the areas of financial analysis and evaluation, financial modelling, and financial structuring
- Previous experience in a similar cooperation or regional program on cogeneration preferred
- Excellent command of the spoken and written English, ability to write reports and good presentation skills

Responsibilities:
- Supports and provides expert advice/inputs to the Africa Cogen Centre and to other stakeholders on matters related to analysis of financial viability, financial structuring, and identification of application financing schemes and sources
- Provides training to, and develops capacity of, the regional/local personnel of the Africa Cogen Centre on financial analysis and evaluation aspects of cogeneration projects
- Acts as a Resource Person on the external training and capacity building activities of the Africa Cogen Centre
- Any other tasks assigned by the Africa Cogen Centre Director and the International Team Leader

Policy Unit
4. Policy Expert
Qualifications:
- Minimum university degree in a relevant field
- Minimum 5 years relevant experience, particularly in the areas of energy policy and reform
- Previous experience in formulation, drafting and/or negotiation of Power Purchase Agreements (PPA)
- Previous experience in a similar cooperation or regional program on cogeneration preferred
- Excellent command of the spoken and written English, ability to write reports and good presentation skills

Responsibilities:
- Supports and provides expert advice/inputs to the Africa Cogen Centre and to other stakeholders on matters related to policy formulation, enhancement and reform
- Provides training to, and develops capacity of, the regional/local personnel of the Africa Cogen Centre on policy matters
- Provides support to the policy makers and other relevant agencies on formulation/enhancements of policies and regulations that will encourage the widespread implementation of cogeneration
- Acts as a Resource Person on the external training and capacity building activities of the Africa Cogen Centre
- Any other tasks assigned by the Africa Cogen Centre Director and the International Team Leader

Technical Unit
5. Cogeneration Expert
Qualifications:
- Minimum university degree in Mechanical Engineering or equivalent
- Minimum 5 years relevant experience, particularly in the development, design, implementation, or operation and maintenance of power plants and/or cogeneration systems
- Experience in biomass combustion
- Previous experience in a similar cooperation or regional program on cogeneration preferred
- Excellent command of the spoken and written English, ability to write reports and good presentation skills

Responsibilities:
- Supports and provides expert advice/inputs to the Africa Cogen Centre and to other stakeholders on matters related to the development, design, implementation, and operation and maintenance of highly efficient cogeneration systems
- Provides training to, and develops capacity of, the regional/local personnel of the Africa Cogen Centre on the technical aspects of cogeneration projects
- Provides technical advice and inputs in the conduct of the Pre-Investment/ Feasibility Studies
- Acts as a Resource Person on the external training and capacity building activities of the Africa Cogen Centre
- Any other tasks assigned by the Africa Cogen Centre Director and the International Team Leader

6. Environmental Expert
Qualifications:
- Minimum university degree in Environmental Engineering or equivalent
- Minimum 5 years relevant experience, particularly in the areas of environmental systems, environmental impact assessments, and Greenhouse Gas (GHG) mitigation activities
- Knowledge of, and experience in, Clean Development Mechanism (CDM)
- Previous experience in a similar cooperation or regional program on cogeneration preferred
- Excellent command of the spoken and written English, ability to write reports and good presentation skills

Responsibilities:
- Supports and provides expert advice/inputs to the Africa Cogen Centre and to other stakeholders on matters related to the environmental aspects of highly efficient cogeneration systems
- Provides training to, and develops capacity of, the regional/local personnel of the Africa Cogen Centre on the environmental aspects of cogeneration projects
- Provides expertise in environmental and socio-economic benefits of the projects, calculation of the GHG emission mitigation of cogeneration projects, and Clean Development Mechanism

- Acts as a Resource Person on the external training and capacity building activities of the Africa Cogen Centre
- Any other tasks assigned by the Africa Cogen Centre Director and the International Team Leader

ANNEX U: POSSIBLE COGEN COUNTRY OFFICES

1. Kenya:
Kenyatta University, P.O. Box 2801, 00200 CQ, Nairobi, Kenya.
Tel: +254 20 535997/8.
Fax: +254 20 811575.

Institute for Research in Sustainable, Energy Development (IRSEAD), P.O. Box 3576, 00100 GPO, Nairobi, Kenya.
Tel: +254 20 570938/846260.
Fax: +254 20 576875.

Kenya Association of Manufacturers (KAM), P.O. Box 30225, Nairobi, Kenya.
Kenya Industrial Research and Development Institute, P.O. Box 1360, Nairobi, Kenya

Kenya institute of Public Policy, Research and Analysis, P.O. Box 56445, Nairobi, Kenya.

2. Malawi:
Mani Consultants, P.O. Box 222, Lilongwe,
Tel/Fax: 01 710 853.

Malawi Industrial Research and Technology Development Center, P.O. Box 30361, Haile Selassie Road, Blantyre
Malawi

Malawi Polytechnic, Mechanical Engineering Department, Private Bag 303, Chichiri, Blantyre 3, Blantyre
Malawi

3. Ethiopia:
Department of Electrical and Computer Engineering, Faculty of Technology, Addis Ababa University, P.O. Box 385,
Ethiopia
Tel: +251 1 122530 or 551022
Fax: +251 1 550911 or 5522601

National Cleaner Production Center, P.O. Box 3672, Addis Ababa, Ethiopia

Dr. Tesfaye Bayou, Independent Consultant, P.O. Box 30792, Addis Ababa, Ethiopia

4. Tanzania:
TaTEDO, P.O. Box 32794, Dar es Salaam, Tanzania.
Tel: +255 22 2700771/2700438.
Fax: +255 22 2774400.

Tanzania Industrial Research, Development Organization, P.O. Box 23235, Dar es Salaam, Tanzania.

5. Zambia:
Center for Energy Environment and Engineering (CEEE), P.O. Box E 721, Lusaka, Zambia.
Tel/Fax: +260 –(0) 1- 240267.

TDAU – University of Zambia, Technology Development and Advisory Unit, P.O. Box 32379, Lusaka
Tel: +260 - (0) 1 29 3869
Fax: +260 – (0) 1 294777

6. Swaziland
University of Swaziland, Kwaluseni, Campus, Private Bag. 4, Kwaluseni, Swaziland

Renewable Energy, Association of Swaziland (REASWA), P.O. Box 6379 Mbabane, Swaziland
Tel/Fax (+268) 404-9040

Environment Action Group, P.O. Box 2061, Mbabane, Swaziland
Tel: (+268) 404 1394/770

Fax: (+268) 404 1394

Renewable Energy, Association of Swaziland (REASWA)
Tel: +268 404 9040
E-mail: reaswa@swazi.net

University of Swaziland
Tel: +268 518 4011 / +268 518 2328

7. Uganda

National Association of Professional, Environmentalists (NAPE), Plot 951/952, Kubiri - Gayaza Round About Kawempe Division, P. O. Box 29909, Kampala, Uganda

Technology Consults Ltd., P.O.Box 8627 , Kampala, Uganda
Tel: +256 41540618

Makerere Institute of Environment and Natural Resources, P.O.Box 7062, Kampala, Uganda
Tel: +256 41 533462/530135

ANNEX V: BENEFITS OF COGENERATION

The benefits of implementing cogeneration systems encompass the efficiency, economic and environmental aspects which governments, industries, businesses and communities of Africa as well as the global environment could gain if efficient cogeneration is properly exploited. Some of the major benefits of cogeneration are mentioned below:

- Energy cost savings

The main benefit that comes from the implementation of a cogeneration system by an industry is the savings in the cost of energy utilized by the facility hosting the cogeneration plant itself. These savings come mainly from not having to purchase power from the grid or from not having to buy conventional fuel for generating power and/or heat, especially if using biomass as fuel. Further savings can be realized due to the lower primary energy consumption of a cogeneration system compared to a conventional separate heat and power generation.

It is known that many sugar factories in Africa, in spite of the huge quantity of bagasse generated though their operation, are not self-sufficient in energy and are still importing power from the grid. For instance, from discussions with the management of Nzoia Sugar Company and Chemilil Sugar Company in Kenya, it was learned that both factories pay around 2,000,000 KShs per month (approx. 28,000 USD/mo.) to the utility for the electricity imported from the grid to cover for the requirements of the factory that their own cogeneration system cannot provide. Moreover, Chemilil pays an additional 2,000,000 KShs per month for the electricity needs of its estate and housing facilities. Another sugar factory, Muhoroni Sugar Company, in Western Kenya gets almost 100 % of its electricity requirements from the grid because of the deteriorating state of its boilers. If appropriate cogeneration systems are implemented in these factories, the amount of money spent for paying the electricity bills would be saved thus reducing production costs.

- Use of indigenous, cheap renewable fuel source instead of imported, finite fossil fuel

Biomass residues suitable for cogeneration can be found in abundant quantities in most sub-Saharan African countries. Notable sources of biomass residues include wood and agro-processing industries such as sugar mills, pulp and paper mills, saw mills, coffee plantations, palm oil plantations, maize plantations and rice mills, . These biomass residues are widely available and common in the region. Using these residues allows agro-industries to generate power and heat from what is considered as indigenous, cheap, environmentally friendly and renewable fuel.

Some of the countries in the region, namely, Kenya, Uganda, Tanzania, are experiencing shortage of power from existing hydroelectric generating capacities and have implemented or are planning to implement thermal power plants using diesel/coal as fuel as additional capacities to augment the shortage. If the available biomass resources are exploited, these additional capacities could either be delayed or could be partly or wholly replaced by cogeneration systems, while freeing up some hydropower capacities for use at more appropriate times.

- Elimination of disposal problems and associated costs for biomass residues

In most wood and agro-industries that produce residues as by-product of their processes, the traditional way of disposing the excess residues that are not used in conventional boilers is through open air burning or using them as landfill. These methods cause problems as open burning can be a fire risk; is increasingly opposed by the nearby residents; and, land for landfill is limited, not to mention the harmful effects of these actions to the environment. Moreover, these disposal methods involve labour and/or transportation costs which add to the expenses of the production. In Kinyara Sugar Works, Uganda, the management revealed during the stakeholders' discussions that the company spends around 200,000 USD/year to dispose the excess bagasse 2 to 3 kilometers away from the factory. For some factories that dispose the bagasse at their backyard, heavy equipment is used to stir the bagasse from time to time in order to avoid fermentation and the risk of spontaneous combustion. Recently, the media in Kenya reported that the bagasse stored at the back of the Chemilil Sugar Company factory caught fire demonstrated its danger to the factory's workers and to the factory itself.[1] It is estimated that in the sugar factories in Africa, only 60 % of the huge quantities of bagasse produced by the sugar mills is utilized as fuel for inefficient energy systems while the rest is disposed at a cost. By using these residues, which had been traditionally considered as a waste matter, as fuel for cogeneration systems, the disposal costs and associated hazards of disposing them could be avoided.

- Loss reduction and improvement in quality and reliability of supplies

In many countries in the African region, the reliability of the power supply from the electric utility is not very reliable, prompting the industries to have their own back up system usually using diesel generators. For example, it is estimated that the Kenyan interconnected grid-system experiences over 10,000 recorded power interruptions every month. This situation is further aggravated by the fact that many agro-industries are

[1] Daily Nation, Kenya, 6 January 2006

located near the sources of the raw material which are mostly at the end of the grid. Voltage drops and fluctuations in these areas are, therefore, even more pronounced. This not only disrupts the operation of the industry but could affect the quality of the process and product produced or could cause some batches of products to be discarded, thereby incurring huge losses to the company's operation.

By implementing their own cogeneration system using the fuel that comes from their own factories, the reliability of the energy system of the factory is enhanced. Furthermore, if excess electricity is sold to the grid, this could also improve the reliability and stability of the grid system in remote rural areas where most sugar industries as well as other agro-industries are often located. In a study conducted by Bothwell Batidzirai[2] on the introduction of a cogeneration plant in the sugar industry in Zimbabwe to sell excess power to the grid, the analysis showed that when embedded generation was introduced into an electricity supply system, the voltage profile on the local network was improved which translate into improved quality of service to local consumers as problems of voltage fluctuations are eliminated. In addition, with properly graded protection system in place, reliability of the local system was improved as the local network can operate in island mode when there is a failure on the main grid. System losses were also reduced significantly, and in the case of Chiredzi network in Zimbabwe, a loss reduction by up to 50 % was possible.

Small cogeneration power plants supplying outlying distribution areas do not only provide benefits to the rural consumers but also to the utility because one of the factors determining the maximum size of any power station is the total capacity of all stations supplying the grid. Ideally, no single station should provide more than 5 to 10 % of the total power within the grid, so that when it is switched in or out of service, the overall effect on the system will be minimal. Conversely, a single power station consisting of more than 50 % of the total supply could create a massive surge and drop of power when switched on or off, respectively. Cogeneration power plants can thus be an important option for stabilizing the grid system and increasing reliability.

Diversification in electricity supply is also important in avoiding over-reliance on any particular technology or source of power. Hydropower, particularly here in East Africa of instance, is susceptible to vagaries of weather, while fossil fuel-based power stations are easily affected by price volatility of fuel in the market. Cogeneration plants are an important option for enhancing Africa's power supply diversity and contribute to improving its reliability.

- Additional income

In cases where a cogeneration plant can be installed to produce electricity in excess of what is required by the host facility, extra income could be generated through the sales of excess electricity to the grid. This is especially true when the legislation supporting this action is in place (In some of the countries participating in this project, the legislation for sale of electricity to the grid is still not clear and is the subject of this project which will aim at removing legal barriers to sale of cogenerated electricity to the grid).

If the tariff structure is made favourable, it will provide additional revenues to the core business of the sugar companies. This has been shown to be the case in countries like Thailand, India and Mauritius, For instance, in Thailand, special purpose companies have been set up by sugar factories specifically for the cogeneration business and are operating profitably, while a typical sugar factory in Mauritius which has implemented a high pressure cogeneration system and sells electricity to the grid can realize power sales revenues that are equivalent to or more than the revenues it receives from the sales of sugar.

Another additional income may come from the sales of a by-product such as rice husk ash in the case of a rice husk-fired cogeneration plant and from supporting schemes such as carbon financing.

- Opportunity for increasing rural electrification levels

In many biomass-producing industries, a cluster of households develops due to the presence of workers in the industry and the secondary economy that emerges as a result of this settlement. The added capacity from cogeneration could be used to electrify the villages and rural community surrounding the industry hosting the cogeneration system. Mumias Sugar factory, for instance has electrified the houses of its workers from the cogeneration system in the factory. The marginal efforts and investments in doing this is not significantly high compared to the social and economic benefits it provides to the community.

- Reduction of transmission and distribution losses

When a centralized pure power generation is implemented and electricity is distributed to the users in different parts of the country, losses of the power generated are incurred. These losses go as high as 20 % in some of the participating countries in this Project.

Since a cogeneration plant is a decentralized system which is implemented at the point of need, the losses due to transmission and distribution and the associated investment costs to put up the lines are generally avoided. The World Alliance for Decentralized Energy (WADE) conducted modelling exercises of the energy situation of many countries. This powerful and unique model enables users to directly compare, in economic and

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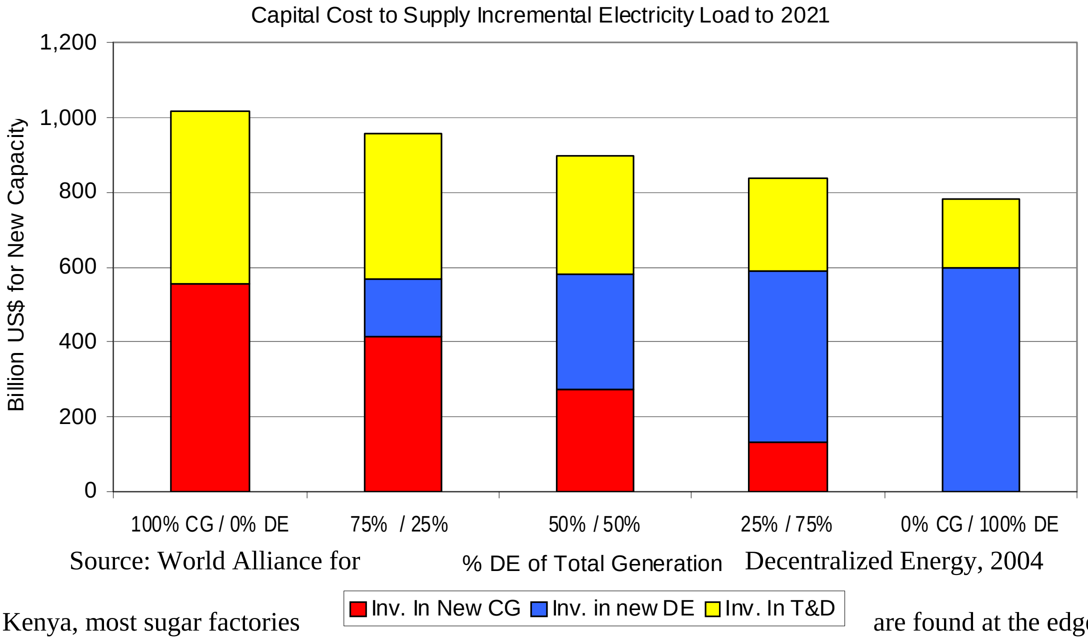
[2] Batidzirai, Bothwell, "Cogeneration in Zimbabwe – A Utility Perspective", AFREPREN Occasional Paper No. 19, 2002.

environmental terms, central and decentralized power as alternatives for meeting future electric capacity requirements. Based on an extensive variety of input data and user defined assumptions the model builds generation, transmission and distribution capacity and compares the results. Outputs that are calculated include:

- The relative retail costs;
- The relative capital costs;
- The relative emissions of CO2 and other pollutants;
- The relative consumption of fossil fuels.

Figure 1.4 shows the comparison of capital costs to supply incremental electricity capacities up to 2021 in China. Although the absolute value for the case in China is much higher than most African countries, the demonstrated pattern would hold for the African region with capital costs for implementing decentralized energy systems significantly lower than that of centralized power stations.

Capital costs comparison to supply incremental electricity load up to 2021 in China



Source: World Alliance for Decentralized Energy, 2004

In Kenya, most sugar factories are found at the edge of the country's interconnected thus requiring an extensive transmission and distribution system. A network of 33 kV and 11 kV rural Overhead Transmission lines serves the sugar factories of Chemilil, Muhoroni, Mumias, Nzoia and West Kenya. This network feeds the nearby towns, surrounding farms and businesses. The introduction of embedded cogeneration facilities would significantly improve the power flow in these areas while reducing losses and costs associated with transmission of power from far-away centralized systems.

- Less burden for the national government in electricity generation investment

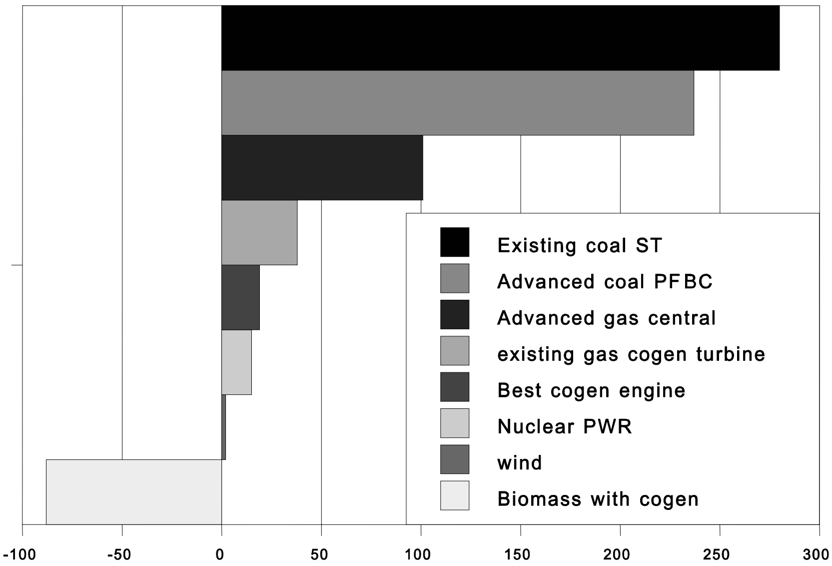
Investments in infrastructure including power generation have traditionally been in the domain of the public sector. However, because of the need to provide additional capacity for the growing demand for power, and the competing demands for the limited public financial resources, governments in the region have started to turn to the private sector for investments in new power generating capacities. The implementation of new cogeneration plants by the industries both for their own energy requirements and sales of excess power to the national grid, reduces the burden for the national government to invest in capital intensive additional power generating capacities. Moreover, as mentioned above, the high costs associated with transmission and distribution networks are avoided.

- Environmental benefits

In general, cogeneration systems with simultaneous production of electricity and thermal energy systems saves fuel energy compared to separate production of electricity and thermal energy. This is caused by the higher overall efficiency, assuming that the cogeneration systems are designed and operated properly and that the thermal energy generation is utilized. The energy consumption is also lower because the losses in the electricity transfer system is minimal for cogeneration plants located close to the demand of electricity compared to electricity production in centralized power systems by utilities and transmitting/distributing via the grid. The reduction in energy consumption in most cases leads to lower emissions of substances harmful to the environment.

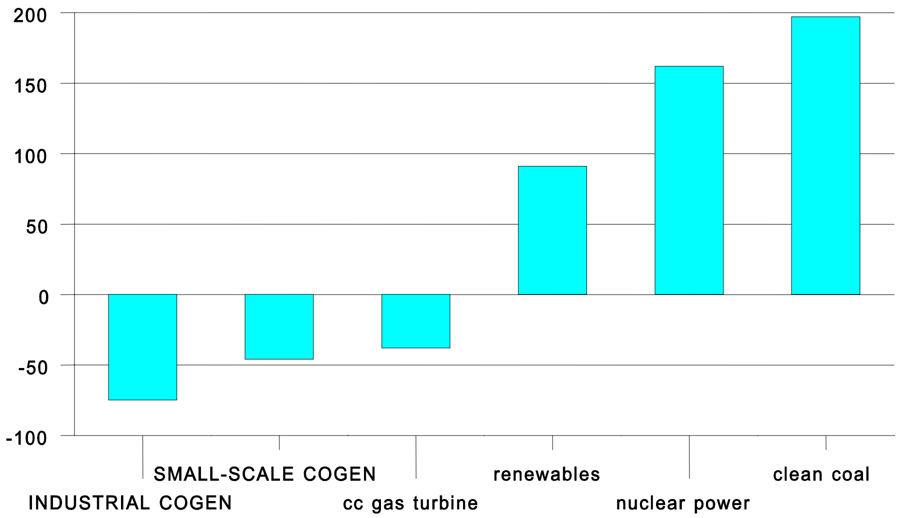
Figure 1.5 presents the relative carbon emissions from different power production technologies. Cogeneration technologies have much lower carbon emission compared to the best conventional pure power production technologies, and if combined with the use of biomass as a fuel for cogeneration, carbon emission is negative due to carbon dioxide-neutrality of biomass. Moreover, comparing the cost-effectiveness of the different carbon dioxide-saving technologies (Figure 1.6), industrial and small-scale cogeneration systems show a dramatic advantage against other technologies.

Carbon emissions from power production



Source: cited by COGEN Europe

Cost-effectiveness of carbon dioxide-saving technologies



Source: cited by COGEN Europe

ANNEX W: LEAST COST ANALYSIS

Cogen for Africa Project

Least cost comparison

Baseline case:	**Diesel Thermal Power Plant**	
Assumptions:		
Total turnkey costs	650,000	USD/MW
Major overhaul	25,000	USD/10,000 hours
Annual O&M costs	40	USD/kW fixed
	0.0038	USD/kWh variable
Diesel price	0.709	USD/litre
Diesel consumption	0.254	li/kWh
Operating hours	5,000	hours/year

	Least Cost Analysis (in USD)						
Indexation Year	**Installed capacity (MW)**	**Investment Costs**	**O & M**	**Total Cost Stream**	**Present Value 10%**	**Electricity generation (MWh)**	**Present Value 10%**
0*	40	26,000,000	38,377,200	64,377,200	64,377,200	200,000	200,000
1	20	13,000,000	57,565,800	70,565,800	64,150,727	300,000	272,727
2	30	19,500,000	86,373,700	105,873,700	87,498,926	450,000	371,901
3	0	0	86,373,700	86,373,700	64,893,839	450,000	338,092
4	30	19,500,000	115,156,600	134,656,600	91,972,270	600,000	409,808
5	0	0	115,156,600	115,156,600	71,503,188	600,000	372,553
6	40	26,000,000	153,558,800	179,558,800	101,356,262	800,000	451,579
7	0	0	153,533,800	153,533,800	78,787,116	800,000	410,526
8	40	26,000,000	191,936,000	217,936,000	101,668,752	1,000,000	466,507
9	0	0	191,936,000	191,936,000	81,399,600	1,000,000	424,098
10	40	26,000,000	230,313,200	256,313,200	98,819,834	1,200,000	462,652
11	0	0	230,313,200	230,313,200	80,723,372	1,200,000	420,593

12	0	0	230,338,200	230,338,200	73,392,849	1,200,000	382,357
13	0	0	230,313,200	230,313,200	66,713,530	1,200,000	347,597
14	0	0	230,313,200	230,313,200	60,648,664	1,200,000	315,998
15	0	0	230,338,200	230,338,200	55,141,134	1,200,000	287,270
16	0	0	230,313,200	230,313,200	50,122,863	1,200,000	261,155
17	0	0	230,313,200	230,313,200	45,566,239	1,200,000	237,414
18	0	0	230,338,200	230,338,200	41,428,350	1,200,000	215,831
19	0	0	230,313,200	230,313,200	37,658,049	1,200,000	196,210
20	0	0	230,313,200	230,313,200	34,234,590	1,200,000	178,372
Total	**240**	**156,000,000**	**3,723,488,400**	**3,879,488,400**	**1,452,057,353**	**19,400,000**	**7,023,239**

Note: Indexation year 0 corresponds to the ending date of the Cogen for Africa Project

Levelized cost per kWh **0.207** **USD/kWh**

Alternative case: **Bagasse-fired cogeneration plant**

Assumptions:

Total turnkey costs	1,500,000	USD/MW
Major overhaul	25,000	USD/10,000 hours
Annual O&M costs	4	% of total turnkey cost
Bagasse price	2	USD/ton
Bagasse consumption	3	kg/kWh
Operating hours	5,000	hours/year

	Least Cost Analysis (in USD)						
Indexation Year	**Installed capacity (MW)**	**Investment Costs**	**O & M**	**Total Cost Stream**	**Present Value 10%**	**Electricity generation (MWh)**	**Present Value 10%**
0	40	60,000,000	3,600,000	63,600,000	63,600,000	200,000	200,000
1	20	30,000,000	5,400,000	35,400,000	32,181,818	300,000	272,727
2	30	45,000,000	8,100,000	53,100,000	43,884,298	450,000	371,901

3	0	0	8,100,000	8,100,000	6,085,650	450,000	338,092
4	30	45,000,000	10,800,000	55,800,000	38,112,151	600,000	409,808
5	0	0	10,800,000	10,800,000	6,705,950	600,000	372,553
6	40	60,000,000	14,400,000	74,400,000	41,996,860	800,000	451,579
7	0	0	14,400,000	14,400,000	7,389,477	800,000	410,526
8	40	60,000,000	18,000,000	78,000,000	36,387,576	1,000,000	466,507
9	0	0	18,000,000	18,000,000	7,633,757	1,000,000	424,098
10	40	60,000,000	21,600,000	81,600,000	31,460,332	1,200,000	462,652
11	0	0	21,600,000	21,600,000	7,570,668	1,200,000	420,593
12	0	0	21,600,000	21,600,000	6,882,426	1,200,000	382,357
13	0	0	21,600,000	21,600,000	6,256,751	1,200,000	347,597
14	0	0	21,600,000	21,600,000	5,687,955	1,200,000	315,998
15	0	0	21,600,000	21,600,000	5,170,868	1,200,000	287,270
16	0	0	21,600,000	21,600,000	4,700,789	1,200,000	261,155
17	0	0	21,600,000	21,600,000	4,273,445	1,200,000	237,414
18	0	0	21,600,000	21,600,000	3,884,950	1,200,000	215,831
19	0	0	21,600,000	21,600,000	3,531,773	1,200,000	196,210
20	0	0	21,600,000	21,600,000	3,210,702	1,200,000	178,372
Total	**240**	**360,000,000**	**349,200,000**	**709,200,000**	**366,608,196**	**19,400,000**	**7,023,239**

Note: Indexation year 0 corresponds to the ending date of the Cogen for Africa Project

Levelized cost per kWh **0.052** **USD/kWh**

ANNEX X: CLEANER ENERGY FUND FOR AGRO-INDUSTRY IN AFRICA (CEFA)

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Sustainable Financing Solutions for Energy, Environment, Health, Innovative Agriculture & Multi-sectoral Business Development Services

Cover Note

Cleaner Energy Fund for Agro-industry in Africa (CEFA)

Wednesday, 08 March 2006

The Cleaner Energy Fund for Agro-industry in Africa (CEFA) concept has been initiated by Kenya-based Integral Advisory Limited ("Integral"). Integral is Eastern Africa Representative for Triodos Renewable Energy for Development Fund (TRED Fund). Integral has proposed TRED Fund as potential sponsor/anchor investor to formulate and capitalize CEFA. TRED Fund is an investment vehicle managed by the Triodos Bank (headquartered in Netherlands).

Triodos Bank is a European bank with presence in Netherlands (H/office), Belgium, UK, Spain. It aims to help achieve a more decent, dignified and kinder society and a world that respects people, the environment and different cultures. The Bank is a pioneering force in the world of sustainable banking.
It finances companies, institutions and projects that add cultural value, benefit people and benefit the environment. Triodos Bank, through its fund management unit, "Triodos International Fund Management BY" (TIFM) already manages several funds, among them three funds that provide finance, both debt and equity, to more than 50 microfinance institutions in approximately 25 developing countries:

Integral is a Kenyan private limited company committed to providing financing solutions, models and portfolio services to key sectors contributing to development, with a special focus on Energy, Environment, Health and Agriculture. Integral currently works in partnership / collaboration with international institutions which share the common goals of equity, sustainable development, food security, energy and health for all in Africa.

CEF A is being created to meet the specific funding needs of a portfolio of investments and deal flow to be generated by two energy initiatives in Africa: "Greening the Tea Industry in East Africa" and "Cogen for Africa Project." These projects are proposed by UNEP/GEF in collaboration with the implementing partners, AFREPREN (African Energy Policy Research Network) and EA TT A (East Africa Tea Trade Association).

Based on discussions with Integral on the potential fund structure and purpose, Triodos has expressed an intention and no commitment at this stage. Firm commitments will be obtained from Triodos once the project sponsors are identified and fund manager fully defined. Specifically, Triodos is prepared to:

1. Act as a potential funder of the fund with possibility of Triodos assisting the fund sponsor and manager to set it up.
2. Triodos will thus, subject to agreement of terms, support the formation and capitalisation of CEFA.

3. Triodos funding of CEF A and support for its formation will be subject to Triodos internal approvals, identification of an appropriate fund manager (possibly including the concept developer, Integral) and identification of specific qualifying projects/project sponsors with actual business plans.

As the proposed principal promoter for CEF A, Triodos Bank will play three key roles: Seed capitalisation of the Fund; Fund set-up expertise; Fund-raising leadership. This approach falls within the strategy of TRED Fund: " ... being a source of finance for new and existing local financial intermediaries that focus on providing financial services to projects and small and medium enterprises in the clean energy
sector ... playing an instrumental role in promoting and structuring new initiatives ... actively seeking collaborations with financial intermediaries such as banks, microfinance institutions and leasing companies for clean energy related SME finance and end user finance."
It is within the scope of the above strategy that Triodos has expressed an interest in CEFA.