PROJECT BRIEF

GEF COUNCIL SUBMISSION

AGENCY'S PROJECT ID: GFL/2328-2721-4868
GEFSEC PROJECT ID:
COUNTRY: Kenya, Uganda, Sudan, Ethiopia, Tanzania, Malawi and Swaziland
PROJECT TITLE: Cogen for Africa
GEF AGENCY: UNEP
OTHER EXECUTING AGENCY(IES): AFREPREN/FWD
DURATION: 6 Years
GEF FOCAL AREA: Climate Change
GEF OPERATIONAL PROGRAM: OP 5: "Removal of Barriers to Energy Efficiency and Energy Conservation"
OP 6: "Promoting the adoption of Renewable Energy by removing barriers and reducing implementation costs"
GEF STRATEGIC PRIORITY: CC-2: Power sector policy frameworks supportive of renewable energy and energy efficiency
SP-2 - Increased Access to Local Resources of Financing for Renewable Energy and Energy Efficiency
SP-4 - Productive uses of renewable energy
Pipeline Entry Date:
ESTIMATED STARTING DATE:
IA FEE:

FINANCING PLAN (US$)	
GEF PROJECT/COMPONENT	
Project	6,032,489
PDF A	
PDF B	417,400
PDF C	
Sub-Total GEF	6,449,889
*CO-FINANCING**	
Government	453,600
Bilateral	
Private Sector	60,625,000
Others (COOPENER)	375,000
Sub-Total Co-financing:	*61,453,600*
Total Project Financing:	*67,486,089*
FINANCING FOR ASSOCIATED ACTIVITIES IF ANY:	
LEVERAGED RESOURCES IF ANY:	

*Details provided under the Financial Modality and Cost Effectiveness section

RECORD OF ENDORSEMENT ON BEHALF OF THE GOVERNMENT(S):

Malawi - R.P. Kabwaza, Director of Environmental Affairs, Ministry of Mines, Natural Resources and Environment	*Date: July 20, 2005*
Swaziland - James Vilakati, Director of Environment, Ministry of Tourism, Environment and Communications	*March 15, 2006*
Kenya - M.O. Mbegera, Director General, National Environment Management Authority, Ministry of Environment and Natural Resources	*June 27, 2005*
Tanzania – A.R.M.S Rajabu, Senior Permanent Secretary, Vice President's Office	*March 20, 2006*
Ethiopia – T. Berhan, Director General, Environmental Protection Authority	*July 25, 2005*
Sudan – Yasin Eisa, Undersecretary, Mohammed, Ministry Of International Cooperation	*March 12, 2006*
Uganda - Keith Muhakanizi, Deputy Secretary to the Treasury, Ministry of Finance, Planning and Economic Development	*March 20, 2006*

<table>
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PROJECT SUMMARY

Project rationale, objectives, outputs/outcomes and activities

Rationale

Cogeneration, which is the simultaneous production of two different forms of energy (usually in the forms of heat and power) from a single energy system and source, is a highly efficient technique to provide electricity and heat to the industries and the national grid. Moreover, when biomass residues from wood and agro-industries are used as fuel for cogeneration, the plant becomes a renewable energy system which, in some instances, could replace the use of fossil fuel. The concept of cogeneration and its associated benefits have been proven in many regions of the world and modern technologies using high-pressure cogeneration systems exist in the global market.

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. A key model of success for this Project is the experience in Mauritius where its sugar industry uses the bagasse residues generated from the factories as fuel in high pressure cogeneration systems which allow the project owners to implement much higher capacities than what the factories need, thereby giving them opportunity to sell excess power to the grid. Today, the electricity produced by these cogeneration plants in the sugar industry is supplying close to 40% of the total consumption of the whole country.

The Cogen for Africa Project intends to promote and harness the potential benefits of implementing highly efficient cogeneration systems in seven African countries that have signified their interest and have officially endorsed the Project, namely, Ethiopia, Kenya, Malawi, Sudan, Swaziland, Tanzania and Uganda. In these countries, cogeneration has been used in the sugar industry for the past 40 years or more. However, during this whole period, only about 200 MW of cogeneration capacity was installed using inefficient, low-pressure systems which are now obsolete and outmoded. These old plants do not have proper cleaning devices that modern cogeneration systems have. They therefore create high negative environmental impacts due to the emission of particulates and the likelihood of releases of dioxins and furans to the air. Although residues in the form of bagasse are generated in abundant quantities (up to 39% by weight of the sugar cane input) in the factories, most of the bagasse is disposed of improperly through open burning or dumping in landfills, while many factories still import a portion of their electricity requirements from the grid.

This situation exists in these countries because of the existence of key barriers that hinder potential project developers/owners from adopting more efficient medium and high-pressure cogeneration technologies in their factories. Without the intervention of the GEF, cogeneration is likely to continue in the region, with low pressure, inefficient and polluting systems. In addition, the sale of electricity to the grid by sugar factories is likely to be insignificant. The Cogen for Africa Project, through removal of barriers that exist and capacity building, technical assistance, and institutional support for policy formulation, has a target to directly support the implementation of an additional of 40 MW of modern and efficient cogeneration capacity as Full Scale Promotion Projects (FSPPs) during the Project duration of six (6) years. These projects will provide showcases for convincing other potential project developers/owners of the technical reliability, economic viability and environmental soundness of more efficient cogeneration systems.

It is also expected that during the Project implementation another 20 MW of projects will have been directly supported through the provision of advice, services and training but will not be considered to be FSPPs. These projects are expected to be under construction or at the advanced stage of project development at the end of the Project. Once the FSPPs are implemented and used as show cases of modern and efficient cogeneration systems, replication of such systems is expected beyond the 6-year duration of the Project for a total of around 200 MW, which includes the 20 MW that have been supported and developed during the Project implementation.

The target of 40 MW direct project and 20 MW direct post-project is ambitious considering the long development stage of cogeneration projects vis-à-vis the Project duration of 6 years. However, taking into account the potential in the participating countries and the design of the Projects which draws lessons and experiences from successful institutional models, this target is realizable. In comparison, the Cogen Programme in Asia realized 30 MW of directly supported projects during the first 10 years and around 150 MW during the third phase and last 3 years of its operations.

The cogeneration projects that will be promoted will be the energy efficient high-pressure systems and with modern air cleaning devices that comply with stringent environmental requirements. The global environmental benefits that are expected to result from the Project are significant. At the end of the Project duration of 6 years, the direct annual CO_2 emission mitigation from the implemented FSPPs is expected to be around 163,200 tons and an accumulated CO_2 emission reduction of 3,264,000 tons during the 20-year lifetime of these projects. In addition, the Project is expected to have a direct post-project annual CO_2 emission mitigation of 65,280 tons and accumulating 1,305,600 tons at the end of the 20-year lifetime of the cogeneration projects. The indirect replication potential is expected to result in an annual CO_2 emission abatement of 587,520 tons which is expected to accumulate to 11,750,400 tons at the end of the cogeneration projects' lifetime of 20 years.

Comparing the bagasse-fired cogeneration plants with diesel power plants, the least cost analyses of the two systems revealed that the discounted levelized cost per kWh generated using bagasse-fired cogeneration plants is 0.052 USD/kWh compared to 0.207 USD/kWh for diesel power plants. This translates to a negative cost incrementality of 0.155 USD/kWh, On top of this, the steam requirements of the sugar factory has been covered without additional cost to the cogeneration plant. Actual fugures from countries like Tanzania and Kenya have shown that the price of electricity offered to Independent Power Producers (IPPs) particularly those producing electricity using diesel as fuel go as high as 0.335 USD/kWh and 0.16 USD/kWh, respectively. There is therefore clear negative cost incrementality in the use of bagasse-fired cogeneration systems.

Project goal, objective, outcomes, outputs and activities

The development goal of the Cogen for Africa Project is the creation of a self-sustaining cogeneration industry in Africa thereby contributing to the reduction of CO2 emissions.

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 more efficient cogeneration systems by removing barriers to their application.

In a continent with a growing demand for energy, cogeneration should become the common standard wherever appropriate and applicable. The project is expected to result in the following outcomes:

- Outcome 1: Capacity of project developers, technical service providers and local manufacturers of modern and efficient cogeneration systems developed and enhanced
- Outcome 2: Financing for cogeneration projects made available and accessed at terms and conditions that are favourable for investments.
- 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.
- Outcome 4: More favourable policies and institutional arrangements that support cogeneration promoted

The outputs and activities under the different outcomes are the following:

Outputs for Outcome 1:

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 installations.

Activities:

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

Outputs for Outcome2:

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

Activities:

2.1 Identify and review existing financing sources and mechanisms relevant for the sector and the region

2.2 Design and recommend financing 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

Outputs for Outcome 3:

3.1 Project Development Guide completed

3.2 Cogeneration Investment Packages (CIP) developed and promoted

3.3 Full Scale Promotion Projects (FSPPs) implemented and promoted for replication

3.4 Technical assistance provided to pipeline of projects (i.e. non-FSPP projects)

Activities:

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

Outputs for Outcome 4:

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 drafted and the stage set for approval

Activities:

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 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 a Standard Power Purchase Agreements (PPAs)

Project concept and approach

A model which inspired the design of this regional initiative is the regional cogeneration program in Asia which has been successfully operated for 15 years and has directly supported the implementation of about 150 MW of efficient cogeneration project and indirectly promoted the replication of up to 450 MW more in the region involving nine countries within the Association of Southeast Asian Nations (ASEAN). The regional nature of the program allowed the resources to be used at an optimum level by setting up a single Executing Agency in the region which hosted the Programme Management Unit where the activities of the program emanate from.

A major platform for the implementation of the Cogen for Africa Project is the creation of a regional centre of excellence to be called the Africa Cogen Centre. It will operate as the center of excellence for cogeneration in the African region. The Africa Cogen Centre will 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 cogeneration stakeholders.

The Africa Cogen Centre will report and will be accountable to the Project Steering Committee while being supported at the national level by National Cogen Offices which will be set up in each of the countries participating in this Project. Upon completion of the project, the one-stop information and service centre 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.

In order to reduce the risks of the potential project developers in spending upfront development costs in a venture that is considered new such as high-pressure cogeneration systems, the Cogen for Africa Project will provide support that limits their development costs, and provides concrete examples of successful projects. One of the major activities that the Project will execute is the implementation of Full Scale Promotion Projects (FSPP) within the seven participating countries. These FSPPs will act as show cases aimed at convincing other potential end-users to implement these technologies by demonstrating the technical reliability, economic viability and environmental friendliness of modern and efficient cogeneration technologies.

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LIST OF ACRONYMS

ACP	African, Caribbean and Pacific
ADLI	The Agriculture Development Led Industrialization
AfDB	African Development Bank
AFREPREN/FWD	Energy, Environment and Development Network for Africa
AIT	Asian Institute of Technology
AREED	Africa Rural Energy Enterprise Development
ASEAN	Association of South East Asian Nations
BOO	Build, Operate, Own
CC	Climate Change
CDM	Clean Development Mechanism
CEO	Chief Executive Officer
CfA	Cogen for Africa
CIA	Central Intelligence Agency
CIP	Cogeneration Investment Package
CO2	Carbon Dioxide
Cogen	Cogeneration
DBSA	Development Bank of South Africa
DEG	Deutsche Investitions -und Entwicklungsgesellschaft mbH
DSCR	Debt Service Coverage Ratio
EADB	East African Development Bank
EAPLC	East Africa Power & Lighting Company
EASCF	East Africa Small Hydro and Cogeneration Fund
EC	European Commission
EC-ASEAN	European Commission - Association of South-East Asian Nations
EEPCo	Ethiopia Electricity Power Company
EIB	European Investment Bank
EPC	Engineering, Procurement, and Construction
ERT	Energy for Rural Transformation
ESCO	Energy Service Company
EU	European Union
FMO	Netherlands Development Finance Company
FS	Feasibility Study
FSDPs	Full Scale Demonstration Projects
FSF	Finchaa Sugar Factory
FSPP	Full Scale Promotion Project
FWD	Foundation for Woodstove Dissemination
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Green House Gas
GoK	Government of Kenya
GWh	Giga Watt Hour
IBRD	International Bank of Reconstruction and Development
IEA	International Energy Agency
IPCC	Inter Governmental Panel On Climate Change
IPP	Independent Power Producer
IRR	Internal Rate of Return
IRSEAD	Institute of Research in Sustainable Energy and Development
IT	Information Technology
KAM	Kenya Association of Manufacturers
KfW	KfW Entwicklungsbank - KfW development bank

KShs	Kenya Shillings
KPLC	Kenya Power and Lighting Company
KSW	Kinyara Sugar Works
kV	KiloVolts
kW	Kilowatt
kWh	KiloWatt Hour
LCPD	Least Cost Power Development
M&E	Monitoring and Evaluation
MD	Man Day
MEMD	Ministry of Energy and Minerals Development, Uganda
MIP	Management Information Principles
MNES	Ministry of Non-Conventional Energy Sources
MoU	Memorandum of Understanding
MW	Megawatt
MWh	Mega Watt Hour
NEPAD	New Partnership for Africa's Development
NPV	Net Present Value
O&M	Operations and Maintenance
OP	Operational Program
PDF-B	Project Development Facility
PDP	Power Development Plan
PMC	Project Management Council
PPA	Power Purchase Agreement
PPD	Project Design Document
PSC	Project Steering Committee
REEEP	Renewable Energy and Energy Efficiency Partnership
RESCO	Renewable Energy Service Company
RSA	Republic of South Africa
SADC	Southern African Development Community
SBIC	Swaziland Industrial Development Company, Ltd.
SCOUL	The Sugar Corporation of Uganda Ltd
SPC	Special Purpose Company
SSF	Shoa Sugar Factory
STAP	Scientific and Technical Advisory Panel
TANESCO	Tanzania Electric Supply Company
TANWAT	Tanganyika Wattle Company
TC	Tonnes of Cane
TCD	Tons of Cane per Day
TCH	Tonnes of cane per hour
TFA	Techno-Financial Analysis
UEB	Uganda Electricity Board
UETCL	The Uganda Electricity Transmission Company Ltd
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USD	US Dollar
WADE	World Alliance for Decentralized Energy
WB	World Bank
ZESA	Zimbabwe Electric Supply Authority

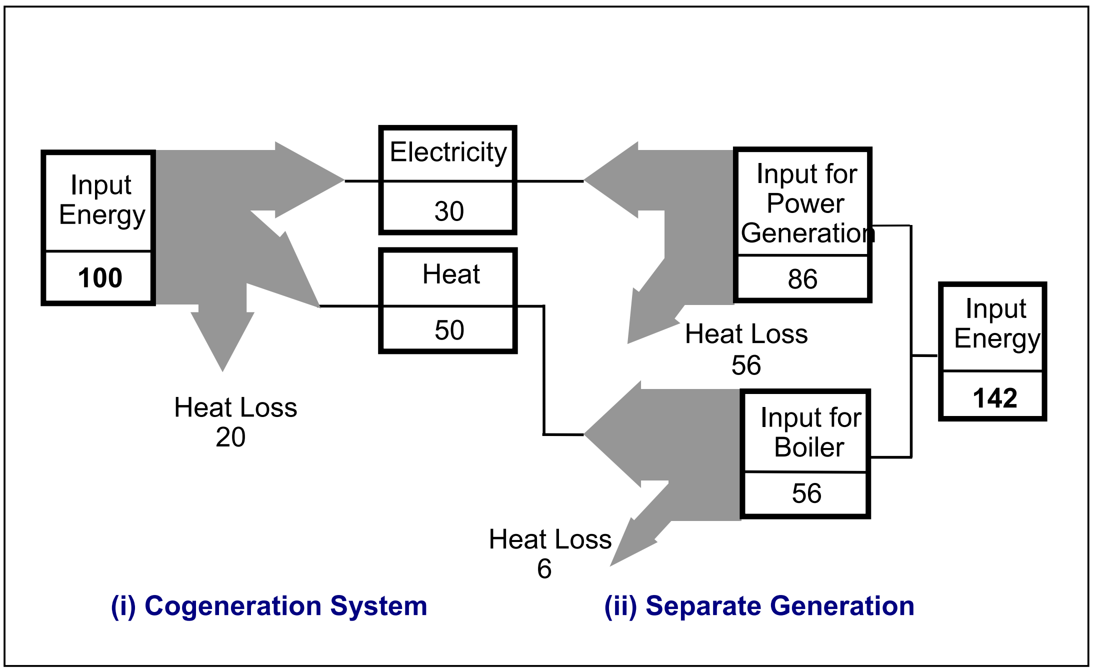
1. BACKGROUND AND RATIONALE

1.1 Why Cogeneration?

In conventional utilities, power production and steam generation are independent of each other and separate fuel sources are used. However, it has been demonstrated that an industry's power and thermal needs can be met using a single energy source. This is called cogeneration.

Cogeneration has the advantage of reducing the primary energy use, while providing a given quantity of two different forms of energy (usually in the forms of heat and power). Conventional energy supply systems require about 40 % more primary energy than a cogeneration system to meet the same energy needs (Figure 1.1). Therefore cogeneration can be both energy efficient and environmentally beneficial. Moreover, when biomass residues from wood and agro-industries are used as fuel for cogeneration, the plant becomes a renewable energy system which, in some instances, could replace the use of fossil fuel.

Figure 1.1: Comparison of energy balances between cogeneration and separate power generation



Source: Mohanty, 2000

Cogeneration has been widely applied in agro-industries such as sugar and palm oil factories. As the trend in wood industries is a shift towards integrated wood complexes, cogeneration plants are being implemented increasingly in this sector, too. In some cases, rice husks as well as coconut husks and shells, can also be used as a fuel to help meet the energy demands of the plant, while abating the environmental pollution associated with their disposal. If appropriate technologies are implemented, cogeneration can not only render these agro-industries self-sufficient in energy, but can also help them to earn a profit by exporting excess electricity produced to the national grid or to neighbouring industries.

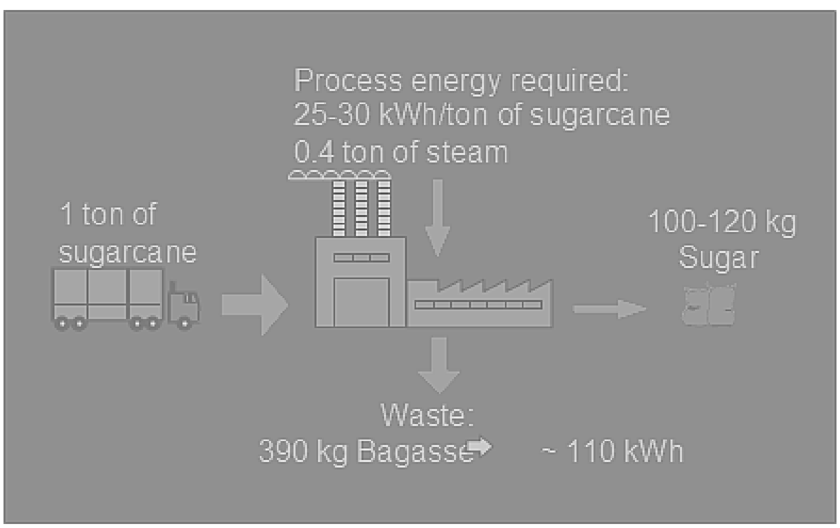
The industries that produce these biomass residues have requirements for energy, usually in the form of electricity and heat. It is therefore customary for these industries to use the residues that are generated in an energy conversion system at least to cover for the internal requirements of the factory itself. Many facilities, however, approach this situation without due regard for energy or environmental merits.

For instance, in sugar factories, after the juice is taken out from the cane, there is about 30-40 % (depending on variety of sugar cane and other agronomical and climatic conditions) of bagasse generated as a waste material in the factory. In the past, because of the limited development of technology and the absence of a regulatory framework that facilitates sales of excess electricity to the grid, the sugar factories' energy systems have been designed to generate just enough electricity and heat for the process while consuming all the bagasse to avoid its accumulation and creation of disposal problems. This approach transforms the energy system into both an energy generating unit and an incineration .

Because of recent developments in the technology which allows the production of high pressure, high temperature steam for the turbine, thus generating more power from the bagasse on one hand, and the potential for the existence of a regulatory framework that allows private generators to sell their excess power to the grid on the other hand, there now exists greater opportunities for generating cleaner power that is not only environmentally benign but an important avenue for generating an additional revenue stream for the sugar industry.

To illustrate, Figure 1.2 shows that for each ton of sugar that comes into the factory for processing, about 100 to 120 kg of sugar is produced. This process of converting sugarcane into sugar needs electricity for its prime movers, motors, pumps, etc. of about 25-30 kWh/ton of sugarcane and heat in the form of low pressure steam amounting to 400 kg/ton of sugarcane. By using the bagasse generated which is around 390 kg in an efficient high pressure Cogen system, up to 110 kWh of electricity could be produced while extracting steam enough for the requirements of the process. The 110 kWh should be able to cover for the electricity requirements of the factory with an excess of around 80 kWh. This excess electricity accounts for more than 2 to 3 times the amount needed internally by the process. This demonstrates the potential of energy that could be harnessed if the conditions are right for implementing efficient Cogen systems in relevant industries in Africa. .

Figure 1.2: Material balance in a sugar factory



With the recent developments in the global sugar market heralding the advent of low sugar prices , African sugar companies are very keen to find ways to reduce costs through efficient operations and additional revenues from complementary activities such as cogeneration. The announcement of the European Union (EU)'s plan to reduce implicit subsidies for sugar exports from African, Caribbean and Pacific (ACP) states, sent fears that the African sugar companies may find it difficult to compete against low prices from other non-African countries[1]. Cogeneration is

[1] Daily Nation, December 7, 2005, Kenya

increasingly perceived by sugar companies as an important opportunity for improving their financial performance by reducing their electricity bills and generating a new stream of revenues. Recent data from Mauritius indicates that half the revenue for sugar factories is from the sale of sugar and the other half from the sale of electricity from cogeneration.

1.2 Applicability of Cogeneration in Africa

Table 1.1 below summarizes the macro-economic figures of the seven African countries that are participating in this project and have expressed keen interest in promoting cogeneration in their industries. It should be observed that for most of them, agriculture alone (and more so if agro-industry is added) account for more than one-third (close to or around 50% for some of them) of the total GDP of the countries. The industries processing these agricultural products normally require energy in the form of electricity to drive their prime movers/machinery and heat for the process. At the same time, they also normally generate residues that could be used as fuel for boilers producing steam for the process and electricity when directed to a turbo-generator. The set up then becomes a cogeneration system.

Table 1.1: Economic figures of the seven countries involved

Countries	Gross domestic product (GDP) in Million USD 2003	Real GDP growth %			Per capita GDP in USD 2003	GDP per sector 2004		
		2002	2003	2004		Agricul-ture %	Indus-try %	Servi-ces %
Ethiopia	6,972	1.9	-3.7	11.6	101.6	47.0	12.4	40.6
Kenya	10,892	1.2	1.8	2.2	341.2	19.3	18.5	62.4
Malawi	1,776	2.7	4.4	4.0	162.0	54.8	19.2	26.0
Sudan	17,800	6.5	6.0	8.6	460	41.2	18.5	40.4
Swaziland	1,487	2.8	2.4	2.5	1,351.8	16.1	43.4	40.5
Tanzania	11,079	7.2	7.1	5.8	308.6	43.2	17.2	39.6
Uganda	6,959	6.8	4.7	5.0	275.3	35.8	20.8	43.6

Source: World Bank, 2005; CIA World Factsheet 2005

In the seven participating countries, the sugar industry that produces bagasse is a major sector given high priority by the governments. On the demand side, the need for additional power capacity is increasing and governments are turning to the private sector to meet the challenge of investing in power generation facilities. For instance, Uganda which is currently facing shortage in power due to the lowering of the water level in Lake Victoria which is the source of the hydro power that supplies most of the country's electricity requirements (see Annex S), as well as Kenya and Tanzania are keen to attract private Independent Power Producers (IPPs) to install additional power generating capacities.

The sections that follow present background information and data on the resources and potential for the application of cogeneration in Africa, and the benefits that could be derived in wider application of cogeneration in the region.

1.2.1 Resource assessment and potential

Based on the information that is currently available, cogeneration has huge potential in relevant sectors such as: sugar, pulp and paper, wood processing, coffee, maize, rice, hotels, hospitals, commercial complexes, etc.

One of the key determining factors that drive the decision of project developers to implement a cogeneration system is the availability of fuel to supply the requirements of the plant at reasonable prices and at a sustained period of time.

Other than coal and natural gas, which are possible fuels for cogeneration, an abundant supply of fuel comes from the residues that are generated by the industries using wood and agricultural crops as raw material. In Annex M the statistics of agricultural produce in each of the participating countries and the availability of biomass residues generated by different industries in the different countries is provided. These agricultural products when processed into their consumable form, produce some residues in the form of biomass wastes. These so-called wastes, being combustible material with significant energy content (calorific value), could be used as fuel in energy conversion systems such as cogeneration plants. Table 1.2 shows the biomass residues produced by the sugar and rice industries in the different countries and their theoretical power generation potential. In these industries, the residues are centralized in the mills/factories where the raw material is processed, which makes it easy for these residues to be gathered and used as fuel.

Table 1.2: Biomass residues by industry by country (2004)

A. Sugarcane

Country	Sugarcane (1000 tons)	Bagasse production (1000 tons)*	Theoretical power generation potential (MWh/year)**
Ethiopia	2,454	859	282,242
Kenya	4,661	1,631	536,014
Malawi	2,100	735	241,500
Sudan	5,500	1,925	632,500
Swaziland	4,500	1,575	517,500
Tanzania	2,000	700	230,000
Uganda	1,600	560	184,000
TOTAL	**22,815**	**7,985**	**2,623,756**

* At an average of 35% bagasse to cane ratio
** At an assumed boiler pressure of 65 bar

B. Rice

Country	Rice paddy (1000 tons)	Rice husk production (1000 tons)***	Theoretical power generation potential (MWh/year)***
Ethiopia	15.50	3	1,550
Kenya	49.30	10	4,930
Malawi	49.72	10	4,972
Sudan	15.75	3	1,575
Swaziland	0.17	0.03	17
Tanzania	680.00	136	68,000
Uganda	140.00	28	14,000
TOTAL	**950.44**	**190**	**95,044**

*** At an average of 20% rice husk to paddy ratio
**** At an assumed boiler pressure of 20 bar

It is, however, acknowledged that due to institutional, policy, regulatory and practical constraints the above theoretical potential may not be fully realized.

One issue that concerns the use of biomass residues as fuel for cogeneration is the seasonality of some of the agricultural products. A good example is the sugar industry. There is a concern that if a cogeneration plant is implemented to supply excess power to the grid on a firm basis, the plant may not be able to operate whole year round due to lack of fuel during the off-milling season. However, experiences from Thailand (with milling season of 3 to 4 months) and Mauritius (with milling season of 7 to 8 months) has shown that a whole year round electricity production is possible to achieve either by spreading out the bagasse to cover the operation during the off-milling season (case of Thailand) or using non-bagasse secondary fuel (case of Mauritius). In most countries here in Africa, the sugar factories operate for an average period of 10 to 11 months. With longer milling duration, the sugar industries in the participating countries of Africa, bagasse production is spread throughout the year which facilitates the operation of the cogeneration plant all year round (by storing a portion of bagasse for four to six weeks into the off-milling season) and eliminates the necessity to use secondary fuel such as coal. Moreover, with the advent of the diffuser technology to extract the juice from the sugar cane instead of the conventional milling, such as the one used in Mumias Sugar factory in Kenya, the down time and scheduled maintenance is significantly reduced thus allowing factories to operate for a longer period in a year.

Other than the above solution on seasonality, the limited period of the sugar milling season might not necessarily be a barrier for cogeneration as investments in generation are often dictated by capacity shortages, instead of energy shortages. As part of the initial planning during Project implementation, capacity balance tables could be constructed for each participating country to show demand and reserves against available energy in both capacity and energy terms on a monthly basis. By obtaining the resultant deficit or surplus in capacity or energy, the need for cogeneration by month could be demonstrated. This would reveal the cost-effectiveness of cogeneration technology for meeting capacity requirements. The information will also be useful for assessing the appropriateness of the Power Purchase Agreement (PPA).

One upside in the sugar industry is the fact that sugar cane also contains tops and leaves (cane trash) which is potentially available as fuel and is comparable to bagasse in terms of its potential available energy content per ton of sugar cane. This is traditionally burned and left on the field for soil conditioning. However, a potion of this could be taken and used as additional fuel which is being done in new cogeneration plants in Thailand as well as pilot plants in Brazil.

On the factory level, within the sugar industry alone (which has more accessible and organized data), the potential to harness the existing bagasse for cogeneration is undeniable. Table 1.3 provides an overview of the potential for cogeneration from sugar cane in the participating countries using 2002 data. The estimated potential is conservative as it does not take into account both the growth since 2002 as well as the future growth of the sugar production in all countries. Use of other biomass fuels (such as residues from wood/pulp/paper industries, coconut husks, rice husks, residues from maize, coffee, sisal and palm oil agro-industries) for cogeneration have likewise not been included in this estimate. In addition, alternative fuels to continue powering cogeneration plants beyond harvesting periods and milling season have not been considered. It can be seen from the table that depending on the efficiency of the system adopted (from medium efficiency to high efficiency, state-of-the-art, high pressure cogeneration systems) the additional power cogeneration capacity would vary from 225 MW to 550 MW.

Among the potential projects in the sugar industry of the participating countries, there are those that have undergone initial project development. These projects and the status of their development are provided in Table 1.4.

Table 1.3: Potential for cogeneration from sugarcane in Eastern and Southern Africa

Country/Sugar factory	Cane crushed (2002)	Electricity generation (Note 1)						IC (Note 2)	Additional power if cogeneration efficiency is improved (Note 3)			Status of cogeneration project development
		44bar - 90kWh/TC		65bar - 115kWh/TC		82bar - 150kWh/TC						
	Tons	**kWh**	**MW**	**kWh**	**MW**	**kWh**	**MW**	**MW**	**MW**	**MW**	**MW**	
ETHIOPIA												
Finchaa Sugar Factory	617,283	55,555,470	10.1	70,987,545	12.9	92,592,450	17.5	7.0	3.1	5.9	10.5	Pre-feasibility study conducted for 34MW, with factory expansion
Wonji/Shoa	530,000	47,700,000	8.7	60,950,000	11.1	79,500,000	15.0	6.4	2.3	4.7	8.6	Pre-feasibility study conducted for 18MW, with factory expansion
Sub Total	**1,147,283**	**103,255,470**	**18.7**	**131,937,545**	**24.0**	**172,092,450**	**32.4**	**13.4**	**5.3**	**10.6**	**19.1**	
KENYA												
West-Kenya	399,000	35,910,000	6.5	45,885,000	8.3	59,850,000	11.3	2.5	4.0	5.8	8.8	
Muhoroni	413,070	37,176,300	6.7	47,503,050	8.6	61,960,500	11.7	3.0	3.7	5.6	8.7	
Nzoia	568,098	51,128,820	9.3	65,331,270	11.9	85,214,700	16.1	4.5	4.8	7.4	11.6	
Mumias	2,207,120	198,640,800	36.1	253,818,800	46.1	331,068,000	62.4	15.0	21.1	31.1	47.4	Selling 2MW to the grid; Pre-feasibility study conducted for 20MW
Chemilil	602,304	54,207,360	9.8	69,264,960	12.6	90,345,600	17.0	6.0	3.8	6.6	11.0	Pre-feasibility study conducted for 15MW
Sony	580,516	52,246,440	9.5	66,759,340	12.1	87,077,400	16.4	7.0	2.5	5.1	9.4	
Proposed - Busia Sugar Company	*1,134,000*	*102,060,000*	*18.5*	*130,410,000*	*23.7*	*170,100,000*	*32.1*	*0.0*	*18.5*	*23.7*	*32.1*	*Feasibility study to implement new sugar factory to include 20MW cogeneration plant*
Sub Total	**5,904,108**	**531,369,720**	**96.5**	**678,972,420**	**123.3**	**885,616,200**	**167.0**	**38.0**	**58.5**	**85.3**	**129.0**	
MALAWI												
Dwangwa Sugar Mill	795,065	71,555,850	13.0	91,432,475	16.6	119,259,750	22.5	7.0	6.0	9.6	15.5	
Ntchalo Sugar Mill	1,300,000	117,000,000	21.2	149,500,000	27.1	195,000,000	36.8	11.5	9.7	15.6	25.3	
Sub Total	**2,095,065**	**188,555,850**	**34.2**	**240,932,475**	**43.7**	**314,259,750**	**59.2**	**18.5**	**15.7**	**25.2**	**40.7**	
SWAZILAND												
Simunye	2,352,000	211,680,000	38.4	270,480,000	49.1	352,800,000	66.5	17.0	21.4	32.1	49.5	Pre-feasibility study for 50MW conducted
Mlhume	1,764,000	158,760,000	28.8	202,860,000	36.8	264,600,000	49.9	18.5	10.3	18.3	31.4	Pre-feasibility study for 50MW conducted, with factory expansion
Ubombo	2,745,600	247,104,000	44.9	315,744,000	57.3	411,840,000	77.6	17.5	27.4	39.8	60.1	
Sub Total	**6,861,600**	**617,544,000**	**112.1**	**789,084,000**	**143.3**	**1,029,240,000**	**194.0**	**53.0**	**59.1**	**90.3**	**141.0**	

Country/Sugar factory	Cane crushed (2002)	44bar - 90kWh/TC		65bar - 115kWh/TC		82bar - 150kWh/TC		IC (Note 2)	Additional power if cogeneration efficiency is improved (Note 3)			Status of cogeneration project development -Feasibility Studies
	Tons	kWh	MW	kWh	MW	kWh	MW	MW	MW	MW	MW	
SUDAN												
Kenana Sugar Co. Ltd.	3,281,000	295,290,000	53.6	377,315,000	68.5	492,150,000	92.8	40.0	13.6	28.5	52.8	
Gunied Sugar Factory	825,000	74,250,000	13.5	94,875,000	17.2	123,750,000	23.3	3.0	10.5	14.2	20.3	Feasibility study conducted for 28MW, with factory expansion
New Halfa Sugar Factory	835,000	75,150,000	13.6	96,025,000	17.4	125,250,000	23.6	6.0	7.6	11.4	17.6	Feasibility study conducted for 30MW, with factory expansion
Sennar Sugar Factory	880,000	79,200,000	14.4	101,200,000	18.4	132,000,000	24.9	6.5	7.9	11.9	18.4	Feasibility study conducted for 28MW, with factory expansion
Sub Total	**5,821,000**	**523,890,000**	**95.1**	**669,415,000**	**121.5**	**873,150,000**	**164.6**	**55.5**	**39.6**	**66.0**	**109.1**	
TANZANIA												
Kilombero Sugar Plant K1	403,200	36,288,000	6.6	46,368,000	8.4	60,480,000	11.4	6.0	0.6	2.4	5.4	
Kilombero Sugar Plant K2	504,000	45,360,000	8.2	57,960,000	10.5	75,600,000	14.3	2.8	5.4	7.7	11.5	
Mtibwa Sugar Estate	1,764,000	158,760,000	28.8	202,860,000	36.8	264,600,000	49.9	13.0	15.8	23.8	36.9	
Kagera Sugar Company	302,400	27,216,000	4.9	34,776,000	6.3	45,360,000	8.6	5.0	-	1.3	3.6	
Tanganyika Planting Company	655,200	58,968,000	10.7	75,348,000	13.7	98,280,000	18.5	3.0	7.7	10.7	15.5	Pre-feasibility study conducted for 20MW, with factory expansion
Sub Total	**3,628,800**	**326,592,000**	**59.3**	**417,312,000**	**75.8**	**544,320,000**	**102.6**	**29.8**	**29.5**	**46.0**	**72.8**	
UGANDA												
Kakira Sugar Works	710,000	63,900,000	11.6	81,650,000	14.8	106,500,000	20.1	6.0	5.6	8.8	14.1	Agreement to sell 12MW to the grid, interested in expansion if attractive PPA is agreed upon
Kinyara Sugar Company	610,000	54,900,000	10.0	70,150,000	12.7	91,500,000	17.3	2.0	8.0	10.7	15.3	Pre-feasibility study conducted for 5MW
SCOUL	387,000	34,830,000	6.3	44,505,000	8.1	58,050,000	10.9	2.0	4.3	6.1	8.9	
Sub Total	**1,707,000**	**153,630,000**	**27.9**	**196,305,000**	**35.6**	**256,050,000**	**48.3**	**10.0**	**17.9**	**25.6**	**38.3**	
GRAND TOTAL	**27,164,856**	**2,444,837,040**	**443.9**	**1,526,038,640**	**567.2**	**4,074,728,400**	**768.2**	**218.2**	**225.7**	**349.0**	**550.0**	

Note 1: 3 scenarios are used to estimate electricity generation, based on improvements in efficiency and boiler pressure from the Mauritius experience. These are: 44 bar pressure at 90kWh/TC, 65 bar at 115kWh/TC and 82 bar at 150kWh/TC. Assumes 35% bagasse to cane ratio at 50 % moisture content
Note 2: IC = Installed capacity. This is the current installed electrical capacity of the sugar factory.
Note 3: The difference between the current installed capacity and the electricity that can be generated under the 3 scenarios, with varying boiler pressure.
Note 4: Conversion from kWh to MW assumes plant operating duration of 270 days, 24hrs a day and capacity utilization of 85%.

Table 1.4: Planned cogeneration investments in sugar factories

Country/Sugar factory	Cane crushed (2002) Tons	Installed capacity	Cogeneration Expansion plans/Pre-Feasibility Studies	Planned Investment (US$)
KENYA		MW		
Mumias	2,207,120	15.0	Selling 2MW to the grid; Pre-feasibility study conducted for 21MW	12million
Chemilil	602,304	6.0	Pre-feasibility study conducted for 15MW	23.7million
Proposed - Busia Sugar Company	*1,134,000*	*0.0*	*Feasibility study to implement new sugar factory to include 20MW cogeneration plant*	*100million (includes cost of factory setup with cogeneration component)*
SUDAN				
Gunied Sugar Factory	825,000	3.0	Feasibility study conducted for 28MW, with factory expansion	34-39million
New Halfa Sugar Factory	835,000	6.0	Feasibility study conducted for 30MW, with factory expansion	31-37million
Sennar Sugar Factory	880,000	6.5	Feasibility study conducted for 13MW, with factory expansion	19million
TANZANIA				
Tanganyika Planting Company	655,200	3.0	Pre-feasibility study conducted for 20MW, with factory expansion	To be confirmed
ETHIOPIA				
Finchaa Sugar Factory	617,283	7.0	Pre-feasibility study conducted for 34MW, with factory expansion	34million
Wonji/Shoa	530,000	3.4	Pre-feasibility study conducted for 18MW, with factory expansion	195million (includes factory expansion with cogeneration component)
UGANDA				
Kakira Sugar Works	710,000	6.0	Agreement to sell 12MW to the grid, interested in expansion if attractive PPA is agreed upon	To be confirmed
Kinyara Sugar Company	610,000	2.0	Pre-feasibility study conducted for 5MW	To be confirmed
SWAZILAND				
Simunye	2,352,000	17.0	Pre-feasibility study for 50MW conducted	77.5million
Mlhume	1,764,000	18.5	Pre-feasibility study for 50MW conducted, with factory expansion	77.1million

Note: The variation in cost per MW from country to country could be due the use of high pressure systems, which are more sophisticated and therefore more costly. In addition, in some countries, the investment includes a bagasse handling facility, and expansion of the sugar plantation and factory.

1.2.2 Target/expected achievement

The potential for implementing medium to high-pressure cogeneration systems (as compared to the current practice of inefficient low-pressure systems) is huge. However, it should be noted that for the past 40 years or more, the sugar industry in the participating countries has installed only around 200 MW of cogeneration equipment even when the need for additional capacity to reach self-sufficiency exists. Moreover, as far as the current phase of this Project has investigated, only the Kakira Sugar Works in Uganda has a 45-bar boiler, although this is still in the construction stage and is not yet in operation.

Given this scenario, it is the Project's target that through its activities of removing the barriers that exist and assisting in transforming the cogeneration industry into a profitable cogeneration market through capacity building, technical assistance, and institutional support for policy formulation, an additional of 40 MW of modern and efficient cogeneration capacity will be implemented as Full Scale Promotion Projects (FSPPs). These projects 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.

It is also expected that during the Project implementation another 20 MW of projects will have been directly supported through the provision of advice, services and training but are not considered as FSPPs. These projects are expected to be either being implemented or at the advanced stage of project development at the end of the Project. Once the FSPPs are implemented and used as show cases of modern and efficient cogeneration systems, replication of such systems are expected to happen most likely beyond the 6-year duration of the Project for a total of around 200 MW, which includes the 20 MW that have been supported and developed during the Project implementation.

The target of 40 MW direct project and 20 MW direct post-project is ambitious considering the long development stage of cogeneration projects vis-à-vis the Project duration of 6 years. However, taking into account the potential in the participating countries and the design of the Projects which draws lessons and experiences from successful institutional models, this target is realizable. In comparison, the Cogen Programme in Asia realized 30 MW of directly supported projects during the first 10 years and around 150 MW during the third phase and last 3 years of its operations.

It must be emphasized that in order to maximize the benefits of implementing highly efficient cogeneration systems in the sugar factories, the efficiency in the use of process steam and electricity in the sugar processing should also be improved. This will free up more bagasse to generate additional electricity for sales to the grid.

1.2.3 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 and are elaborated in Annex V.

- Energy cost savings

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. Notable examples of this situation are mentioned in the Annex. 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. 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 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. It is estimated that in the sugar factories in Africa, only 60 % of the huge quantities of bagasse produced by the sugar factories 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.

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. 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.

- 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 has been shown to be the case in countries like Thailand, India and Mauritius where sugar factories have implemented cogeneration systems that generate excess electrical capacities for sale to the grid and receive revenues from electricity which account for up to the same amount as the income from the sugar business.

- 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

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[2] Batidzirai, Bothwell, "Cogeneration in Zimbabwe – A Utility Perspective", AFREPREN Occasional Paper No. 19, 2002.

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,[3] emphasizing the need for embedded generation such as Cogen.

In Africa, most sugar factories are found at the edge of the country's grid thus requiring an extensive transmission and distribution system. 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

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, 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 gasses and particulate matters harmful to the environment.

1.3 Potential Role of Cogen in the Region's Electricity Industry

The countries in Africa, and particularly those that are participating in the Cogen for Africa Project have much lower per capita electricity consumption compared to other developing nations in other regions (please see Table 1.5). As these countries grow in economic development and also grow in population, it is expected that high demand (or high suppressed demand) in electricity would need an increase in generating capacity.

Although current sources indicate that hydro power supplies a significant portion of the electricity consumption, this resource could face limitations in the future. Already, because of on-going droughts, the water level of Lake Victoria which is the source of water used by hydro power stations in Uganda, has dropped which caused power production in some hydro plants to fall by nearly half prompting utilities to draw power from more expensive fossil-fuelled Independent Power Producers (IPPs)[4]. In addition, there is a need to meet an increase in demand due to increase electrification and also due to improved quality of life requiring additional electricity generation capacity.

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[3] For instance, overall system losses in the following countries are: Malawi: 19%, Tanzania: 22%, Swaziland: 16%.

[4] Daily News, November, 15, 2003; Daily Nation, January 19, 2006, Kenya; The East African News, January 23-29, 2006.

Considering the potential that electricity from cogeneration plants could provide using indigenous and even renewable fuel and using investments coming from the private sector, it is obvious that the financial burden to the governments and environmental burden to the global environment could be reduced.

Table 1.5: Electricity supply and demand scenario in the seven countries involved (2003 figures)

Countries	Population (mil.)	Installed capacity (MW)	Electricity production (GWh)					Elect. consumption per capita (kWh)
			Total (GWh)	By source				
				Fossil Thermal	Hydro	Geo-thermal	Other (renewables)	
Ethiopia	68.6	493*	1812*	17	1790	-	5	20.6*
Kenya	31.9	1143	4563	1431	2574	480	78+	119
Malawi	11	306	1177	81	1096	-	-	88.2
Sudan	33.5	1380	3165	1649	1516	-	-	87.8
Swaziland	1.1	180	395	202	193	-	-	1,066
Tanzania	35.9	863*	2770*	144	2573	-	53	55.8*
Uganda	25.3	303	1756	12	1744	-	-	55.4
TOTAL	**207.3**	**4,668**	**15,638**	**3,536**	**11,486**	**480**	**136**	**-**

Source: World Bank, 2005; CIA World Factsheet 2005; AFREPREN, 2005; African Energy 2005.
*2001 data. More recent estimates indicate the Installed Capacity as 1088MW, and the per capita electricity consumption at 84kWh ;
+ Natural gas and wind

In Annex L, a review of the electricity supply industry of the participating countries is conducted with the aim of analyzing the usefulness and applicability of implementing cogeneration systems to supply the additional power requirements in these countries. Below, brief analyses of some countries show the potential role of cogeneration in the countries' electricity industry.

Kenya currently has a total installed capacity of 1155 MW, consisting of hydropower at 677.3 MW (58.6 %), followed by thermal at 349.3 MW (30.2 %), geothermal at 128 MW (11 %) and wind at 0.4 MW (0.03 %).

For a long time, the power sector in Kenya was dominated by a vertically integrated power utility, the Kenya Power and Lighting Company (KPLC), which was the dominant player in the generation, transmission and distribution of power in the country.[5] With the enactment of the Electricity Act of 1997, the generation segment was liberalized allowing the participation of Independent Power Producers (IPPs). These IPPs have installed mainly diesel power plants (284.5 MW out of the total 348.5 MW between 1997 to 2001), resulting in high tariffs at an average of 11.25 KSHs/kWh (0.16 USD/kWh). Table 1.6 presents the summary of the most recent IPP investments.

[5] Mbuthi, P. and Yuko, D., A Review of Geothermal and Cogeneration Technologies in Kenya, in Sustainable Energy in Africa, AFREPREN/FWD, 2005.

Table 1.6: Summary of IPP investments in Kenya

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
Tsavo Power Co.	Kipevu	**Diesel** Plant	75	85	July 2001

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

The use of thermal fossil power plants will continue to dominate the future capacity additions in the country's electricity supply industry, as evidenced by the Least Cost Power Development Plan (PDP) issued by the Ministry of Energy. As shown in the Table 1.7, it is planned that up to 2016, 1,123 MW of power capacity (consisting of 67.5 % of total capacity additions) will come from thermal power plants mainly fuelled by coal and diesel.

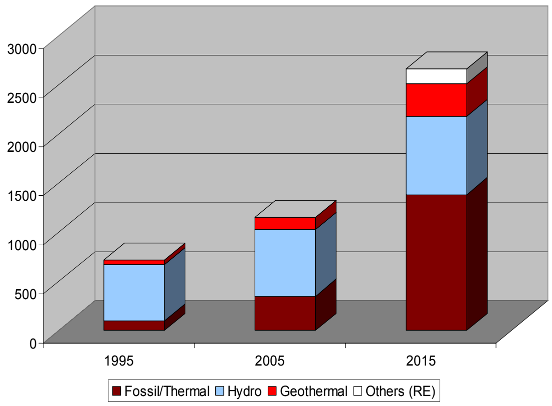
Table 1.7: Power Development Plan for Kenya (2006-2016), in MW

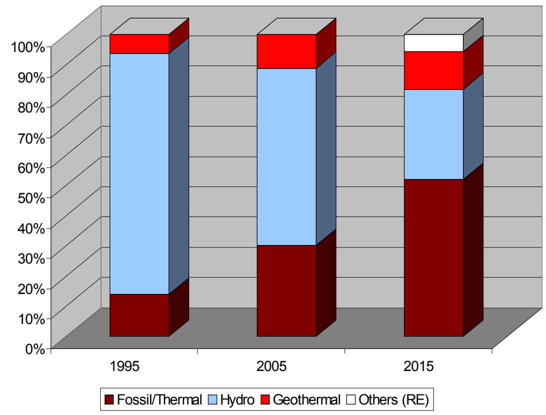
Year	Hydro	Geo	Thermal			Total thermal	Others (import/ line ext.)	TOTAL
			Gas	Coal	Diesel			
2006			43			**43**		**43**
2007					240	**240**		**240**
2008	120.6	69.6						**190.2**
2009		67.2		150		**150**	50	**267.2**
2010								**-**
2011				150		**150**		**150**
2012		67.2					100	**167.2**
2013				150		**150**		**150**
2014				150		**150**		**150**
2015				150		**150**		**150**
2016		67.2	90			**90**		**157.2**
Total	**120.6**	**271.2**	**133**	**750**	**240**	**1,123**	**150**	**1,664.8**

Source: Data from Ministry of Energy, 2005

Figure 1.3 shows the trend in power source mix for the years 1995, 2005 and 2015. The 2015 figures were calculated from Least Cost Power Development Plan (PDP) issued by the Ministry of Energy. Considering the current per capita electricity consumption of 121 kWh, and the population's access to electricity at the national level of 15 %, there is significant room for the capacity and demand to increase in the future.

Figure 1.3: Kenya's installed generating capacities in 1995, 2005 and 2015 in MWe (left) and in percentage of mix (right)





Source: Data from PDP of Ministry of Energy, 2005

With the trend of increased fossil fuel power plants in the future, the prices of electricity is set to go higher especially in the backdrop of the insecurity linked to fluctuating world oil prices. On the environmental point of view, this certainly leads to more emissions of harmful Greenhouse Gasses.

If the sugar companies and other developers of cogeneration are given the right incentives to exploit the residues generated by the industries to implement additional capacities in order to sell excess power to the grid, cogeneration plants using bagasse and other biomass could partially replace the planned thermal plants using fossil fuel.

Although it is not reflected in the PDP, the Government of Kenya recognizes the potential role of cogeneration in supplying the growing electricity requirements of the country. In Sessional Paper No.4 of 2004 on Energy and Ministry of Energy's Strategic Plan (2004-2009), the Government undertakes to promote the exploitation and expansion of existing cogeneration capacity in order to improve the diversity of national power supply and save foreign exchange currently used to import fossil fuels for generation of power. This undertaking has further been strengthened by the current trend of escalating fuel prices in the world market hence the government's greater resolve to assist cogenerators and other independent power producers (IPPs) to secure favourable bulk electricity tariffs and supply related terms. In particular the government intends to:[6]

- Undertake appropriate studies on cogeneration
- Assess bagasse-based cogeneration potential and use the Least Cost Power Development (LCPD) criteria to implement identified projects.
- Launch medium term bagasse-based cogeneration investment programme

However, until now, there are insufficient incentives given to project owners/developers to implement efficient and high capacity cogeneration systems. The proposed Cogen for Africa Project is expected to assist in helping the government and the private sector in creating the right stimuli and transforming the market conditions so that the aforementioned plans to promote a major cogeneration industry are realized.

On the industry front, developments indicate that this project's objectives of promoting high pressure cogeneration systems could match well with the activities and plans of the sugar industry. A recent survey and round of discussions with the sugar factories for the preparation of this PDF-B indicated that all the factories have rolled out plans to scale up their sugar crushing capacities as well as incorporate cogeneration, first to ensure power self-sufficiency as well as export to the national grid. For example, SONY Sugar Company has a two-phased programme to increase crushing capacity from

[6] (Government of Kenya, 2004, 2005)

3,000 tons of cane per day to 6,500 and as a result inject 26 MW of electricity to the national grid in the first phase. In the second phase, the company has planned to increase the crushing capacity to 8,000 tons and subsequently be able to export 36 MW to the grid.

In addition to the existing factories that have plans for expansion, Busia Sugar Company which currently owns their own sugar cane plantation and manages around 8,000 farmers (with a plan to increase to 30,000 farmers) is in the advanced stages of establishing a sugar factory with a capacity of 4,200 tons of cane per day. This company plans to incorporate a cogeneration unit with a capacity of 20 MW in the initial phase, if the viability of the project could be ascertained.

It is known that in Kenya, about six million inhabitants are directly or indirectly dependent in the sugar industry. With the increased competition due to low sugar prices from other countries and the planned rationalization in the Kenyan sugar industries, cogeneration is a potential important contributor to the competitiveness of sugar sector in Kenya.

It should be noted that Kenya has other agro-industrial residues - an estimated amount of 2.7 million tons annually (Ministry of Energy as cited by Yuko, et. al., 2005) - that could be exploited for cogeneration. Details of their locations and achievable potential could be investigated further during the Project implementation.

Other national and social goals that are met by implementing cogeneration from bagasse and other biomass include:

- The power sector will benefit from additional generation of power from an indigenous source with a price regime that is more stable than oil.
- The energy will replace more expensive imported fossil fuel generation.
- The excess electricity sold to the national grid will improve the revenues and profitability of the sugar factories.
- Farmers will benefit from higher payments for their cane. In addition, they may be able to sell the cane trash for power generation, further increasing their revenues.
- It is expected that this chain of activities will result in more income and jobs (cogeneration could stimulate increased cane acreage) for the 6 million Kenyans directly or indirectly dependent on the sugar sector, and a general reduction in poverty levels.

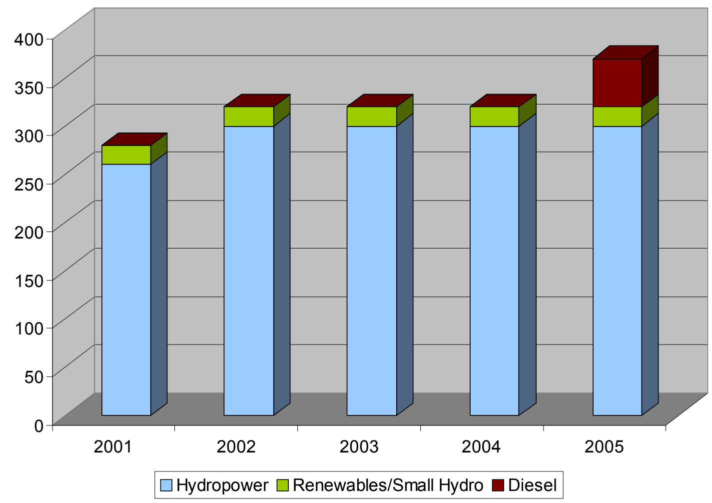
By creating added value to the sugar cane and particularly to the bagasse and other biomass which are traditionally burned inefficiently or disposed in landfills, numerous commercial, economic, environmental and social benefits would be realized that would enhance national, industrial and individual well being.

In Uganda, most of the electricity is generated by hydropower stations. The country is estimated to have a total hydropower potential of about 2,700 MW along the Nile River and a further 50 to 100 MW of mini and micro hydropower elsewhere in the country. Out of these, 320 MW of hydropower has been exploited and installed, with 300 MW coming from large hydro plants of Kiira and Nalubale, as can be seen in Figure 1.4 which shows the trend of the installed generating capacity of the grid in Uganda between 2001 to 2005.

However, prolonged drought for the past years as well as other factors[7] has resulted in a drop in the Lake Victoria by about 2 meters according to several sources which reduced the effective generation capacity of the Kiira and Nalubale hydropower plants to as low as 190 MW. With a current peak demand estimated at about 330 MW, there is still a deficit of about 100 MW of electricity for the country. This has prompted the government to introduce power rationing and daytime load shedding.

[7] The Daily Nation, Kenya, January 19, 2006, reported that according to a Tanzanian hydrologist Dr. Raymond Mgodo, the drop in Lake Victoria's level can be attributed to 3 factors: low rainfall, reduced in-flows from rivers and increased outflow into the Nile River due to increased power generation by Uganda.

Figure 1.4: Installed generating capacity grid mix (in MWe), Uganda



Source: Data from the Ministry of Energy and Minerals Development, Uganda

Recently, an emergency diesel thermal power plant with a capacity of 50 MW was procured to reduce the power shortage. It is therefore expected that Uganda will implement additional emergency fossil-fuelled thermal power plants which could become a baseline power supply (in the short to medium term) especially if the planned two large hydropower stations (i.e. Bujagali and Karuma) do not materialize. Table 1.8 shows the projected demand and sources of power for Uganda.

Table 1.8: Projected demand and supply of power, Uganda (in MW)

Description	Year										
	2004	2005	2006	2007	2008	2009	2010	2012	2015	2020	2025
Demand	**230**	**347**	**377**	**409**	**444**	**481**	**497**	**647**	**783**	**1181**	**1910**
Existing capacity (effective)											
Firm Nalubale & Kiira	220	220	265	265	265	220	265	265	265	265	265
Firm Kiira (Unit 14 & 15)		40	40	40	40	40	40	40	40	40	40
Small hydropower	20	20	20	20	20	20	20	20	20	20	20
New generation capacity											
BUJAGALI						150	200	250	250	250	250
KARUMA								100	150	150	150
Small hydro			20	45	60						
Renewables and Geothermal						70	70	90	120	150	150
Emergency thermal		**50**	**50**	**50**	**50**						
Thermal			**75**	**75**	**75**	**75**	**75**	**150**	**200**	**300**	**400**
(Municipal wastes / gas turbine) (MW)											
AYAGO (N+S)									100	350	550
UHURU											300
KALAGALA											200
Total generation capacity	**240**	**330**	**470**	**495**	**570**	**620**	**670**	**915**	**1145**	**1525**	**2325**

Source: RE Policy for Uganda (Draft), 2005

It is therefore fitting that the government should look to other options, such as cogeneration, to meet the shortfall which can only be met on a short term by emergency thermal plants owing to the uncertainty and long development and construction time of large hydropower plants.

The sugar industry of Uganda offers potential for generating excess power from the residues produced by the factories that, if tapped, could augment the electricity needs of the country and partially replace the emergency and other thermal power plants that are planned to be built as indicted in Table 1.8 above.

There are currently three sugar factories in Uganda with installed cogeneration facilities using low pressure systems totalling 10 MW. However, if they implement high pressure cogeneration systems the total potential that could be generated from these three factories could range from around 18 to 38 MW depending on the boiler steam pressure used.

These three sugar factories are upbeat on the prospects of the sugar sector and have plans for expansion in their capacities, which in turn further increases the power capacity that could be potentially implemented from this industry. Moreover, an old factory, the Sango Bay Sugar Factory is under rehabilitation and is expected to start production in 2007. Table 1.9 gives the capacities of the factories once the planned expansion/rehabilitation is completed.

Table 1.9: Planned expansion of sugar factories in Uganda

Company	Planned through put (TCH)	Completion date
Kakira	200	2008
Scoul	130	2008
Kinyara	140	2007
Sango Bay	25	2007

Source: Discussions with factory owners

Uganda is also endowed with other indigenous resources that could be used as fuel for cogeneration. According to the National Biomass Energy Demand and Supply Strategy Study (2001), the total amount of crop residues left after harvesting or processing of crops amount yearly to roughly 11 million tons. These include residues from sugarcane, banana, maize, sorghum, beans, coffee groundnuts, rice and Soya beans. Of course, not all of these residues could be utilized as many of them remain in the field or are scattered throughout the country and need to be gathered and transported which could make the cogeneration unviable. However, some products such as rice and coffee (other than sugarcane) are centrally processed and therefore present a potential for their residues to be utilized in cogeneration plants. One big industry processing rice in Uganda is the Tilda Uganda Ltd. whish has a production capacity of 250,000 tons per year. The potential of implementing a cogeneration plant using rice husks produced from this factory and those nearby could be investigated during the implementation stage of this Project.

There are some developments in the Ugandan energy sector that are seen to help in making the environment more encouraging to for private sector developers to invest in new cogeneration projects. In 1999, the Government of Uganda enacted the Electricity Act which removed the monopoly of the state utility, the Uganda Electricity Board (UEB) and allowed the introduction of other players into the sector, hence paving the way for independent generation and entry of Independent Power Producers (IPPs). The Act also provides for the establishment of the Electricity Regulatory Authority (ERA) to regulate the sector. The government has issued concessions for generation and distribution and is in the process of providing the same for transmission networks to increase the role of the private sector. A rural electrification fund which could provide subsidies for capital investments of rural electrification projects has also been established.

In 2001, a 10-year Energy for Rural Transformation (ERT) project was implemented by the World Bank and the Government of Uganda. It aims to develop rural energy and information technology so that they make a significant contribution to bringing about rural transformation. Strong emphasis is placed on the promotion of solar/PV systems, although other systems such as small/micro-hydro and cogeneration will also be supported through the renewable energy power generation component.

Through the above frameworks, the sugar industry was encouraged to sell any excess electricity to the grid. Notably, Kakira Sugar Works has used a WB/GEF capital investment subsidy and a loan provided by the East African Development Bank under the ERT Refinance Facility. It will allow the company to sell 12 MW of electricity to the grid for 18 hours a day. The Sugar Corporation of Uganda Ltd. (SCOUL) also hopes to secure similar support for its new generating capacity and sell around 2.0 MW of electricity to the grid.

Although this is a step further than what they have at the moment, it should be noted that Kakira has chosen to implement a 45-bar boiler steam pressure and SCOUL has opted for a 32-bar boiler steam pressure and a back-pressure turbine, which are lower compared to what can be potentially implemented. Kakira and Scoul have mentioned high capital expenditure, lack of local expertise and absence of an attractive tariff to make the high pressure system viable as the main reasons for not going into the more efficient cogeneration system (Please see Box 3.2 for more information on Kakira).

Uganda is the least electrified country in East Africa, with only 5 % of its population having access to electricity and less than 1 % of the rural population. The country has an electricity consumption per capita of around 55 kWh. Some of the sugar factories in Uganda are near the end of the grid. Kinyara for example is located in the Masindi area, near the North-West border of the country. Being at the edge of the power system, the grid in the area is weak due to long transmission distances. If the factory supplies electricity to the grid, it will make more electricity available to the locality and will help reinforce the low (33kV and 11 kV) voltage lines thus strengthening and stabilizing the national grid.

The investment in cogeneration systems by the private sector to supply power to the grid could also have a benefit in reducing the debt burden of the country in implementing large conventional power stations through foreign loans (see Table 1.10 below). Large scale power projects are normally implemented by the government with debt financing coming from foreign/multi-lateral institutions. By replacing some of the capacities required for conventional power generation with cogeneration projects that are implemented by the private sector which provide the equity and take up the loans for their projects, the country's debt burden could be reduced.

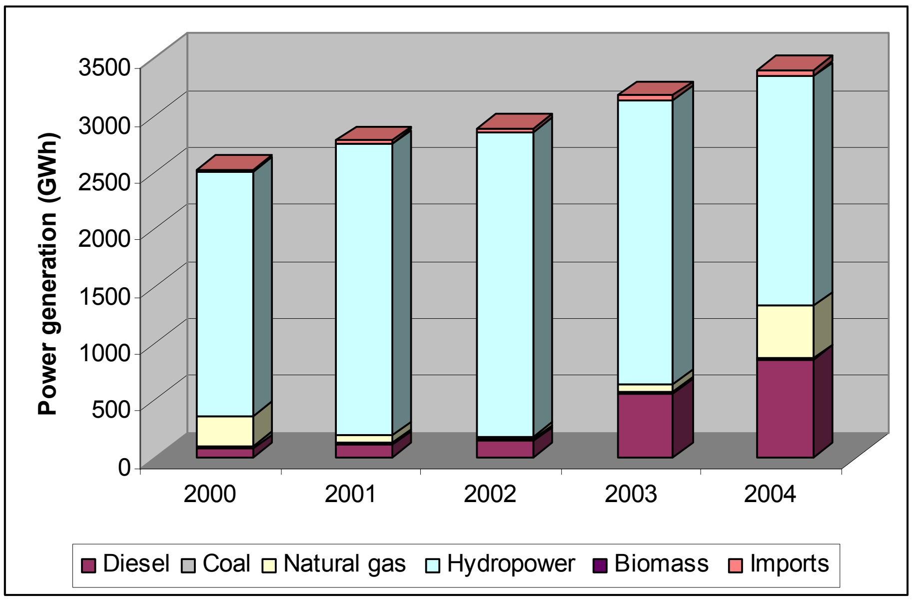
Table 1.10: Projected energy sector loans and total energy sector loans as proportion of total debt burden

Project energy investment	Project costs (US$)
Bujagali Hydropower project	580,000,000
Karuma Hydropower project	300,000,000
Rukiga Power extension project	150,000,000
Owen Falls extension project	230,000,000
Power II (Old Owen falls Dam)	28,800,000
Total project investment in conventional energy projects in Uganda	1,288,800,000
Uganda's estimated current debt burden	4,000,000,000
Proportion of conventional energy sector loans	32.22%

Source: Kamese and Engorait, 2005

Tanzania's peak electricity demand is currently about 510 MW with annual energy generation of about 3,000 GWh. The reported demand is suppressed in order to save the national grid from a total collapse, as back up thermal capacity is far less than sufficient to meet peak demand. The trend of energy consumption in Tanzania shows a rapid growth, of about 10% annually, which is attributed to population growth and increase in economic activities. The approach to electricity generation has been to run the hydropower system at near-full generating capacity during rainy season and to reduce hydropower generation during dry season. The hydropower stations supply about 55% of the installed capacity (1018 MW) whereas the remaining quantity is supplied by thermal power plants and imports (8 MW form Republic of Uganda and 5 MW from Republic of Zambia). Furthermore, 182 MW is generated from natural gas and an insignificant amount from coal and biomass. During the recent years, electricity generation from diesel has been increasing as shown in Table 1.9 below.

Figure 1.5: Power generation mix by fuel in Tanzania (2000-2004)



Source: AFREPREN, 2005

Electricity supply in Tanzania consists of both the national interconnected grid and isolated distribution systems. The electricity sub-sector is still dominated by the state-owned utility, Tanzania Electric Supply Company Ltd (TANESCO), which is responsible for about 98% of the electricity supply. TANESCO's distribution network serves about 400,000 customers most of whom are supplied by the national grid. As such, electrification level is still marginal leading to low per capita electricity consumption of about 84 kWh. Extension of the distribution network is hampered by the historical poor financial performance of the utility.

Tanzania's power is undergoing sectoral reforms that aim at accelerating its capacity of meeting the challenges of electrification. The reforms are therefore expected to bring about regulation and control, modernization, and meeting energy conservation and efficiency including the emerging environmental legislations. These reforms are meant to address barriers to electrification and investments in the sector.

Cogeneration in Tanzania exists in sugar-processing factories, in a wattle processing plant, and in a saw mill. Tanganyika Wattle Company (TANWAT) located in Iringa region operates a cogeneration plant which is being fired by wood logs and spent wattle barks. Moreover, Kilombero Sugar Company (KSC) located in Morogoro region, Mtibwa Sugar Estate also located in Morogoro region, Kagera Sugar Company in Kagera region and Tanganyika Planting Company (TPC) of Kilimanjaro are utilizing bagasse in their cogeneration plants. Saohill Saw Mill, located in Iringa region, owns a cogeneration plant using saw mill waste as fuel.

KSC has recently signed a contract with TANESCO to deliver 2 MW of electricity into the national grid during the crushing season. Although Mtibwa Sugar Estate generates a total of 10 GWh of electricity during production season, still imports about 4.0 GWh annually from TANESCO for irrigation and domestic purposes. There are plans to expand the capacity of the factory from the current 90 tonnes of sugar per hour to 250 – 300 tonnes of sugar per hour which could allow the factory to implement up to 30 MW cogeneration capacity and sell excess power to the grid.

Power generation at TPC is through two back-pressure turbo alternators rated at 3 MW and 2.5 MW respectively. The generated power cannot supply all operations at the estate. The irrigation activities and part of the estate houses are therefore powered by electricity imported from TANESCO. Annual electricity produced by cogeneration amounts to 11.2 GWh, whereas 18.7 GWh is imported electricity. TPC plans to increase the cane-crushing rate of the factory from the existing 130 TCH to 200 TCH, giving the company an opportunity to implement a higher capacity cogeneration system. Cogeneration at Kagera Sugar Company is done through two steam turbines rated 2.5 MW. There is a potential for the extra power to be used for electrifying nearby villages, as the national electricity grid is yet to reach Kagera region.

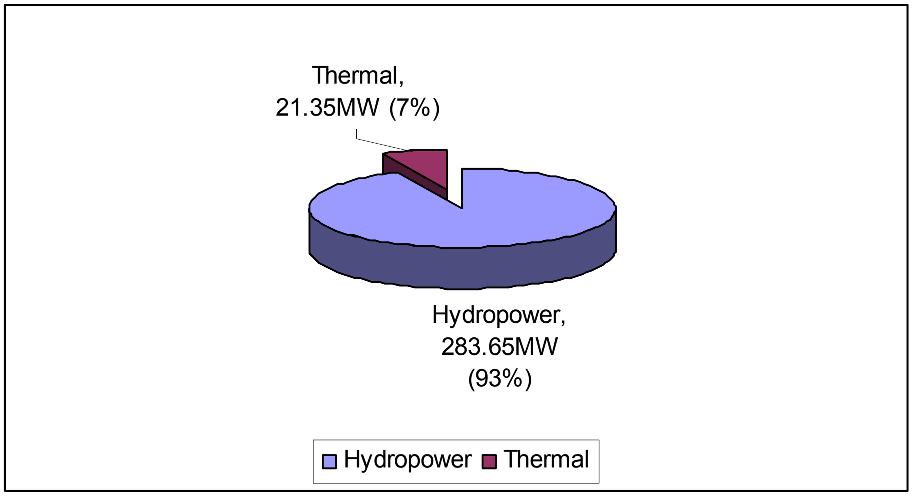
Currently, Saohill Saw mill's steam engine generates 1 MW electrical power for internal use. The cogeneration plant in TANWAT has an installed capacity of 2.5 MW, out of which about 35% is exported to the TANESCO isolated grid at Njombe. The sales of power to third parties are at 8.5 to 11 US¢ per kWh. TANWAT has plans to build a second power plant with a capacity of 15 MW. The plan would be implemented if TANESCO accepts to sign a ten-year contract for a feed-in tariff of at least 7.0 to 7.5 US¢ per kWh.

The following observations can be drawn from the experience in Tanzania:

- The cogeneration systems in Tanzania use mainly low-pressure boilers and back-pressure turbines with a few condensing turbines.
- There is a large potential to increase the efficiency of the systems currently installed in Tanzania by adopting advanced high-pressure systems.
- By utilizing the abundantly available raw materials, the electricity to be produced from these biomass cogeneration plants has an opportunity of improving the Tanzania's low level of electrification in a more environmentally friendly manner.
- The cogeneration plant owners have shown the need to expand their biomass cogeneration systems with a possibility of becoming IPPs.
- Regulatory framework need to be put in place for increasing private sector participation in energy generation, transmission and distribution.

Malawi's Electricity Supply Industry (ESI) generates power for the grid mainly by hydro and thermal (largely diesel and gas based) systems (see Figure 1.6). Photovoltaic (PV) systems are used in modular form for telecommunications, lighting and water pumping in rural areas where there is no grid power. Moreover, a significant number of commercial and industrial enterprises have installed their own bagasse, diesel and petrol driven generators.

Figure 1.6: Grid power generation in Malawi (2004)



Source: Mhango, 2005

The commercial electricity supply industry is dominated by a publicly owned and vertically integrated power utility, the Electricity Supply Corporation of Malawi (ESCOM) Ltd., which was established by an Act of Parliament in 1957 (revised 1963, 1998 and 2003). In 2004, ESCOM's total installed capacity was estimated at 305 MW. Of this, approximately 284MW (93%) is generated by hydropower and the remaining 21 MW (7%) is thermal plants. Except for a small mini-hydro plant at Wovwe (4.5 MW) in Karonga, all ESCOM's hydroelectric generation capacity is located along the Shire River, the main natural outlet for Lake Malawi. This makes Malawi's power generation system very vulnerable to the considerable variations in the lake's levels and, hence, flow rates on the Shire.

Access to electricity in Malawi (at 7%) is very low and demand is highly skewed in favor of industrial and large commercial customers who consume approximately 60% of the total electricity production. Domestic users account for around 25%, while the remaining 15% goes to small commercial consumers. Demand has been growing at between 6% and 8% a year.

The ESI in Malawi has, in recent years, failed to provide the quality of service demanded by consumers. Power outages are frequent and impose severe costs on consumers and on the economy. Industrial and other consumers have increasingly been installing their own generators and cogeneration systems. Some of these responses are unlikely to have been least cost investments from the national point of view. The approved new National Energy Policy for Malawi has addressed these and other issues.

For example, in the short to medium term, the new policy has outlined reforms to the ESI by restructuring the market and promoting private sector participation. Reforms are aimed at changing the market structure by unbundling the vertically integrated industry into generation, transmission and distribution markets niches.

In order to realise these goals, the energy policy has set a number of objectives for the ESI reforms. The most important ones relevant to cogeneration projects are as follows:

- increase the sector's technical and economic efficiency;
- make the sector financially viable and, in the short term, minimise the subsidies required from GoM's budget and, in the longer term, make ESI a net contributor to that budget;
- improve the reliability and quality of electricity supply;
- attract private capital and participation;
- increase capacity to meet growing demand; and
- meet the growing demand for electricity at least cost.

These objectives mean that the Electricity Supply Industry in Malawi intends to create a level playing field which would enable the private sector to participate in the power supply including cogeneration.

Currently there are two sugar factories in the country. These are the Dwangwa and Nchalo sugar factories. Their combined annual production of bagasse is 60,000 tons. Almost all of the bagasse generated goes to cogeneration systems for the factories' own use.

The Sugar plantation in Dwangwa near Nkhotakota District in the Central Region of Malawi is located about 200 kilometers Southeast of the Capital Lilongwe. It has an installed power cogeneration capacity of 7 MW. The plant can sometimes produce only up to 6 MW during the low season of sugar cane crashing. The sugar factory consumes 3.5 MW while the water pumping activity for cane irrigation consumes 1.5 MW. All staff houses use a total of 1.5 MW. The factory imports up to 1 MW from ESCOM.

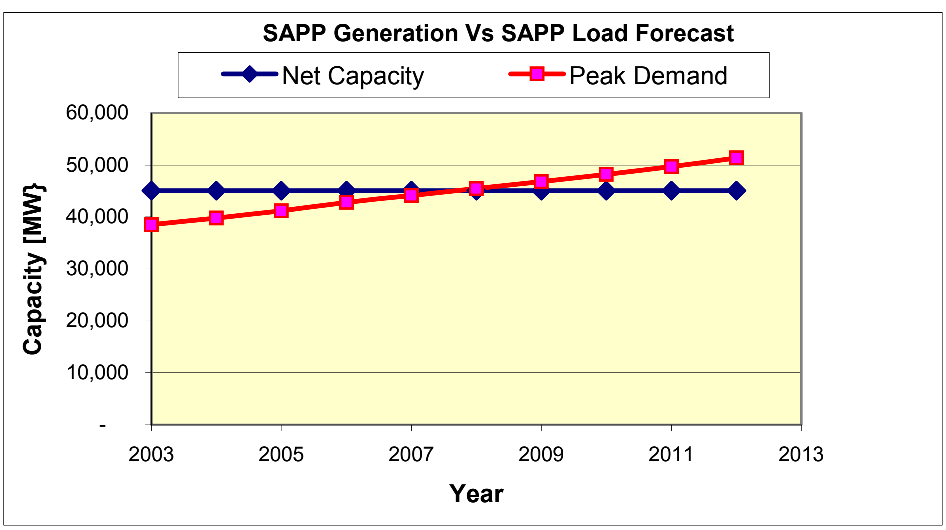
The other sugar plantation is located at Ntchalo about 150 kilometers south of Blantyre, the commercial city of Malawi. Here the installed capacity is 11.5 MW. However because the sugar plant is bigger, the maximum power demand for the whole establishment is 20 MW, which necessitates the sugar company to import up to 9.5 MW from ESCOM.

There are plans to implement highly efficient cogeneration systems in these factories to cover the energy requirements of the factories and sell excess power to the grid.

Currently, Malawi is experiencing a power shortage which has reached a critical stage due to the fact that the Shire River where all the major hydropower generation plants are located, is experiencing environmental degradation. Options that are available to Malawi include increasing the capacity of the existing cogeneration plants and putting up more new ones, coal fired power generation, diesel fired power generation or the more unpredictable hydropower generation.

Others argue that perhaps Malawi should go for the interconnection of its power to its neighbouring countries. Unfortunately, while interconnection would likely to be the long run solution to the country's power problems, it should be considered that the whole of the SADC region under the Southern African Power Pool (SAPP) could face shortage of power generation capacity by the year 2007 (see Figure xx). This leaves cogeneration as a very strong contender for the country to increase its power generation capacity without jeopardizing the sustainability of its environment.

Figure 1.7: SAPP generation vs. SAPP load forecast



Source: SADC- SAPP Planning Data

The above trends in the four countries are also happening in other countries in the region. The current electricity sources are being strained and increases thermal power generation using fossil fuel are ongoing or are planned. Implementing cogeneration systems with excess capacity available for sales to the grid would fully or partially replace the installation of the planned thermal plants in these countries.

1.4 Successful Examples and Models

Successful examples of cogeneration systems abound in other countries within the region and other regions of the developing world. In the islands of La Reunion and Mauritius, cogeneration has been successfully introduced and utilized. In Mauritius, cogeneration facilities fuelled primarily by bagasse which is generated extensively by the sugar industry, now covers around 40 % of the total electricity demand of the entire nation A typical sugar factory in Mauritius which has implemented a high pressure cogeneration system and sells electricity to the grid earns revenues equivalent to or more than the revenues it receives from the sales of sugar. A WB-GEF intervention a decade ago was instrumental in bringing about the shift to cogeneration and as such may provide valuable lessons for the introduction of Cogen facilities to other African nations, particularly for those with similar, sizeable sugar industries. Annex R describes the cogeneration developments in Mauritius and prospects for the African continent.

Another example that provides valuable information and cases of successfully implemented and operated Cogen systems is in Southeast Asia. Around fourteen years ago, a Cogen Program funded by the European Commission and based at the Asian Institute of Technology (AIT) in Bangkok was set into motion. The program focused initially on Indonesia, Malaysia, the Philippines and Thailand and later included other additional member states of the Association of South East Asian Nations (ASEAN) namely, Brunei, Cambodia, Laos, Singapore and Vietnam. During the second phase (Cogen 2), the program realized cogeneration projects amounting to around 30 MW_e and 354 MW_{th} of installations. With a financial support from the European Commission amounting to 5.5 M €, private sector investments of around 60 M € in Cogen projects were realized. The third phase of the Program (Cogen 3) which started in January 2002, lasted for three years and ended in December 2004. During this period, the Programme has directly assisted the implementation of a total of close to 150 MW in the form of full-scale demonstration projects, while promotional efforts, policy intervention, and techno-economic and financial advice were provided to other projects that led to the realization and replication of additional cogeneration capacities in the region, bringing the impact of the Programme to around 600 MW. The concept of a Cogen Center and associated Country Offices, the manner in which technical assistance is provided, the way financial incentives are provided through promotional projects are all relevant in the formulation of this Cogen for Africa initiative. Additional information on the EC-ASEAN Cogen Programme and some relevant projects implemented through its support are provided in Annex Q.

2. COUNTRY OWNERSHIP

Cogeneration is relevant for most nations in Africa. However, starting a continent-wide cogeneration program would be very likely too complex and poses tremendous challenge in coordination. For an initial phase, it is proposed that the project concentrate on a selection of interested countries in Eastern and Southern Africa that possess certain features favourable to the implementation of the project namely, anticipated sizable potential for cogeneration, interest in cogeneration project development and private sector participation, national (business) language and prevailing peace and order situation. The countries that have been initially selected are:

- Ethiopia;
- Kenya;
- Malawi;
- Sudan;
- Swaziland;
- Tanzania; and
- Uganda

The island state of Mauritius could be a source of expertise in project development and management, financing and PPA negotiations. The Republic of South Africa (RSA) could provide the technology needed and could also be a source of project funds and technical expertise. For this particular Project, both countries do not feature in terms of directly gaining from GEF funds but are expected to be important sources of technical and financial support.

2.1 Country Eligibility

As a pre-requisite, all of the pre-selected countries are a signatory of the United Nations Framework Convention on Climate Change (UNFCCC). In the Cogen for Africa project all countries that are participating have signed and ratified the convention. The summary below provides an overview of the countries and their eligibility:

Table 2.1: UNFCCC ratifications

Country	Date of signature	Date of ratification
Ethiopia	10 June 1992	05 April 1994
Kenya	12 June 1992	30/August 1994
Malawi	10 June 1992	21 April 1994
Sudan	9 June 1992	19 November 1993
Swaziland	12 June 1992	07 October 1996
Tanzania	12 June 1992	17 April 1996
Uganda	13 June 1992	08 September 1993

2.2 Country Drivenness

A brief inventory of policies and measures supporting Cogen as they exist in individual countries in the region is given for all the seven countries considered. These policies either mention cogeneration or biomass energy explicitly or are indirectly referred to through supporting measures to Independent Power Production (IPP) as a way of increasing national power generation to meet the increasing demand in these countries.

Table 2.2: Inventory of policies supporting cogeneration in the seven participating countries

Country	Reference	Paragraph/article supporting or mentioning cogeneration
Ethiopia	Energy Policy of the Transitional Government of Ethiopia	*The policy indirectly supports cogeneration in agro-industries. "Wherever possible, energy demand in the agricultural sector will be met through locally-produced modern energy resources"*
	Extract from AFREPREN/FWDs Occasional Paper 24	*"The Agriculture Development Led Industrialization (ADLI) strategy makes agricultural development as the corner stone and engine for all programs on sustainable development in Ethiopia. Included in the plan are poverty alleviation and multi-sectoral socio-economic developments in both rural and urban settlements. Although not fully considered and integrated in the original formulation of the strategy, it is now being recognized that energy is a necessary input for all development activities. In this context, therefore, since biomass-based* ***cogeneration*** *is the result of agro-industrial development, its optimum and efficient uses should be viewed positively in many respects. In addition, it is important to first appreciate the potential merits and demerits that are likely to be associated with co-generation in Ethiopia."*
	National Communication	*"The policy document stipulates that alternative energy sources and technologies shall be developed to meet increasing demand and encouraged and supports adoption of renewable energy technologies. It also encourages and support rational and use of modern fuels and, introduction of energy conservation and energy saving measures in all sectors. The national energy policy also clearly states that development and use of energy resources shall give due consideration to the protection of the environment"*
Kenya	Draft National Energy Policy of 2004, Section 4.7	*"**Cogeneration** using bagasse as a primary fuel is a practice in the domestic sugar industry in Kenya. The industry comprising seven sugar companies produces an average of 1.8 million tonnes of bagasse with fiber contents of about 18 % by weight annually. Out of this quantity, 56 % was used in co-generation using an installed capacity of 25 MW and the balance disposed at a cost. Mumias is the only sugar company among the seven that is self-sufficient in electricity production and has the capacity to export its surplus to the national grid. Despite having adequate generating capacity to meet their respective standards and surplus for export, the other six companies are net importers of electricity from the grid. These companies are being restructured with a view to improving their financial performance to enable them, among other things, be self reliant in electricity generation with surplus capacity for export to the grid at competitive prices. In addition and given that Kenya is a net importer of sugar there are plans to expand the existing factories to make the country self-sufficient and produce surplus for export, these new developments will provide opportunities for increased **cogeneration** and reduce reliance on oil fired electricity generation".*
	Section 6.3.2	*"Promote cogeneration….in the sugar industry and other commercial establishments where opportunities exist";* *"Undertake appropriate studies on co-generation"*
	Draft of "Kenya's Climate Change Technology Needs and Needs Assessment Report" (3rd Draft, June 2004)	*The Ministry of Environment and Natural Resources identify **bagasse** as a renewable fuel mentioned under Electrical Power Generation Technologies. Under Technology Needs, cogeneration is mentioned as a key option, i.e.: "There is a need to support factories in the adoption of cogeneration".*
Malawi	National Energy Policy Document of 2003	*Cogeneration (of biomass) is indirectly mentioned under Section 4.3:* *"About 8 % of all energy and 12 % of commercial energy is used by the agricultural and natural resources sector. Nearly 60 % of the solid fuel used in this sector comes from biomass residues (cotton seed husks, **bagasse**, saw dust, rice husks etc.); 25 % is fuelwood and the remaining 15 % is coal. Agro-industrial production of most export crops, such as tobacco and tea, relies almost exclusively on fuelwood. This sector also accounts for just over 20 % of fuelwood usage, second only to households. Agriculture is pursued both commercially and for subsistence".* *In Section 4.3.3 Energy Production through Agriculture is mentioned: "Although the agricultural sector consumes relatively little energy, its*

		contribution to the supply of biomass is crucial. Many agricultural, forestry and agro-forestry products, by-products and residues can serve as raw materials for processing into modern bio-fuels, suitable for the operation of fuel-driven technologies at high efficiencies. Bio-fuels include briquettes, biogas, gel fuel and ethanol. The Dwangwa and Nchalo sugar plantations' production of waste materials in the form of bagasse and molasses is 60,000 and 90,000 tons respectively. Some of the bagasse goes to thermal power generation for the producer's own use. Nearly two-thirds of the molasses are converted into ethanol fuel at the 18 million-liter ethanol plant in Dwangwa. Ethanol can also be produced from starchy materials such as cassava, potatoes, maize, cane sugar etc. Further down the chain, the production of ethanol produces a waste called vinasse, which can be used in biogas production".
	Climate Technology Transfer and Needs Assessment (2003)	*Chapter 4 identifies biomass technology in its list of Technologies in Power Generation as one of its priorities. Furthermore, under Waste Technologies, cogeneration is specially singled out as a priority in the category of Biomass Wastes*
	National Communication	*"Sugar factories are being encouraged to go into cog-generation as a means of reducing production costs by using readily available **bagasse** to generate electricity"*
Swaziland	National Communications for the UNFCC for Swaziland, Page 12, Section 1.5 (Executive Summary/General Description of steps)	*The document mentions electricity generation through **cogeneration** by the use of high-pressure steam turbines burning **bagasse** and wood-pulp residue as input fuel.*
	Swaziland National Energy Policy (2004)	*Chapter 3.3: "The Government is called upon to improve the situation to ensure there are clear guidelines for open access to the national grid" and "The Government is further called upon to investigate and promote efficient and environmentally sound technologies for the utilization of indigenous resources of electricity production".* *Bills that will facilitate these previous statements are currently being prepared for Cabinet consideration before being discussed in the two houses of Parliament. In Chapter 3.3.7, issues concerning Independent Power Producers are addressed: "The Government will create an enabling environment to allow the establishment of IPPs as well as support such initiatives".* *Finally in Chapter 5.1.4: "Government wants to diversify supply and increase indigenous power generation".*
Tanzania	National Communications to the UNFCC for Tanzania, Table: 3.1: Some GHG Mitigation Options	*"Energy Efficiency Improvements: Improve efficiency in existing plants through maintenance, improved steam production and management, improvements to motor drive systems, cogeneration and power factor correction."* *"To develop indigenous sources of energy (natural gas, coal, solar, wind, geothermal, hydropower and biomass fuels) to substitute for imported petroleum products."* *"To ensure that the existing and expanded supply of energy is environmentally sustainable."*
	National Energy Policy of 2003	*The energy policy document indirectly supports biomass cogeneration:* *"Generation of electric power shall be fully open to private and public investors as independent power producers. Investment shall be based on economic and financial criteria considering open access to regional network, balanced domestic supply and environmentally impacts"* *"Promote efficient biomass conversion and end-use technologies in order to save resources….and minimising threats on climate change"*
Uganda	Energy Policy for Uganda (2002),	*"Diversify power generation sources to ensure security of supply"* *Priority Policy Action no. 2 (strategic intervention): "Develop selected*

	Section 1.2.4: New and Renewable Sources of Energy Sub-sector: Biomass	*renewable energy projects e.g. Kakira sugar **cogeneration**…."*
	National Communication	*"To meet some of the objectives, Government shall employ the following strategies:* - *Promote the use of alternative sources of energy and technologies, which are environmentally friendly.* - *Promote efficient utilisation of energy resources* - *Promotion of private sector participation in the development of both conventional and renewable energy resources"*
Sudan	Renewable Energy Masterplan	*"The Rural Energy Masterplan for Sudan highlights a number of renewables that should be fast-tracked for development in Sudan, which includes **biomass cogeneration** for industries.* *To further develop this important option, it is suggested that a project of about US$ 250,000 per year, (primarily for financing of pre-feasibility studies) would be adequate to engineer a major increase in co-generation contribution to Sudan's power sector"*
	National communication	*"This mitigation measure would introduce higher-than-standard efficiency boilers for use in variety of medium to large industries, including sugar factories, edible oil, refineries, etc"*

2.3 Endorsements

Letters of endorsement from the participating countries are provided in Annex G.

3. PROGRAM AND POLICY CONFORMITY

3.1 Fit to GEF Operational Program and Strategic Priority

Cogeneration technologies support the global environmental objective of reduction of GHG emissions by promoting the use of indigenous biomass (waste) material for the generation of both power and heat in a most efficient manner. As such, it addresses the following Operational Programs in the GEF Focal Area of Climate Change:

- GEF Operational Program OP 6: "Promoting the adoption of Renewable Energy by removing barriers and reducing implementation costs". This Operational Program is the most relevant for the proposed project which will focus on the conversion of biomass residues into electric power and heat;
- GEF Operational Program OP 5: "Removal of Barriers to Energy Efficiency and Energy Conservation". This is the second relevant Operational Program. Many existing facilities that provide energy for the needs of the industries are not energy efficient. For instance, some sugar factories which could generate power enough to export twice as much as its own needs do not even generate sufficient power for their own consumption; some need to import power from the grid, as mentioned elsewhere in this document.

As regards the GEF Strategic Priorities, the program will also address each of the following identified strategies:

- CC-2: Power sector policy frameworks supportive of renewable energy and energy efficiency: Addressing legal framework issues regarding sale of excess power and addressing associated tariff concerns will enable power sales to the grid and thus set up a conducive and sustainable business environment for cogeneration.

Other additional strategic objectives include:

- SP-2 "Increased Access to Local Resources of Financing for Renewable Energy and Energy Efficiency": The project will mobilize local equity investments from sugar factories and financing from local and regional financial institutions for investment in cogeneration and energy efficiency.
- SP-4 "Productive uses of renewable energy": The produced power will substantially meet the productive energy needs of the sugar sector and surrounding rural productive enterprises such as maize mills and irrigation pumps.

3.2 Problem Analysis

3.2.1 Current status of cogeneration in Africa

The current use of cogeneration in the East and Southern African region is very limited. Based on available information, discussions with stakeholders and investigations conducted by the Country experts, the use of cogeneration at this time is mostly in the sugar factories. However, these systems are outmoded, inefficient and oftentimes polluting. As explained earlier, these systems have been designed to generate just enough electricity and heat for the process while consuming all the bagasse generated by the factory to avoid its accumulation and creating disposal problems. This approach makes the cogeneration system both an energy generating unit and an incineration system at the same time.

Below are details of the cogeneration status in some countries participating in this Project:

Ethiopia

In Ethiopia, cogeneration is currently utilized only in the sugar industry. The country has four sugar factories, three of which (Metahara, Shoa, Wonji) are owned by the same company. The fourth is Finchaa Sugar Factory (FSF) is located about 335 km away from Addis Ababa. Although most of these sugar factories adequately produce electricity from their cogeneration systems to meet internal power needs, bagasse-based cogeneration that produce excess power for export to the national grid is not yet practiced. In fact, some of the companies use electricity from the national utility, Ethiopian Electric Power Company (EEPCo), for their irrigation and surrounding residential areas. During the crop season, FSF produces electricity not only for internal factory use, but also to power its irrigation systems as well as surrounding towns and villages. Table 3.1 presents the current cogeneration installed capacity in Ethiopia from the four sugar companies.

Table 3.1: Current cogeneration installed capacity in Ethiopia

Factory	Current Cogeneration Installed Capacity (MWe)
Finchaa Sugar Factory (FSF)	7.0
Wonji-Shoa-Metahara Sugar Factories	6.4
Total	**13.4**

Source: Wolde-Ghiorgis, 2004

The sugar processing plant which included the cogeneration plant in Wonji was commissioned in 1954. The machinery at Wonji are now about 52 years old and hence are outdated. Shoa Sugar Factory was commissioned in 1962. At 44 years of age, its plants and machinery are also obsolete. Both cogeneration plants have boilers producing low-pressure steam at 16 bar.

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.

Kenya

Cogeneration is already practiced in the western part of Kenya where sugar factories use bagasse as a primary fuel. A total of seven companies use cogeneration, although recently, one sugar factory (Miwani) went under receivership and has stopped operations. Currently, the sugar factories in Western Kenya produce an average of 1.8 million tons of bagasse per annum, 60 % of which is used as boiler fuel for steam generation, with electricity being generated from surplus steam. The remaining 40 % of bagasse is simply discarded usually at a cost (Yuko et al, 2003; Rabah, 2000). During the recently-held stakeholders' meetings and discussions, it was observed that huge volumes of bagasse were stored in the backyard of some factories and are becoming a nuisance due to its rapid accumulation and disposal problems (see Annex S). In the case of the Chemelil sugar company, the bagasse has become fire risk – its bagasse dump which is adjacent to the factory recently caught fire and threatened the factory's premises.

Only Mumias Sugar Company among the seven companies is self-sufficient in electricity from its cogeneration system, with a small surplus capacity of 2.5 MW for export to the national grid. Presently, Kenya Power and Lighting Company (KPLC) has allowed Mumias to export electricity to its grid for a maximum of only 2 MW and for a duration of 12 months at a price that barely covers the production cost of electricity. The remaining sugar companies, because of the old equipment used for energy generation, are net importers of electricity (Rabah, 2000; Yuko et al, 2003; Githinji and Maina, 2003). Generally, the boilers in these sugar factories use inefficient, low-pressure systems of 20 to 30 bar pressure. Most sugar factories in Kenya are in dire need of reinvestment to replace their cogeneration equipment which is at or near the end of its useful life. Muhoroni Sugar Factory is, in fact, importing almost 100 % of its power requirements from the grid, with its boilers supplying mainly the steam requirements of the factory. The Institute of Research in Sustainable Energy and Development (IRSEAD, 2004) reports that the current production of bagasse is equivalent to a net capacity of over 300,000 tons of oil annually, a significant amount to replace the potential use of fossil fuel for the expected capacity additions in the next few years, if the shortage of power continues due to prolonged drought in the region.

During the recent seminar on cogeneration in Nairobi[8], the Ministry of Energy reported that it intends to provide a framework and incentives to encourage sugar companies to invest in new cogeneration facilities to generate more power from their bagasse and sell to the grid. Although this step could encourage sugar companies to install larger and more efficient boilers to enable them to fully utilize all the bagasse they produce, it is not immediately seen how the government would operationalize this plan. Some preliminary assessment of cogen potential in selected sugar factories in Kenya are provided in Annex P.

Table 3.2 presents a summary of the status of cogeneration of the western Kenya sugar factories.

Table 3.2: Current cogeneration installed capacity in Kenya

Factory	Current Cogeneration Installed Capacity (MWe)
Western	2.5
Muhoroni	3.0
Nzoia	4.5
Mumias	15.0
Chemilil	6.0
Sony	7.0
Total	**38.0**

Source: Yuko et al, 2004; Kagucia, B., 2005; Mbithi, J.M.P., 2005

Malawi

Malawi's experience related to cogeneration came mainly from the bagasse-fired systems that are currently operating in the sugar factories. The country currently has two sugar factories in operation: Nchalo Sugar Mill located 80 km south of Blantyre and Dwanga Sugar Mill located in the central region. Both factories are managed and operated by the Illovo Sugar Company which is a company based in South Africa. The two factories, almost 600 km apart have the potential of processing around 2 million tons of cane and recover 260,000 tons of sugar annually.

The installed cogeneration capacities in these two factories are shown in the following table.

Table 3.3: Current cogeneration installed capacity in Malawi

Factory	Current Cogeneration Installed Capacity (MWe)
Nchalo Sugar Mill	11.5
Dwanga Sugar Mill	7.0
Total	**18.5**

At present, both factories are not able to meet their electricity requirements for cane processing and are importing power from the national grid. However, based on experience on sugar cane bagasse energy generation elsewhere it is considered that for a sugar factory that adopts energy efficiency and

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[8] *Consultative Workshop on Financing for Cogeneration, Nairobi, 8th December 2005.*

conservation measures in cane processing can meet all its energy requirements from bagasse and can also export a significant amount of excess power to the grid. Preliminary assessments of the cogen potential in the two sugar factories are provided in Annex P.

Sudan

Sudan is one the largest sugar producing countries worldwide. It has four operating sugar factories and an additional two is under construction. Three of the existing factories (i.e. New Halfa, Gunied and Sennar sugar factories) are owned by the state and managed by the Sudan Sugar Company. The fourth is Kenana Sugar Company which is a privately owned factory. The original design of each sugar factory had incorporated a cogeneration plant. The original installed cogeneration capacities in these sugar factories are given in Table 3.4

Table 3.4: Current cogeneration installed capacity in Sudan

Factory	Current Cogeneration Installed Capacity (MWe)
Kenana Sugar Factory	40.0
Gunied Sugar Factory	3.0
New Halfa Sugar Factory	6.0
Sennar Sugar Factory	6.5
Total	**55.5**

Source: Hamid, M.A., 2005

Swaziland

Swaziland is a small country (17,000 sq. km) in Southern Africa with around 1.0 million people. Yet, it has a sizable sugar industry producing more than 600,000 tons of sugar in 2005. This production is shared among three sugar factories namely, Simunye Sugar Mill, Mhlume Sugar Mill and Ubombo Sugar Mill, the first two being owned by the Royal Swaziland Sugar Corporation (RSSC). The three factories have a combined capacity of 26,400 TCD and all have cogeneration systems using bagasse and coal as fuel. Coal is used during the milling season to stabilize the combustion in the boilers and during the off-milling season for other activities such as ethanol production and refinery.

Despite the huge amount of bagasse generated by the process, the sugar factories are currently importing electricity from the Swaziland Electricity Board (SEB), the agency responsible for the generation, transmission and distribution of electricity in the country. The electricity from SEB is mostly used for the irrigation of the sugar cane estates owned by the factories. The electricity import costs and the production of electricity using coal, which is imported from South Africa, are a large expense in the operating costs of these sugar factories.

Table 3.5 shows the current cogeneration capacity in Swaziland. Although the combined capacities of the three sugar factories reach 53 MW, this power is generated from low-pressure boilers and none of the electricity generated is sold to the grid.

Table 3.5: Current cogeneration installed capacity in Swaziland

Factory	Current Cogeneration Installed Capacity (MWe)
Simunye Sugar Mill	17
Mhlume Sugar Mill	18.5
Ubombo Sugar Mill	17.5
Total	**53**

Source: Kamese, 2004; Isingoma, J.B., 2005

Tanzania

The estimated theoretical cogeneration potential in Tanzania is over 395 MW. Currently, the country has an installed capacity of 33 MW from both sugar and wood-based industries. The following table presents a summary of existing biomass-fuelled cogeneration plants in Tanzania.

Table 3.6: Current cogeneration installed capacity in Tanzania

Factory	Current Cogeneration Installed Capacity (MWe)
Kilombero Sugar Plant K1	6.0
Kilombero Sugar Plant K2	2.8
Mtibwa Sugar Estate	13.0
Tanganyika Planting Company	3.0
Kagera Sugar Company	5.0
Sao Hill Saw Mill	1.0
Tanganyika Wattle Company (TANWAT)	2.5
Total	**33.3**

Source: Gwang'ombe, 2004

The current cogeneration facilities in Tanzania are inefficient with low pressure applications resulting in import of power from the grid. Kilombero Sugar Factory has recently signed a contract with the Tanzania Electric Supply Company (TANESCO) to deliver 2 MW of electricity to the national grid during the crushing season. With the exception of this and of Tanganyika Wattle Company (TANWAT), which exports between 1,400 and 2,100 kVA of electricity to TANESCO, the above agro-industries generate electricity primarily for captive power with some limited electrification of the immediate neighborhoods (Ariss, 2003; Ngeleja, 2003; Gwang'ombe, 2004). TANWAT plans to expand its cogeneration plant to 15 MW if TANESCO accepts to sign a 10-year contract at 7 to 7.5 cents USD per kWh.

Uganda

In Uganda, three sugar factories produce an average of 130,000 tons of sugar annually: the Kakira Sugar factory in eastern Uganda (rated capacity of more than 3,500 TCD) has an installed capacity of 6 MW of electricity; the Kinyara Sugar Works (rated capacity of 2,500 TCD) has an installed capacity of 2 MW; and the Sugar Corporation of Uganda (rated capacity of 2,400 TCD) has an installed capacity of 2 MW.

These factories produce electricity from cogeneration to meet most of their internal factory demand using low-pressure systems. With finance from the World Bank and the East African Development Bank, Kakira has recently signed a power supply contract with the Uganda Electricity Board (UEB) to supply 12 MW to the national grid. Table 3.7 presents the current cogeneration installed capacity in Uganda from the three existing sugar factories.

Table 3.7: Current cogeneration installed capacity in Uganda

Factory	Current Cogeneration Installed Capacity (MWe)
Kakira Sugar Works (1985) Ltd.	6
Sugar Corporation of Uganda Ltd.	2
Kinyara Sugar Works	2
Total	**10**

Source: Kamese, 2004; Isingoma, J.B., 2005

There is great interest among the sugar factories in Uganda to expand their cogeneration capacity by more than twice the current capacity if a favourable policy framework for selling excess power to the grid will be put in place.

Based on data available, there appears to be a significant potential to further develop cogeneration technology, especially in industries generating biomass waste (sugar, wood, etc.). Comparing with what other countries have achieved, it appears that there is still much room for increased capacity implementation of cogeneration in the seven participating African countries. See pre-feasibility assessments summarized in Annex K.

3.2.2 Baseline scenario - What happens if Cogen for Africa is not implemented?

Although the potential for cogeneration, particularly in the sugar industry existed for many years, it is shown in the previous sections that only a very small portion (around 3 % of the national capacities) of this potential has been tapped using outmoded low-pressure equipment and inefficient technologies which have been installed many years back. This situation exists because of key barriers to wider use of more efficient high-pressure cogeneration technologies which include (see detailed discussions in Section 3.3):

Technical barriers

- Lack of in-country experience in using high-pressure, high-temperature systems
- Lack of local capability/expertise to support the development, implementation, operation and maintenance of modern and efficient biomass cogeneration systems
- Absence of local manufacturing capability

Financing barriers

- Absence or lack of low-cost, long-term financing
- Lack of assets that could be used as collaterals and guarantees to secure loans
- Lack of developers with the skills to prepare financing packages that responds to the requirements of financial institutions
- Limited expertise in financial institutions to evaluate cogeneration projects
- Lack of experience by financing institutions working in new service areas leading to a higher perception of risk.

Commercial/market barriers

- Lack of successful examples of biomass cogeneration installations in the region
- High capital, development and transaction costs
- Inadequate technical and economic information to make investment decisions
- Lack of framework securing revenues from sales of electricity from cogeneration systems

Regulatory/policy/institutional barriers

- Inadequate policies explicitly promoting cogeneration
- Limited awareness among senior decision makers of the potential benefits of advanced high-pressure cogeneration
- Lack of supporting institutions providing information and services for new and highly efficient cogeneration
- Bureaucratic and non-coordinated procedures to obtain permits
- Lack of regulations related to interconnection to the grid and operation of mini-grids for rural electrification

If the above barriers are not removed, the baseline scenario for the countries within the region which are participating in this project would basically be a continuation of the present situation. Table 3.8 presents the summary of cogeneration in the countries participating in the Cogen for Africa Project.

Table 3.8: Summary of current cogeneration installed capacity in some countries of Africa

Country	Current Cogeneration Installed Capacity (MWe)	Installed National Capacity (MWe)	As % of total their National Capacity
Ethiopia	13.4	493	2.7
Kenya	38.0	1143	3.3
Malawi	18.8	306	6.1
Sudan	55.3	1380	4.0
Swaziland	53	180	29.4
Tanzania	33.3	863	3.9
Uganda	10.0	303	3.3
Mauritius	**242**	**725**	**33.4**

Sources: Gwang'ombe, 2004; Yuko et al, 2004; Kamese, 2004, Engorait, 2004; Wolde-Ghiorgis, 2004; Kagucia, B., 2005; Mbithi, J.M.P., 2005; Isingoma, J.B., 2005

This means that in the sugar industry, the factories will continue to maintain their old and inefficient equipment, while the ones that will expand their sugar processing activities will install additional systems mostly for captive power (see following Box) or with a small excess capacity for sales to the grid, whenever the utility allows them to do so. It is very unlikely that the factories will invest in medium to high pressure systems which allow them to generate high excess capacities for sales to the grid. In this scenario, large amounts of biomass residues which can be used as fuel will be dumped most of the time at a cost, while the industry will continue to rely on both grid electricity and, in many cases imported, fossil fuel. Furthermore, as described in Section 1.3, governments – some of which already started to install fossil-fuelled thermal power plants – would find themselves more and more dependent on diesel or coal-fired power plants as evidenced by the Power Development Plans of some countries.

The Sugar Corporation of Uganda Ltd., because of the deteriorating condition of their cogeneration system and the anticipated expansion of their sugar processing capacity, decided in 2005 to install a 6.0 MW cogeneration system. After studying the feasibility of the different technologies and investigating the viability of selling excess power to the grid, the company has decided to invest in a relatively inefficient technology (32-bar boiler and back-pressure turbine) citing lack of technical expertise to operate the high-pressure cogeneration system, high capital investment costs and low feed-in tariff as the reason for this decision.

Similarly, the Mhlume Sugar Mill in Swaziland bought three years ago a 65-bar boiler for their cogeneration plant. However, because the company cannot justify the purchase of a bigger, highly efficient turbine due to the low viability of the project based on the low feed-in tariff proposed by the utility (Swaziland Energy Board), this boiler has been downgraded to 30-bar steam pressure in line with the steam requirement of the existing turbines.

The above two cases illustrate that without appropriate intervention, low-pressure inefficient systems will continue to be implemented in spite of the availability of cheap, renewable fuel and the existence of modern and efficient cogeneration systems in the global market.

It should be mentioned that the current process of power sector reform in many countries has made prospects for power sales to the grid increasingly more interesting. Thus, without a catalytic effect of a devoted Cogen program, cogeneration plants might gradually find more acceptance among relevant agro-industries, but an acceptance that will basically be limited to captive power applications while large amounts of potential biomass fuel will continue to be discarded as waste.

Moreover, if the status of cogeneration in the sugar industries remain in the same level of technology and exploitation, it is unlikely that the concept of cogeneration would spread to other potential sectors such as wood/pulp/paper industries and other agro-industries as well as in other non-renewable fuel applications.

It is also feared that if nothing is done to increase the competitiveness of the sugar industry in the African region through increased productivity, cost effectiveness and increased revenues from other sources, the situation may lead to further deterioration in performance.

3.2.3 Alternative scenario - What would happen if Cogen for Africa is implemented successfully?

Looking back at the experience of the EC-ASEAN COGEN Programme in Asia, when the program started in 1991, biomass residues were considered wastes in the region and the bulk of agro-residues were disposed of either by burning them in the open atmosphere or discarding them into landfills. For the industries that use them as fuel, such as in the sugar and palm oil industries, the residues were used to generate low pressure steam that was sent to back pressure turbines generating heat for the process and electricity just enough for the needs of the factories. In some factories, the power generated was not even enough for the needs of the factory that they had to import power from the grid. This scenario is very much similar to what is now being experienced by agro- industries in many parts of Africa. After the implementation of the 13-year Cogen Programme in Asia which provided technical support, policy interventions and other kinds of services, more than 20 demonstration projects have been implemented and the widespread promotion of cogeneration has resulted in the implementation of around 600 MW of cogeneration capacity in the region. Examples of cogeneration plants that were recently implemented and are relevant to the sugar industries of Africa are shown below.

Box 3.1: Highly efficient cogeneration plants recently implemented in Thailand

Description	Cogeneration Plant 1	Cogeneration Plant 2
Owner/developer:	*Dan Chang Bio-Energy Co., Ltd.*	*Phu Khieu Bio-Energy Co., Ltd.*
Project type:	*Bagasse-fuelled energy plant*	*Bagasse-fuelled energy plant*
Location:	*Dan Chang, Suphanburi, Thailand*	*Phu Khieu, Chaiyapoom, Thailand*
Description:	*The project is a 53 MW high-pressure (65 bar) cogeneration system. The plant is located adjacent to a sugar factory which supplies bagasse as fuel. The electricity and steam generated from the project is sold to the sugar factory and the excess power is sold to the Electricity Generating Authority of Thailand (EGAT). The project consists of a new 41 MW system & old equipment transferred from the sugar factory.*	*Dan Chang Bio-Energy is a special purpose company set up to implement a 65 MW cogeneration project consisting of 41 MW new equipment and an existing 24 MW turbine from the sugar factory. The plant is a state-of-the-art high-pressure system implemented to supply power and steam to the adjacent sugar factory, which in turn will supply bagasse as fuel. The excess power is sold to the grid.*
Power Purchase Agreement:	*"Firm" contract, 21 years*	*"Firm" contract, 21 years*
Tariff:	*1) energy payment, indexed to natural gas price* *2) capacity charge, indexed to Dollar exchange rate*	*1) energy payment, indexed to natural gas price* *2) capacity charge, indexed to Dollar exchange rate*
Incentives:	*BOI privileges, EPPO subsidy*	*BOI privileges*
Commercial operation date:	*May 2004*	*June 2004*

The long-term objective – a realizable one – and in fact, the objective of the Cogen for Africa project is to help transform the cogeneration market and encourage project developers and industries to have profitable cogeneration investments while creating positive impacts on the environment and the socio-economic life of the community.

The potential is there. Based on available data of a few countries in the region, there is evidence that a significant potential exists for further development of the Cogen technology in the region, first of all in industries generating biomass waste. Table 1.3 in Section 1.2.1 shows this huge potential.

Cogeneration in many Eastern and Southern African countries is still in its embryonic stage and largely limited to generation for captive power, above all in the sugar industry. Considering the ever increasing need for power in Africa, the potential for cogeneration projects on the continent, as well as the encouraging results of the Mauritius experience and the Cogen program concept as successfully implemented in Asia, it is expected that a similar activity in Africa and for Africa will yield positive results.

Cogeneration allows generation of both power and heat in a most efficient and environmentally friendly way and adds new capacity to existing rural power grids, delaying the need for additional power plants. This form of "power resource diversification" will certainly help to increase local power supply reliability, a basic ingredient for economic development especially in countries that depend largely on hydropower, as drought appears to be a recurrent phenomenon in the region. With kWh prices assumed to remain between USD 0.06/kWh to USD 0.08/kWh, electricity from cogeneration plants will be competitive and both government and utility will be interested in buying power from agro-industries.

Electricity produced from cogeneration, either as captive power (consumed by the host factory) or sold to the grid is thought to compete in price with most, if not all, of the tariffs charged by national electric power utilities. However, feed-in tariffs offered by utilities to owners of cogeneration plants may not be that promising in many of the participating countries, which is one of the issues that needs to be addressed by the proposed project. Eventually, the economic benefits of cogeneration to both industries and governments should become clear and provide sufficient momentum for further dissemination and regional acceptance of the technology.

Recognizing that cogeneration can yield fuel energy utilization rates of up to 90 % at low or even negative cost per ton of carbon, GEF would be supporting a viable and important mitigation option in the region. Without GEF assistance, cogeneration would not be able to reach its optimum utilization in the region, thereby increasing the need for building new fossil fuel power plants. In a few countries, it is also possible that cogeneration, in the medium to long term, will be able to provide additional power for rural electrification.

The sugar industry in Southern and Eastern Africa should be a first candidate for additional Cogen projects in the area, as the sugar factories already operate cogeneration plants and possess some of the expertise required to expand to more efficient cogeneration applications. Clearly, the core business of a sugar factory is to produce sugar. However, with the price of sugar in the global market being low, electricity generation would allow these companies to diversify their earnings. The program should address regulatory framework and tariff issues in order to avoid situations such as recently occurred in Zimbabwe where the sale of excess power from sugar factory based cogeneration facilities was initially agreed but never realized because no settlement could be reached on the tariff pricing. The production of ethanol is yet another way of income diversification for a sugar factory. This process requires large amounts of heat that is readily available in Cogen systems.

Although the cogeneration approach is considered to be "environmentally friendly" because of the use of (sustainable) biomass (or because of the energy conservation that occurs due to higher efficiency even when using conventional fuels), cogeneration systems could be polluting if not done according to "best practice" and using state-of-the-art technology solutions. The concern for the existing Cogen facilities currently in operation in Africa is that many of them are still using outmoded, low-pressure and inefficient equipment which still necessitates the factories to import electricity from the grid, while burning the residues generated from their factories or discarding and allowing them to rot in open fields.

Even though the environmental objective (i.e. GHG emission reduction) might be clear, the development aspect of cogeneration projects is not negligible. Industries will be better situated to meet their own power needs through captive power waste, while excess power can be sold to the grid giving additional revenue stream to the factories. The benefits derived by the industry could cascade to the farmers who could get higher prices for the sugar cane and to the individuals through more employment opportunities or better employment conditions. Cogen facilities will generally create employment opportunities both directly (in Cogen Plants) and indirectly (both the availability of power and heat may create new industries, new products and new jobs), while avoiding the (improper) discarding of biomass waste. By increasing the profitability of the sugar industry, cogeneration investments could indirectly lead to expanded sugar cane plantations which would generate a large number of jobs. As big percentages of the populace in the sugar-producing countries directly or indirectly rely on the sugar industry, this positive effect could ripple through to millions of individuals. For example, in Kenya, it is estimated that over 6 million people are directly or indirectly dependent on the sugar sector.

On the national level, the plans for additional power generation could be partially or wholly postponed, bringing benefits to the people in general and to the national governments of the participating countries of Africa.

As in the experience of the Cogen Programme in Asia, the above scenarios will not come easy, simply because many barriers exist that hinder the widespread acceptance and implementation of new and highly efficient cogeneration systems.

The next section describes and analyses how key barriers will be addressed by this Project.

3.3 Barriers for the development and implementation of biomass cogeneration in Africa

It has been shown that there is huge potential for using energy efficient cogeneration systems to generate additional cogeneration capacity to supply the energy requirements of industries and selling extra power to the utility for the use of the national grid. This generates additional benefits that could alleviate poverty, enhance the socio-economic condition of the communities and have a positive impact on the environment (detailed description of which have been treated in Section 1.2.2 above). But this is not currently happening and is not foreseen to change significantly in the near future due to a number of barriers that prevent or hinder the potential project developers and other stakeholders from making the necessary decisions to implement these systems.

To investigate the identified barriers, key stakeholders were consulted and interviewed to better understand the situation on the ground. The stakeholders that were consulted consisted of biomass producers and facility owners (i.e. sugar factories), government personnel within the energy sector, experts in the industries and energy sector, and financing institutions (See Annex N).

Based on these consultations and interviews as well as other secondary sources such as authoritative papers, policy papers, books, reports and pre-feasibility studies, the barriers on the widespread acceptance, development, implementation and dissemination of high pressure, efficient and environmentally friendly biomass cogeneration technologies were identified and analyzed. These were then grouped into major categories reflecting similar/related nature so that it will be easy to design measures and activities for their removal. Four major categories of barriers emerged and are ordered according to importance, as perceived by the stakeholders, as follows:

- Technical barriers
- Financing barriers
- Commercial/market barriers
- Regulatory/policy/institutional barriers

Each of these categories is explained in detail hereafter.

Technical barriers

Technical barriers include aspects such as operational performance, reliability of the equipment, extent to which technologies are proven, and the technical capability of support services and personnel relevant for the technology. Key technical barriers that are found in the region include:

- Lack of in-country experience in using high-pressure, high-temperature systems

Although energy generation using bagasse is used traditionally by existing sugar factories, the energy systems that have been installed remain inefficient and do not optimize the use of bagasse as a fuel. As a matter of fact, for many of these factories, the existing energy generation systems cannot generate enough electricity for their own requirements which require them to import electricity from the grid. With the use of modern and efficient cogeneration systems, however, the factory can generate enough heat for the process requirements and electricity which is twice as much as quantity the factory requires.

The inefficiencies in the sugar factories are not only reflected in the energy systems but more importantly, in the core sugar processing systems themselves. Of the five sugar factories visited in Kenya during stakeholders consultations and PDF-B preparations, it was only Mumias Sugar, a publicly listed company (one of the best performing companies in the Nairobi Stock Exchange), which exhibited a highly efficient sugar processing system. West Kenya Sugar, the only other private sugar company in Kenya, is currently building a new plant which is using state-of-the-art equipment. Most of the other sugar factories in Kenya have yet to install modern sugar processing facilities and rely on outmoded and inefficient processing equipment.

- Lack of local capability/expertise to support the development, implementation, operation and maintenance of modern and efficient biomass cogeneration systems

Technical know-how, both among the project developers implementing cogeneration projects and the local institutions providing services, is important for the success of the implementation and operation of cogeneration projects. However, there remains a continuing shortage of personnel in the region who are qualified to provide the required expertise and experience.

One example of expertise which is important in the development and implementation of biomass cogeneration projects is the capability to assess the feasibility of developing a certain potential project. This expertise is lacking, even non-existent, in the participating countries. Other more advanced skills needed during installation and operation of advanced high-pressure cogeneration systems are virtually absent.

> During a visit to Kakira Sugar Works in Uganda, the management revealed that because of the absence of in-house expertise and inability to find it in the country, they had, in the past, hired consultants from India and Hawaii to conduct studies and advice them on their decisions regarding improvement/expansion of their cogeneration systems.

- Absence of local manufacturing capability

Although cogeneration (with low pressure systems) have been used for many years in some industries in the region, such as the sugar factories, the bulk of the equipment used is manufactured and imported from abroad. For high pressure cogeneration systems, apart from civil works, the majority of the components cannot be manufactured in the participating countries due to lack of manufacturing capability and facilities. It is estimated that only about 5 to 10 % of the total parts for this type of system could be manufactured locally. As a consequence, the capital costs for cogeneration plants are high and the current benefits to the local manufacturing industry are limited.[9] In addition, the situation necessitates that capital costs are paid in foreign currency which is not favourable to the industries and the countries in the region as a significant proportion of revenues accrued by the sugar industry are primarily in the form of local currency earnings.

Financing barriers

Financing is becoming one of the single-most important factors that determine the decision to proceed or not to proceed with a co-generation investment, and the eventual success of its implementation. In spite of its importance, project developers of energy projects tend to postpone facing the financing challenges to a later stage of project development, a move which oftentimes delay the whole implementation process, considering that there are some serious barriers that need to be overcome in order for a cogeneration project to successfully reach financial closure.

These barriers include:

- Absence or lack of low-cost, long-term financing

Studies have shown that the main obstacle to implementing renewable energy projects is often not their technical feasibility, but the absence of low-cost, long-term financing. This problem is complicated by competition among projects for limited funds and is compounded by unfavourable macro-economic conditions of the countries in the region (AFREPREN, 2005). Biomass cogeneration, as a renewable energy solution, is not an exception. This becomes even more pronounced for larger scale cogeneration systems which require higher degree of financing leverage and therefore, a larger amount of debt financing. Discussions with commercial banks in the region revealed that typical commercial loans have interest rates between 15 to 20 % p.a. and tenors of not more than 5 years.

- Lack of assets that could be used as collaterals and guarantees to secure loans

The potential investors in biomass cogeneration projects are either the agro-industries producing the wastes to be used as fuel, or third party developers with or without joint venture partnership with the agro-industry facility owner. These companies generally lack untied assets that could be used as collateral required by banks as security for the provision of loans. Some may also lack the financial muscle to provide or mobilize guarantee instruments in lieu of collaterals in the form of assets. Moreover, a number of sugar industries in Africa have higher debt/equity ratio than what is normally accepted by banks; so, borrowing on their balance sheets would be quite difficult. This is particularly true of state-owned sugar companies whose financial performance is often below par. Sugar companies with significant private sector ownership or which are outrightly owned by the private sector have a much better financial performance track record which provides a good basis for balance sheet financing.

- Lack of developers with the skills to prepare financing packages that responds to the requirements of financial institutions

Small to medium-sized project developers lack the in-house expertise to look for funds, prepare the financial plan of the cogeneration project, and negotiate with lenders to obtain the most favourable financing terms. The WB-GEF Energy for Rural Transformation (ERT) program in Uganda has

[9] Kamese, G. and Engorait, S., Status and Prospects of Biomass-based Cogeneration and Geothermal Technologies in Uganda, in Sustainable Energy in Africa, AFREPREN/FWD, 2005.

indicated that one of the major problems they face in evaluating the projects applying for ERT financial support is the low quality of proposals received from the project proponents and developers. In addition, existing financing schemes usually require a long application and approval procedure that tend to discourage potential developers from pursuing cogeneration investment.

- Financial institutions lack the expertise to evaluate cogeneration projects

Although financial institutions are normally adept at developing financing plans, their knowledge of cogeneration investments is often limited and, therefore, find it difficult design the right financing scheme that would suit projects involving biomass energy, as well as construct a credit structure that would be acceptable to all parties involved.

Financial institutions do not normally maintain staff members with the skills and expertise to evaluate cogeneration projects. The staff who evaluate projects requesting for financing are, in general, not familiar with these technologies. This leads to reluctance in even starting to consider undertaking due diligence of cogeneration projects.

Whenever financing institutions do not have the in-house expertise to evaluate cogeneration projects, the alternative is to hire an external consultant for this purpose. The cost for this activity is then passed on to the project developer which increases the overall financing costs for the project.

- Lack of experience by financing institutions working in new service areas leads to a higher perception of risk.

Among the financing institutions consulted during the preparation of this document, a few were familiar with the agro-industries in the countries they operate or even of the region. However, there is a general lack of knowledge and familiarity among these financial institutions in cogeneration technologies involving renewable energy such as biomass. This is partly because they are unfamiliar with the technologies used in these projects. This makes them too cautious in lending to these kinds of investments. Although references of projects successfully operating in similar environments are available, such as in Mauritius, very few financiers have visited these projects and have seen them operating successfully.

Commercial/market barriers

The commercial/market barriers refer to impediments that prevent or discourage potential project developers of biomass cogeneration systems from implementing new and modern systems to replace the obsolete and inefficient existing systems.

Without doubt, the barriers related to commercial/market conditions are a major cause the lack of development and implementation of biomass cogeneration technologies in the region. The specific barriers under this category include the following:

- Lack of successful examples of biomass cogeneration installations in the region

In almost any area of new technological introduction, especially in traditional sectors such as the wood and agro-industries, the presence of successful references as concrete examples has an important and crucial impact on the adoption and widespread dissemination of the technologies being introduced. They provide a showcase, a source of lessons to draw from and a basis of confidence that the technology is working and generating the intended benefits. Although modern and efficient biomass cogeneration systems are technically well proven and used widely in some parts of the world, even in nearby Mauritius, there is no example of a high pressure system (i.e. 60 bar and over) implemented in the seven countries participating in this project. This is true in spite of the abundance of biomass wastes produced from industries such as sugar factories that have significant needs for energy in the form of heat and power. This absence of successful examples is one of the major barriers in convincing potential developers to invest in modern biomass cogeneration technologies.

- High capital, development and transaction costs

Highly efficient, high pressure cogeneration projects, using biomass as fuel, are in general more expensive per installed capacity compared to conventional energy technologies. Moreover, with its higher development costs, the overall initial costs of biomass cogeneration tend to be much higher than the low-pressure options even if the amortised costs over the lifetime of the technologies are lower compared to lower pressure equipment. The impact that transaction costs have on energy system prices should also be considered. These affect the viability of the project, a factor which is of prime importance for the participation of the private sector.

For instance, although the two sugar factories in Uganda – the Kakira Sugar Works and Sugar Corporation of Uganda – have implemented larger systems in order to sell excess power to the grid within the existing policy/regulatory framework, and with the financial support of the Energy for Rural Transformation program, the two factories still opted to use low-medium pressure systems (32 bar and 45 bar, respectively). This is because the tariff provided by the utility cannot compensate adequately for the higher costs of the more efficient equipment and the additional costs of hiring foreign consultants/experts needed to commission a more sophisticated high-pressure cogeneration investment. As an indication, a high-pressure system using a 65-bar boiler and an extraction-condensing turbo-generator costs about 50 % more than a low-pressure 30-bar boiler/back-pressure turbo-generator system.

- Inadequate technical and economic information to make investment decisions

Information is a key to making intelligent investment decisions. Because of the lack of reliable and ready information that the developers can customize for their specific projects, potential developers of cogeneration projects tend not to take active steps to initiate investigation on the viability of these projects. For instance, it is acknowledged that in Mauritius a feasible cogeneration plant for factories should only be considered for plants with cane crushing capacity of 200 tons per hour and above; however, the conditions might be different in Malawi, allowing also smaller capacities to be viable. Thus, if a sugar industry in one of the participating countries decides to seriously consider implementing a biomass cogeneration plant, the management would need to hire a consultant either from Mauritius or outside the region to conduct a thorough feasibility study which would be costly. If in-house or local engineers are trained to conduct such studies and information is available locally to be used for technical and economic inputs to the study, this barrier would be minimized or eliminated.

A case in point is the Busia Sugar Company in Kenya. Busia Sugar currently owns 340 ha. of sugar cane plantation and manages around 8,000 farmers (with plan to increase to 30,000 farmers) and is in the advanced stages of establishing a sugar factory with a capacity of 4,200 tons of cane per day which will incorporate a cogeneration unit. A feasibility study for the sugar factory has already been undertaken, and includes a rough assessment of the cogeneration potential. Although Busia Sugar is confident of their capacity and competence to make an informed decision on the sugar processing aspect, the management is concerned that they do not have the capacity and expertise to evaluate the cogeneration aspect enough to make a good decision. In the letter to UNEP/DGEF, the management of Busia Sugar has expressed that the Cogen for Africa project could assist them in the following areas:

- Undertaking detailed pre-feasibility/feasibility study on the cogeneration component, which builds on the factory-wide feasibility study already undertaken
- Advising on financing models and financing opportunities
- Establishing contact with co-financiers and assisting in financial packaging
- Negotiating a viable power purchase agreement
- Lobbying policy makers for more favourable policy and regulations

Moreover, as there is lack of comprehensive overview available on the (potential) resources of cogeneration in the region outside the sugar industry, [10] it is difficult for a new developer to focus his/her efforts on the sectors and areas with the greatest potential without incurring some expenses in making initial investigations.

Since biomass cogeneration projects are not seen on the same level as conventional energy systems, they are perceived as more risky which contribute to the uncertainty of recouping back the investments made in high-pressure, advanced cogeneration systems.

- Lack of framework securing revenues from sales of electricity from cogeneration systems

A major source of revenues which makes high-pressure cogeneration projects commercially viable is the sales of electricity in excess of what is required by the factory to the national grid. This revenue stream will determine the profitability of the venture. Moreover, the assurance of the off-take of electricity through a secure framework can strengthen the bankability of the project when loan is borrowed on a Project Finance basis which allows the lender to look mainly on the future cash flows of the project for the payment of its principal and corresponding interest.

However, in the participating countries in Africa, a favourable and secure framework for the off-take of excess electricity from cogeneration plants do not exist. A discussion on the Power Purchase Agreement (PPA), which is a major document related to this issue, is described in the next barrier category.

Regulatory/policy/institutional barriers

Promoting biomass cogeneration on a major scale will require substantial private sector investment, which, in turn, requires a supportive policy and regulatory framework that better define the risks and rewards of cogeneration investments.

On one hand, poor or inappropriate government policies can create or raise barriers to the widespread implementation of these technologies; on the other hand, the creation and faithful implementation of appropriate policies and programs could help overcome barriers, create confidence in the market, and stimulate investments in modern and efficient biomass cogeneration projects. Some of the barriers observed within this category include:

- Inadequate policies explicitly promoting cogeneration

Adequate polices to promote cogeneration and encourage potential project developers to implement them should cover provisions such as:

- fiscal incentives such as tax holidays, waiver for import duty, etc.
- adequate feed-in tariffs
- grid access assurance
- targets that are reflected in the Power Development Plans
- cogeneration or renewable energy quotas for utilities
- subsidies, where appropriate

In most cases, the above provisions are at best mentioned as intentions in the general policies and electricity acts of the countries in this region. Specific policies that provide figures and concrete steps are often not available in the countries participating in this cogeneration initiative. This gives mixed signals to the potential developers who perceive the governments as not being sufficiently committed to the promotion of cogeneration in their countries.

- Limited awareness among senior decision makers of the potential benefits of advanced high-pressure cogeneration

[10] During the PDF-B preparation a survey of the potential in the sugar industries was done. AFREPREN has undertaken some limited work in other industries.

The general concept of cogeneration is well known among senior technocrats in the ministries of energy in the countries of the region. However, high pressure systems that allow industries such as the sugar companies to use all the bagasse produced by the factory to generate three to four times what the factory itself needs and sell excess power to the national grid are not as widely known or understood by many decision makers in the region.. Hence, the government are, often, not fully aware of all the technical, economic, social and environmental benefits this advanced cogeneration investments could deliver at national, sectoral and individual levels.

This is apparent in the fact that when approached by potential sellers of electricity from cogeneration plants owned by sugar factories, ministries of energy and utilities are not willing to provide favourable purchase prices because they argue that bagasse which is used as fuel is a free resource and should not be given tariffs that are comparable to those enjoyed by fossil fuel IPPs.

- Lack of supporting institutions providing information and services for new and highly efficient cogeneration

In both regional and national level in this region, there is a dearth of institutions that provide support, information and assistance to stakeholders involved in cogeneration. Of special importance is assistance in obtaining information on the potential of cogeneration, applicable technologies, suppliers of equipment and experts and consultants with appropriate skills and experience. Some sugar companies intending to implement new cogeneration systems to sell excess power to the grid (for instance, Mumias of Kenya, and Scoul, Kinyara and Kakira of Uganda) had to hire consultants from as far as Hawaii, South Africa and India to conduct assessment and feasibility studies.

There is thus, a great need for a one-stop center, ideally with a regional scope but with focal points to conduct capacity building activities, provide advice and services and provide much-needed information to the stakeholders in the region.

- Bureaucratic and non-coordinated procedures to obtain permits

In many African countries, the procedures to obtain permits for medium-to-small scale energy projects such as cogeneration, renewable energy and energy efficiency are not well defined. In fact, it is not uncommon in some countries to require inputs from many different government agencies.

> In Kenya, cogeneration in the sugar sector is likely to require the involvement of at least three Ministries (Energy, Agriculture and Industry) and at least five other state agencies (national utility in charge of generation – KENGEN; transmission and distribution - KPLC; the national electricity regulator – ERB; the national sugar agency and the national environment agency – NEMA).

The extra effort required to understand how the system works and go about the approval process from the different agencies greatly increase the transaction costs of developing cogeneration projects, thereby increasing the overall project costs.

One of the barriers mentioned earlier which hinders developers from pursuing cogeneration investment opportunities is the high transaction costs. If governments can structure their procedures so that there is a single agency responsible for the planning, promotion, approval and monitoring of cogeneration (or renewable energy and energy efficiency projects), the efforts and costs involved in developing and implementing projects could be substantially reduced, thereby lowering also the barriers related to affordability of projects. An example often mentioned is the case of India which has a ministry dedicated to renewable sources of energy[11]. This ministry does not only act as a "single window" in the processing of projects such as biomass cogeneration, but it also provides other support such as participation in the financing and offering incentives to encourage project developers and industry owners to implement projects from renewable energy sources.

- Lack of regulations related to interconnection to the grid and operation of mini-grids for rural electrification

[11] The Ministry of Non-Conventional Energy Sources (MNES) was established by the Government of India in 1992.

Since cogeneration projects are typically smaller than traditional power projects, they need to have a stable and predictable framework laying down the conditions for their interconnection with the electricity grid. The framework should provide standardized criteria aimed at non-discriminatory and transparent regulations on different grid systems and interconnection issues as well as operation of mini-grids for rural electrificaton. Key issues that need to be clearly defined include:

- Dispatch priority
- Guarantee of transmission and distribution (e.g. mini-grids for rural electrification) of electricity produced by cogeneration units
- Principles concerning who bears the costs relating to grid connection, grid reinforcement, etc.
- Tariffs for use of system (including transport tariffs, tariffs related to sales of surplus electricity to the grid and tariffs for purchase of backup power from the grid).
- Tariffs taking into account possible costs and benefits of decentralized embedded generation.
- The possible use of net-metering for future small cogeneration units allowing consumers to offset electricity consumption with on-site production.

At the moment, regulations that are specifically designed for cogeneration in the seven countries participating in this project are, at best unclear, and at worst, non-existent. For example, when Kakira Sugar Works submitted their specifications to the utility in Uganda for the installation of the distribution line from their cogeneration plant to sub-station owned by the national distribution utility (which Kakira Sugar Works had to pay for), it took the utility four months of review and discussions with Kakira before providing the final approval of the specifications. This is simply because certain regulations do not exist and therefore Kakira had to make the proposal for the specifications themselves.

- Absence of a Standard Power Purchase Agreement (PPA)

One of the reasons for the lack of adoption of advanced environmentally sound medium and high-pressure cogeneration systems, among many others, is the absence of a Standard PPA which has a long-term duration and favourable tariff. The off-take of electricity from a reliable buyer is one of the most important arrangements to secure the flow of revenues in a cogeneration plant. The Power Purchase Agreement (PPA) is the common document used in this arrangement and is agreed between the cogeneration plant owner and the buyer of electricity. If the cogeneration plant sells electricity to the grid, the PPA is signed by the utility. Having a well designed PPA that protects the interest of the cogeneration plant, such as “take-or-pay” provisions, could lessen the risk of the developer and raise sufficient comfort for the banks to lend to the project.

In the example cited earlier, the projects successfully implemented in both Asia and Mauritius have long-term PPAs (more than 20 years) with a reliable off-taker which is the utility (and the sugar factory for heat and electricity) at tariffs that were calculated using a standard and transparent formula and adequate to make the project viable.

Unfortunately, a Standard PPA which is transparent and which provides reasonable tariff conditions does not exist in all countries in this region. Out of the seven countries participating in this project, none has an approved Standard PPA that provides long-term contract using standard tariffs that are transparent and publicly known. At best, contracts with utilities have been negotiated on a case-by-case basis resulting in terms that do not provide favourable conditions to the owner of the cogeneration plant. The ones that have received a contract had to go through a lengthy process and series of negotiations and delays. The case examples described in the Box 3.2 aptly illustrate the need for a standard long-term PPA.

Box 3.2: Mumias Sugar Company (Kenya) and Kakira Sugar Works (Uganda): two tales of lengthy Power Purchase Agreement (PPA) negotiations

Mumias Sugar Company, Kenya

Mumias Sugar is the largest and most progressive sugar company in Kenya. As a publicly listed company and one of the best-performing in the country, the management tries to keep the company competitive and profitable by employing state-of-the-art sugar processing facilities in the factory. However, it still uses low-pressure cogeneration equipment. In 1976, with the increase in production to 7,000 tons of cane per day (TCD), Mumias realized that with the tremendous amount of bagasse that the factory produced, it needed to implement a bigger capacity cogeneration system for both captive and electricity export purposes. Hence, the then East Africa Power & Lighting Company (EAPLC) and the Ministry of Energy were approached with a view of formulating an agreement for EAPLC to purchase the excess electricity produced by Mumias. Meanwhile, because the power house switchboard had a long order lead time, Mumias decided to place a firm order for the switchboard and facilities. Unfortunately, when the negotiation for the sales of power to EAPLC was concluded, Mumias found that the price that EAPLC was willing to pay was not enough to make the project viable. They then decided, instead, to buy low pressure boilers and inefficient back-pressure turbines to drive the prime movers of the factory.

In 1990, Mumias embarked on a factory rationalization program to replace the milling technology with a more modern and efficient diffusion technology. Once again, the now Kenya Power and Lighting Company (KPLC) was approached by Mumias to see if KPLC was willing to buy any excess electricity from Mumias but the proposal was declined citing the reason that power from sugar factories are unreliable. Hence, Mumias proceeded with the expansion of its cogeneration facilities without investing in a highly efficient system for electricity export purposes.

In July 2000, when there was an acute power shortage in Kenya due to an extended drought, KPLC approached Mumias soliciting for purchase of excess electricity for a period of 12 months. During this time, Mumias had an installed capacity of 15 MW while needing only 10 MW for its operations. The Ministry of Energy was approached to intervene so that a long-term Power Purchase Agreement (PPA) could be agreed between Mumias and KPLC. However, this did not yield positive result and finally, KPLC contracted Mumias to sell 2 megawatts of electricity to the grid for 12 months, although the sales ran for 18 months when the contract was terminated.

Recently, Mumias has started selling excess power again to KPLC (about 2 MW) but on a short-term contract that does not encourage Mumias company to invest in high-pressure more efficient and larger capacity cogeneration facilities. If Mumias embarks on upgrading its system to the efficiency level of the best systems in Mauritius, it is estimated that around 57 MW could be implemented using the bagasse currently generated from the factory, and with the need of around 10 MW in the factory, it could sell up to 47 MW to the grid.

Kakira Sugar Works, Uganda

Being the largest and most progressive sugar factory in Uganda, Kakira Sugar Works constantly seeks to find opportunities for improvement and use all its resources optimally. Operating at over 3,500 tcd, the factory produces more than 400,000 tons of bagasse annually. With the current in-house factory requirements of around 4 to 4.5 megawatts, there is a large quantity of surplus bagasse which is disposed through open-field burning.

With its plan for increased sugar production, and having seen an opportunity to sell excess power to the grid by using the bagasse produced by the factory, Kakira submitted a proposal in June 1998 to the Ministry of Energy and Mineral Development (MEMD) for the company to sell 18 MW to the national grid. However, because the government was expecting that the 250 MW Bujagali hydroelectric project would be implemented at that time, it did not make any decision on Kakira's proposal.

When the Energy for Rural Transformation (ERT) program was established in 2001, Kakira submitted a down-sized plan to MEMD with a proposal to sell 7 MW to the national grid on a 24-hr. basis. The government's response was to allow Kakira to sell power only during the peak period for 6 hours per day. With this condition, Kakira had to choose a low efficiency technology (i.e. 20-bar boilers) and had to reduce its agricultural/factory expansion plan from 6,000 tcd to 4,000 tcd.

Still, Kakira decided to submit the first draft of the PPA in February 2002 with a proposal for a tariff of 8 US cents considering that the equipment will have a utilization of only 25 %. In July 2003, after 17 months of negotiations, the PPA was signed between Kakira and the utility at a low tariff of 4.9 US cents/kW, for the sale of 6 MW for 6 hours/day on take-or-pay basis, and with the condition that Kakira build a 14-km 33 kV new distribution line to connect to the grid at Kakira's own costs. It took the utility 4 months to approve the line specifications.

When the developer of the Bujagali hydropower project pulled out in late 2003, Kakira proposed to the government to extend the PPA to 12 MW, for which the government agreed to take for 18 hours a day. To support the project in reaching the required viability, a grant of 3.3 mil. USD and a loan of around 8 mil. USD were approved under the ERT program.

It is worth noting that had the government accepted Kakira's original proposal to sell 18 MW to the grid, the cogeneration plant using a more efficient design would have been completed and already selling power to the grid. This would have reduced the need for emergency diesel thermal power plants or as well as reduced the unpleasant power load shedding that is now being experienced in Uganda.

The above two cases show that without favourable government policies such as a long-term PPA with favorable tariff, agro-industries possessing biomass residues will not be likely to invest in modern, highly efficient cogeneration systems that are designed at maximum capacity to sell excess power to the grid.

Source: From discussions with factory owners

Despite the challenging bureaucratic environment exemplified by the experiences of the two factories mentioned in Box 3.2, the governments in the region have started structural power sector reforms and initiatives to improve the regulatory environment and encourage private participation into the electric power supply of the countries. Currently, in many countries in the region, regulations that officially allow sales of privately generated power by Independent Power Producers to the national grid are in place (see Table 3.9 below for regional details). However, it appears that although the legal framework exists development of standard tariffs through a transparent, long-term Standard Power Purchase Agreement are the final obstacle to be addressed, if the full potential for cogeneration is to be harnessed.

Table 3.9: Status of power sector reform in some African countries

Country	Status of Power Reform Sector					
	Reform Policy	New/Amended Electricity Act	Regulation Agency	Licenses Issued	Access to Grid Granted	Private Sector Participation
Ethiopia	Implemented	Implemented	Implemented	No	No	Pending
Kenya	Implemented	Implemented	Implemented	Implemented	Implemented	Implemented
Malawi	Implemented	Implemented	Implemented	Implemented	Implemented	Pending
Mauritius	Implemented	Implemented	No	Implemented	Implemented	Implemented
Mozambique	Implemented	Implemented	Pending	Pending	Implemented	Pending
Namibia	Implemented	Implemented	Implemented	Implemented	Implemented	Implemented
South Africa	Implemented	Implemented	Implemented	Implemented	Implemented	Implemented
Sudan	Implemented	Implemented	No	Pending	Pending	Pending
Swaziland	Implemented	Pending	Pending	Pending	Pending	Pending
Tanzania	Implemented	Pending	Pending	Implemented	No	Implemented
Uganda	Implemented	Implemented	Implemented	Pending	Pending	Implemented
Zambia	Implemented	Implemented	Implemented	Implemented	Implemented	Implemented

3.4 Removal of Barriers

The success of the Cogen for Africa Project will mainly hinge on how effective it proves to be in removing the above-mentioned barriers. Hence, the activities of the project will be designed and structured to facilitate effective removal of the identified barriers which is expected to transform the cogeneration market in Africa and to lead to expanded and wider use of efficient high pressure cogeneration systems in the region.

In order to design measures that would be acceptable, appropriate and effective according to the realities and conditions of the market and the political climate of the countries involved, at least two local experts from each participating country – one from the energy agency and the other from a biomass producing industry – were commissioned to conduct market assessments and background investigations. The information obtained, together with the observations from discussions and interviews conducted with stakeholders (see Annex N), and the experience gained from the success of the cogeneration initiatives in Mauritius and Southeast Asia, were used to design and formulate activities that are expected to remove the identified barriers. The individual activities are not independent nor are they confined to remove a barrier in one category they are placed under, but will criss-cross through the different barrier categories and their synergy is expected to expedite the barrier removal process.

Below are the measures and activities that will be undertaken by the Cogen for Africa Project to remove the barriers in the different categories.

Removing technical barriers

The overall strategy of the Project in removing the technical barriers is for the Cogen for Africa Project, with its pool of international and regional technical experts, to develop and enhance the capacity of project developers, local technical service providers and local manufacturers in the countries involved.

One area where the potential project developers and project owners of cogeneration projects could be helped is in understanding the sectors where cogeneration is applicable and the magnitude of projects that could be implemented in these sectors. In order to provide a good understanding of the resources available for implementing cogeneration projects, an assessment of the fuel resources, mainly biomass outside the sugar industry (an initial assessment in the sugar industry has been made during the PDF-B stage) , in the seven participating countries will be conducted. Once these resources are mapped out, the potential capacities that could be implemented by tapping these resources will be determined. On the technology supply side, a survey and assessment of relevant cogeneration technologies available in the global market, suppliers of these technologies and their capabilities, and the applicability of these technologies in the African cogeneration market will be conducted.

To capture the above information, a comprehensive, relational and user-friendly Cogen Database will be designed and developed. The Database, which will also contain information related to financing, policy and other technical matters, will be used to source technologies, conduct matchmaking activities between foreign suppliers and local manufacturers, mobilize funds, disseminate promotional and other relevant information, and for other related activities of the Project.

The capacity building activities on the technical area will be conducted mainly for local engineers and technical personnel in the countries involved. This capacity building activities will be in the form of seminars, workshops and training in subjects covering:

- Fundamentals of cogeneration
- Cogeneration application and technologies
- Biomass as fuel for cogeneration
- Technical and feasibility analysis of cogeneration projects
- Operation and maintenance aspects
- Environmental aspects

The capacity building activities will also aim to develop technical know-how and capability among the relevant local staff of the Africa Cogen Centre and the National Cogen Offices (the introduction of the Africa Cogen Centre and the National Cogen Offices and their descriptions are detailed in Sections 3.5.3 and 3.5.4). It is envisaged that a comprehensive training module, which will ideally include a hands-on training within an existing cogeneration plant, will be developed and provided to the staff of the Africa Cogen Centre. The Africa Cogen Centre staff, once trained, will conduct the training of the staff of the National Cogen Offices. This approach is aimed to create a core competence within the personnel directly involved in the implementation of the Project and is expected to help in ensuring the sustainability of the Africa Cogen Centre after the completion of the project.

In addition to the capacity building activities, in order to address the lack of in-house and in-country expertise and experience in implementing biomass cogeneration projects, the Cogen for Africa Project will provide technical assistance and services to project developers and potential owners of cogeneration systems. These services will, among others, include the following aspects:

- Fuel aspects (availability, supply, storage, preparation, etc.)
- Estimation of energy potential from biomass fuel
- Technology selection
- Optimal system configuration
- Major equipment components and scope of supply
- Technical issues and considerations in contractual matters
- Project implementation and management

- Training of operators
- Operation and maintenance aspects

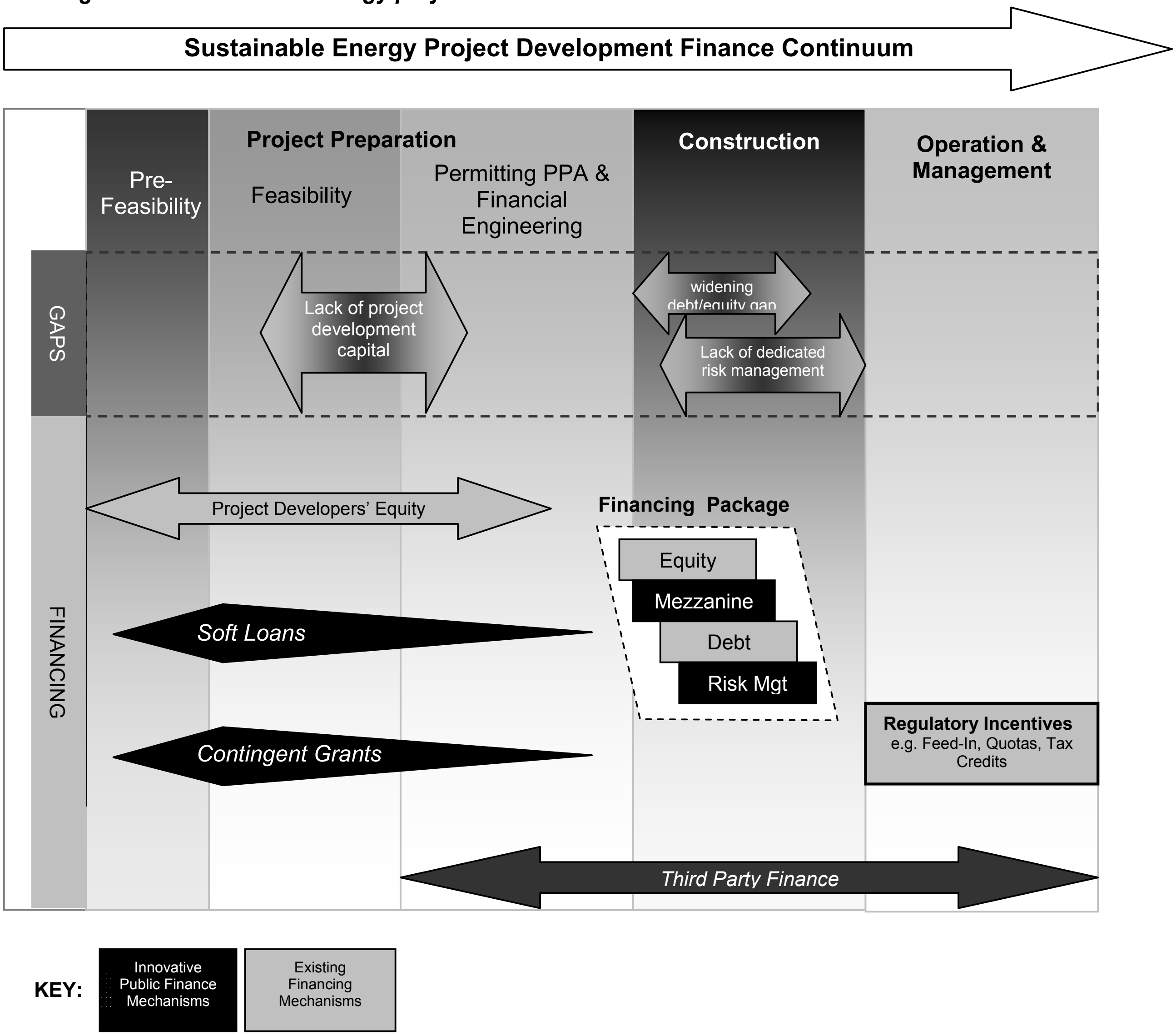
Since there are no existing references of successfully operating high pressure biomass cogeneration systems in the region (with the exception of Mauritius), particularly in the seven participating countries, it is generally useful for potential project developers to see a project which is successfully operating in a similar environment in order to increase their confidence to invest in the technology. Thus, the Project will organize visits by sugar factories from the region to successfully operated references in Mauritius. After one or more reference projects are implemented by this Project in the participating countries, visits to these installations by major stakeholders will be organized on a regular basis.

The lack of local manufacturing capability can be improved by encouraging partnerships between local manufacturing companies which have relevant scope of activities and foreign equipment suppliers. These partnerships could include licensing, joint venture partnerships after-sales service agreement, etc., perhaps starting from the non-critical pressure parts of boiler systems, for instance. A matchmaking strategy and program will be designed aiming at establishing these partnerships and enhancing local manufacturing capability during the project execution.

Removing financing barriers

Non-conventional or sustainable energy projects do not normally have the large scale viability of conventional energy projects, and therefore do not enjoy the financing opportunities and terms that are given to the larger and more financially attractive energy projects. A study launched by UNEP has shown that there is a gap in financing that exists particularly during the project preparation stage, reflected in the lack of development capital to support the efforts of project developers (see Figure 3.1).

Figure 3.1: Sustainable energy project finance continuum



Source: Public Finance Mechanisms to Catalyze Sustainable Energy Sector Growth, UNEP

In order to buy down the risks of investors and lenders in financing the projects, the Africa Cogen Centre will facilitate and assist projects in obtaining financial support from multi-lateral/bi-lateral agencies and public funds.

> The EC-ASEAN COGEN Programme in Southeast Asia provided grant support of up to 15 % of the equipment cost (with a ceiling of 400,000 Euro) to project developers/owners of biomass cogeneration plants. The support, which lowered the capital investment and mitigated some risks, directly stimulated investments which resulted in the implementation of more than 20 industrial scale demonstration projects with a total of more than 150 MW installed capacity.

The Cogen for Africa project has the possibility to stimulate and bring in support from different sources[12]. The support could come in different forms such as:

- Concessional/soft loans
- Seed capital
- Subsidies
- Provision of credit guarantees
- Other financial incentives

The Project will also provide assistance to both project developers and financing institutions in fulfilling the requirements for the projects to reach financial closure. This could be in the form of:

- Training and capacity building to project developers in matters related to:
    - investment appraisal and decisions
    - financial analysis and financing concepts
- Assistance to project developers in:
    - preparation of information memorandum
    - financial packaging
    - presentation of projects to financing institutions
- Training and capacity building to financing institutions in matters related to:
    - fundamentals of biomass fuels and cogeneration technologies
    - assessment of biomass cogeneration technologies
- Assistance to financing institutions in:
    - conduct of due diligence of projects
    - technical evaluation of projects

Financing of cogeneration projects, especially using biomass as fuel, requires particular attention and structuring in order to ensure its success. The following Box (Box 3.3) gives a checklist which developers should consider for cogeneration projects to be financed successfully. The experts within the Project will train developers and assist them in fulfilling the different aspects required in financing their projects.

Box 3.3: Checklist for successful financing of cogeneration and renewable energy projects

Shareholding and ownership

- *There is a clear shareholding and ownership structure which is reflected in a well structured Shareholders' Agreement.*
- *The owners and sponsors of the project have enough verifiable financial resources to contribute as equity according to the financial institution's minimum requirements.*
- *The owners and sponsors of the project have enough collateral and/or other guarantees to provide whenever required.*

Fuel aspects

- *The ownership of fuel (if biomass) or water rights (if hydro) is ascertained.*
- *The availability of fuel is surveyed and is proven to be available and enough for the use of the energy plant.*
- *An agreement for the supply of fuel (Fuel Supply Agreement) on a long-term basis (at least as long as the duration of the loan) is reached.*

Technology supply, construction and operation

- *Conceptual engineering has been done to ascertain the configuration of the plant and the technology has been selected appropriate for the chosen system.*
- *The main technology supplier(s) have been selected through a transparent and competitive process and their reliability/reputation ascertained.*
- *The complete scope of supply has been established and a turnkey supplier or an integrator (in the case of non-turnkey supply) has been selected.*

[12] A list of sources for financing support is provided in Section 4.3.

- *The equipment supply and construction contract reflects crucial aspects such as fixed costs conditions, performance guarantees and liquidated damages.*
- *An operation & maintenance (O&M) programme has been defined using a competent in-house team, or a reputable external O&M company is contracted.*

Off-take

- *The off-taker of energy (power and/or steam) has been ascertained and a sound, long-term agreement (Power Purchase Agreement) obtained.*
- *If electricity is sold to the grid or to a third party, the regulatory, logistical and technical aspects have been studied and ascertained.*

Financial viability

- *The financial analysis shows that the project is viable using conservative assumptions at different likely scenarios.*
- *The financial modelling shows acceptable cash flow and adequate debt service coverage*

Other development aspects

- *Studies and investigations related to the project development have been conducted such as: Fuel Availability Study, Feasibility Study and Due Diligence.*
- *The Information Memorandum summarizing the major aspects of the project has been prepared for submission to the financing institutions.*
- *Permits, consents and other documentary requirements have been ascertained and completed.*
- *Risks have been thoroughly assessed, adequately mitigated and properly allocated to the relevant and competent parties.*
- *Acceptance of the community and relevant interest groups has been obtained to implement the plant.*

Source: Gonzales, A.D., 2005

Removing commercial/market barriers

Looking at the specific barriers mentioned in the preceding section within this category, the major thread that goes through and links them together is the issue of risk. The risks related to the off-take of electricity because of the lack of a sound and long-term PPA, the perceived technical risk because of the lack of information and concrete examples in the region, and the risk related to viability because of high equipment and transaction costs, all hinder the potential developer to make the crucial move of making an investment in a modern and efficient cogeneration system.

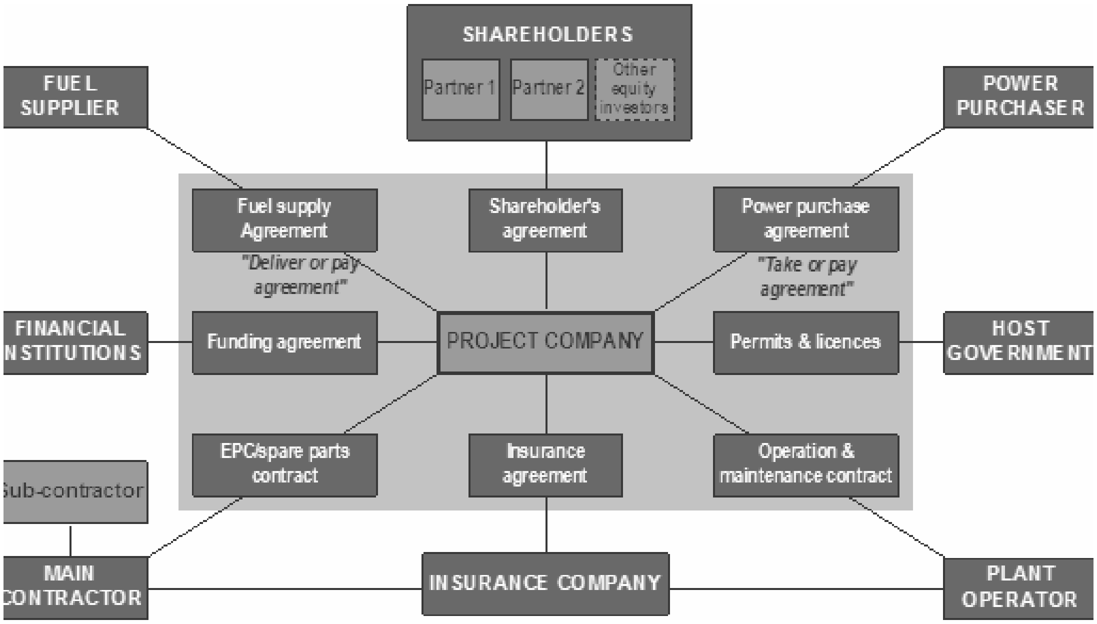
One important feature in the success of the project development process is the concept of risk transference and mitigation. In order to limit the risks to the sponsors of the project, and to the project company itself, there is a need to transfer or to allocate specific risks to external parties who are best able to manage, absorb or mitigate them in the most efficient manner.

A major way to structure the project so that the risks are mitigated and allocated properly is to have credible and fundamentally sound security arrangements consisting of contracts and agreement with the different parties involved. These commercial contracts form the basis of the security structure which creates and ensures the cogeneration project cash flow. The typical principal contracts that should be secured include:

- engineering, procurement, and construction (EPC) agreement
- fuel supply contract
- operations and maintenance agreement
- power purchase agreement
- shareholders agreement

In Figure 3.2, the security arrangements for a typical power project are shown.

Figure 3.2: Security arrangements of a sound cogeneration project



Developing a sound project and organizing all the security arrangements take a lot of efforts and costs. Since most, if not all, of the local developers do not have the in-house expertise to do them and the local/regional capability is limited, they would require services of expensive external service providers for this purpose. The Cogen for Africa Project, as part of its Technical Assistance activities, will assist project developers in structuring their projects and in providing services and advice in making investment decisions and carrying our their project development activities. This is expected to lower the expenses of the projects related to transaction and financing costs which will help in increasing the viability of the projects.

Further to this, it was earlier identified that the absence of successful examples is one of the major barriers in convincing potential developers to invest in modern cogeneration technologies. One of the major activities that the Cogen for Africa will do to demonstrate the technical reliability and economic benefits of modern and efficient biomass cogeneration systems is implement a set of Full Scale Promotion Projects (FSPP) within the six participating countries. These FSPPs will act as show cases aiming at convincing other potential end-users to implement these technologies.

The initial set of FSPPs will become show cases which similar industries and other stakeholders such as project developers, financing institutions, government agencies, NGOs, civil and community groups, could visit and ascertain the technical feasibility, economic viability/benefits, social impact and environmental performance of the projects. The FSPPs are expected to provide good references not only within the six participating countries but also to the other countries in the African region.

As the first set of FSPPs will not have the benefit of successful examples to follow in the region, and since there is a dearth of information and expertise available to assist in the development and implementation of these projects, supporting mechanisms will be provided to encourage the potential developers to decide and invest in the technology.

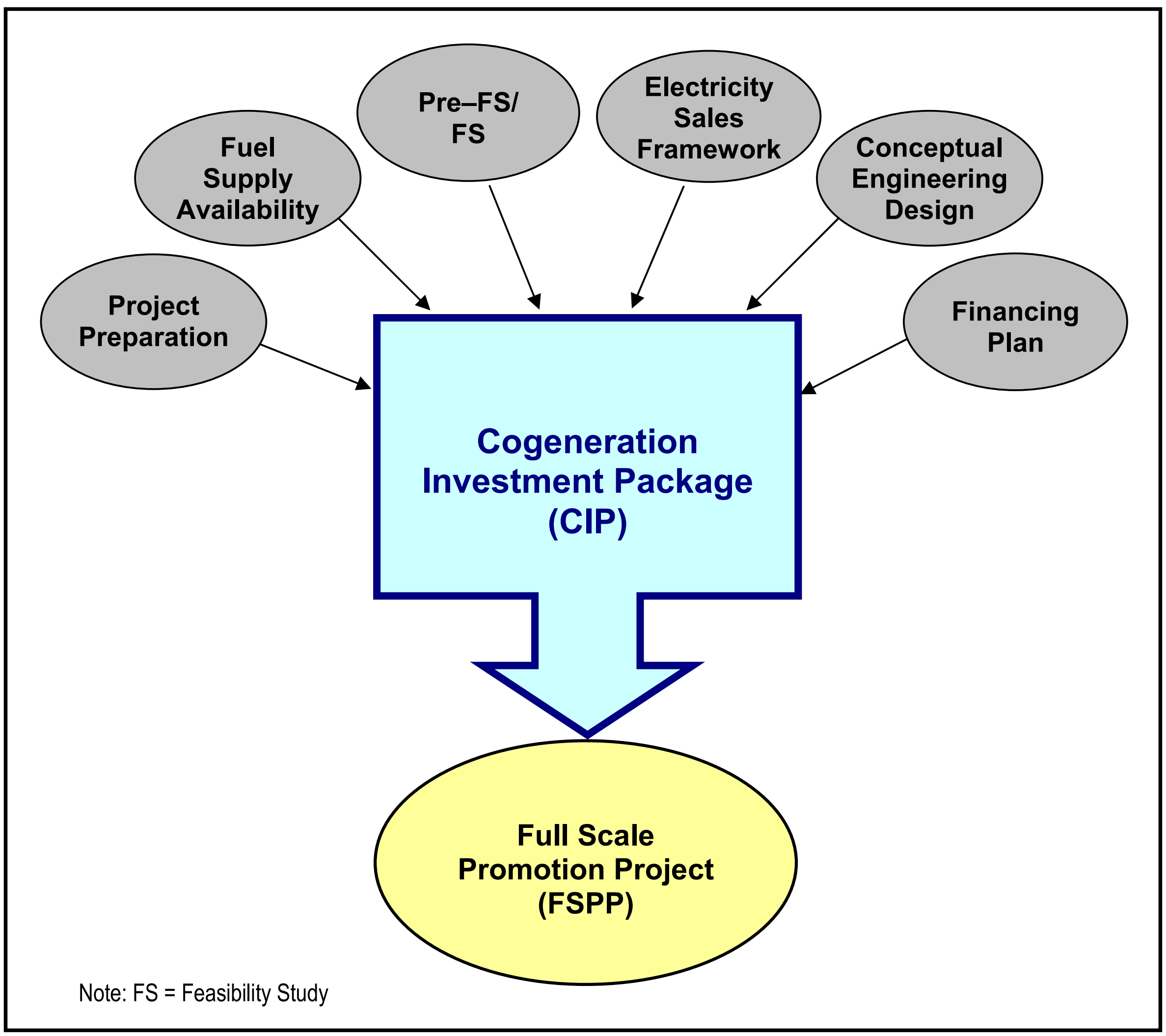
These supporting mechanisms will consist of advice and services provided free-of-charge during the development stage of the project.

More specifically, in order to find ideal candidates for FSPPs, the Project shall identify biomass-producing industries that are willing to be assisted in developing projects that are in the conceptual stage into full-blown commercial and industrial scale projects. For these projects, necessary documentation, studies, and activities will be conducted and the resulting outputs will be documented and packaged into a report to be called the Cogeneration Investment Package (CIP). With the CIP on hand, the potential project developer/owner will have reliable and detailed information which shall be enough to proceed with more advanced development and implementation of the project. The specific items to be addressed which will be contained in the CIP are listed below and are graphically represented in Figure 3.3.

- Business model and project structuring
- Fuel supply availability
- Pre-feasibility study/Feasibility study
- Electricity sales framework
- Conceptual engineering design
- Financing plan

It should be noted that the preparation of the CIP for the developer/owner of the project should reduce the development and transaction costs of the project which normally costs between 5 to 10 % of the total project cost, and therefore reduce the risk of having to spend on sunk costs that may not result to profitable projects. The reduction in development costs for the investor will also yield in higher returns for both the project and the equity invested by the developer.

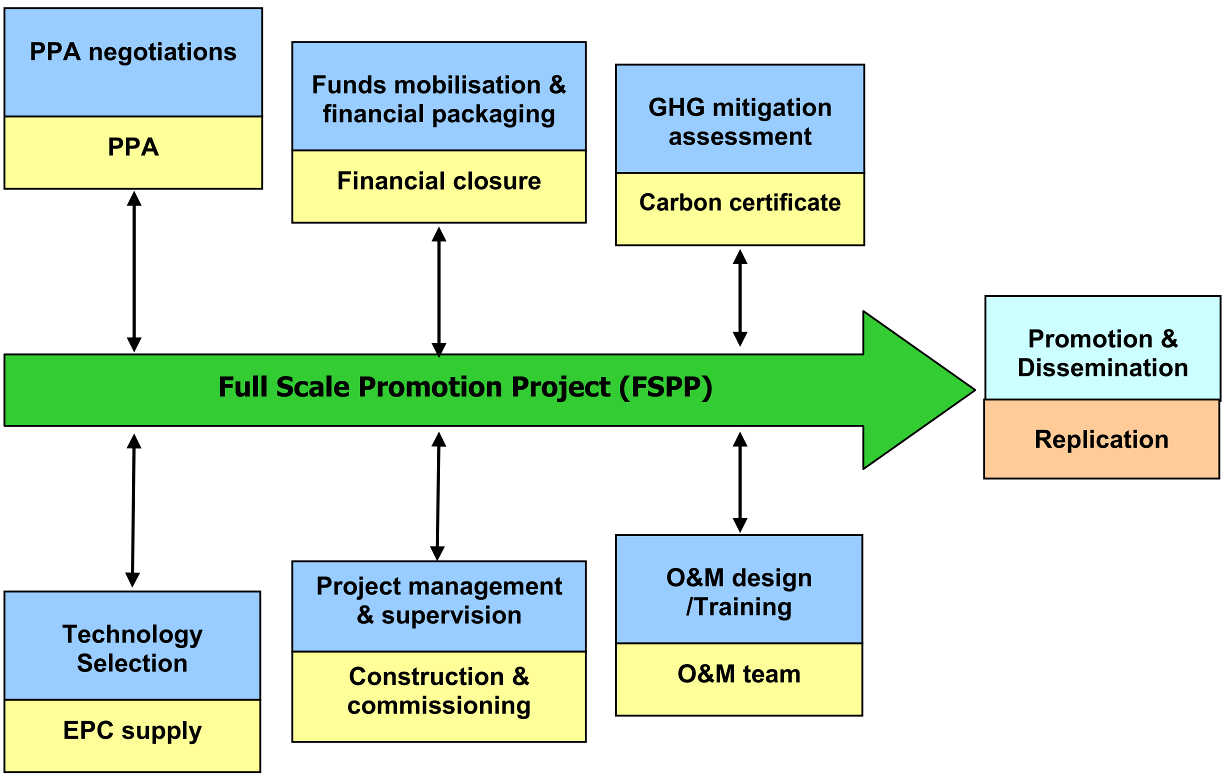
Figure 3.3: The Cogeneration Investment Package



The CIPs should lead to actual investment proposals in projects that will evolve into FSPPs. At this stage, further services will be provided to the project developer/owner(s) for the purpose of advancing the projects into implementation stage (Figure 3.4). Additional and more detailed services will be provided consisting mainly of the following aspects:

- Assistance in selection of technology and equipment suppliers
- Advice in project management and supervision during construction and commissioning
- Advice in the design of O&M framework and training of operators
- Assistance in negotiations of PPA
- Assistance in funds mobilization and financial packaging to attain financial closure
- Assistance in accessing environmental and carbon finance support

Figure 3.4: Support services for FSPPs



Notes: PPA = Power Purchase Agreement
GHG = Greenhouse Gas(es)
EPC = Engineering, Procurement & Construction
O&M = Operation & Maintenance

Further details on the mechanics of the FSPP are described in the Methodology section.

In parallel with the development of FSPPs, potential projects that are in the early conceptual stages will be identified. These will be followed up and, if appropriate, advice will be provided in order to bring them to a level of development where they can be developed into FSPPs. These projects in the pipeline could also be implemented as replications of the FSPPs. The replications are projects that are implemented following the example of an FSPP and without the same comprehensive support provided to an FSPP.

At the initial stage of the project implementation, it is also planned that in order for potential project developers and participants to have a good understanding of the prospects for cogeneration, an assessment of the available resources, particularly biomass, in the industries, will be conducted at the early part of the project implementation. Once mapped out, the energy potential of all these resources will be calculated, and together with the data and assumptions on the efficiency of the equipment, an estimate of the potential for electricity and heat generation will be made. This information will be made available to the staff of the Cogen Country Offices who will assist in exploiting the potential in their countries and to the potential project developers.

Removing regulatory/policy/institutional barriers

The Cogen for Africa Project will aim to remove the barriers to the widespread implementation of cogeneration in Africa due to regulatory, policy and institutional constraints, but more importantly, it will aim to promote more favourable policies and institutional arrangements that support cogeneration. Below are some of the specific actions that the Project will try to address:

- Increase awareness among senior decision makers of the potential benefits of advanced high-pressure cogeneration
- Lobby for explicitly policies that promote cogeneration
- Encourage the reduction of bureaucratic and non-coordinated procedures to obtain permits
- Formulate and lobby for clear, transparent and explicit regulations related to interconnection to the grid and rural electrification
- Support the establishing of dedicated regional and national institutions providing information and services for new and highly efficient cogeneration

To support the above actions, at the start of the project implementation a review and analysis of the existing policies and regulations in the seven participating countries will be conducted. The aim is to identify gaps in policies and to recommend policy interventions and enhancements supporting cogeneration.

Some of the policies and regulations to be explored and proposed to the governments, where applicable include:

- Feed-in tariffs and regulations
- Other special tariffs
- Guaranteed grid access
- Special grid connection rules
- Reduction in administrative procedures
- Ability to sell electricity to third parties (e.g. mini-grids for rural electrification)
- Tax breaks
- Planning obligations (e.g. obligatory use of cogeneration for steam supply in new industrial estates)
- Planning constraints on new power stations (prioritizing cogeneration installations)
- R&D programs
- Demonstration programs
- Information dissemination programs
- Education and training

An advocacy plan and program will be designed to lobby for and influence policy reforms that promote highly efficient cogeneration and their effective implementation. As far as the governments allow, the Project will also provide policy guidance and assist relevant agencies in formulating policies and regulations to support cogeneration.

One of the major issues which the Project will focus on is the formulation of a Standard Power Purchase Agreement (PPA) that reflect reasonable feed-in tariffs and terms that are transparent and reflect long-term commitments from utilities in all the participating countries.

Because currently, there are no established institutions dedicated at providing information and services to stakeholders involved in cogeneration, a one-stop information center, hosted by the Project will be created.

Since information and awareness are key to making the policy makers and other stakeholders understand the value and benefits of implementing modern, high-pressure cogeneration systems, a promotional strategy will be developed and implemented to prepare and disseminate relevant information to targeted audience.

Table 3.10 below summarizes the barriers identified according to the four main categories and the specific measures/activities proposed in the Cogen for Africa Project to remove them. The detailed activities to be carried out by the Project and their descriptions are delineated in Section 3.5.6.

Table 3.10: Summary of barriers and measures within the project to remove them

Barriers	Measures to remove barriers	Specific activities of Cogen for Africa Project to remove barriers
I. Technical • Lack of in-country experience in using high-pressure, high-temperature systems • Lack of local capability/ expertise to support the development, implementation, operation and maintenance of modern and efficient cogeneration systems • Absence of local manufacturing capability	• Capacity building activities to develop local expertise • Provision of expert advice and support to potential developers • Partnerships between foreign equipment suppliers and local manufacturers • Visits and study tours to successful installations in a similar environment	• Conduct of seminars, workshops and trainings • Train local engineers within the Cogen Centre • Provide technical advice and services to project developers • Matchmaking for partnerships between foreign suppliers and local manufacturers • Organize visits to successfully operated references in Mauritius and later, within the region
II. Financing • Absence or lack of low-cost, long-term financing • Lack of assets that could be used as collaterals and guarantees to secure loans • Lack of developers with the skills to prepare financing packages that responds to the needs of financial institutions • Financial institutions lack the expertise to evaluate cogeneration projects • Lack of experience by financing institutions working in new service areas leads to higher perception of risk.	• Assistance to project developers in obtaining funds at favourable terms to the project • Assistance to financing institutions in the conduct of technical due diligence and project/technology assessments • Capacity building and training of project developers on financing matters • Capacity building and training of financing institutions on understanding biomass energy and assessment of cogeneration technologies	• Assist project developers in mobilization of funds, financial structuring and financial packaging • Provide financing advice and services • Assist financing institutions in the conduct of due diligence and technical evaluation of projects • Conduct training of project developers on investment appraisal and financial analysis • Conduct training for financing institutions on biomass aspects and assessment of cogeneration technologies
III. Commercial/market • Lack of successful examples of biomass cogeneration installations in the region	• Implementation of demonstration/promotion projects as showcases for replication in the region • Availability of adequate technical	• Organize, support and promote Full Scale Promotion Projects (FSPPs) in the region • Conduct comprehensive assessment of resources and

• Inadequate technical and economic information to make investment decisions • High capital, development and transaction costs • Lack of framework securing revenues from sales of electricity from cogeneration systems	and commercial and economic information for investment decisions • Provision of support and advice to project developers in matters related to investment decisions, project structuring and project development • Provision of services to reduce pre-investment expenses	potential for biomass cogeneration • Assist project developers in project structuring and project development activities • Provide pre-investment services to reduce transaction costs • Provide advice related to investment options and decisions
IV. Regulatory/policy/ institutional • Inadequate policies explicitly promoting cogeneration • Limited awareness among senior decision makers of the potential benefits of advanced high-pressure cogeneration • Lack of supporting institutions providing information and services for new and efficient cogeneration • Bureaucratic and non-coordinated procedures to obtain permits • Lack of regulations related to interconnection to the grid and mini-grids for rural electrification • Absence of a Standard Power Purchase Agreement (PPA)	• Policy formulation, reform and enhancements to support cogeneration • Effective implementation of regulations and policies • Establishment of a centralized supporting agency to provide information and services related to cogeneration • Centralization/harmonization of permits and approvals for implementing cogeneration plants • Awareness campaign for relevant stakeholders • Formulation and approval of a framework to sell excess power to the grid (e.g. PPA, etc.), including operation of mini-grids for rural electrification	• Assess the existing regulations and policies, analyse gaps and provide recommendations for policy intervention • Implement advocacy activities to influence policy reforms and implementation to support cogeneration • Provide policy guidance to relevant agencies in formulating policies and regulations to support cogeneration • Act as a one-stop information centre for the provision of information and services related to cogeneration • Conduct awareness campaign through forums and dissemination of relevant information • Assist in the formulation and establishment of frameworks in each participating country for selling of excess power to the grid (Standard PPA), including operation of mini-grids for rural electrification

3.5 Project Design and Methodology

3.5.1 Objectives

The development goal of the Cogen for Africa Project is the creation of a self-sustaining cogeneration industry in Africa thereby contributing to the reduction of CO2 emissions.

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.

In a continent with an increasing demand for energy, cogeneration should become the common standard wherever appropriate and applicable. The project is expected to result in the following outcomes:

- Outcome 1: Capacity of project developers, technical service providers and local manufacturers of modern and efficient cogeneration systems developed and enhanced

- Outcome 2: Financing for cogeneration projects made available and accessed at terms and conditions that are favourable for investments.
- 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.
- Outcome 4: More favourable policies and institutional arrangements that support cogeneration promoted

3.5.2 Overall concept and approach

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. These are described below.

The Mauritius model

The tiny island of Mauritius has something to offer to Africa and to the world – in the field of cogeneration. Its sugar industry which had been churning out bagasse as residues from its sugar processing activity, is using these residues as fuel in highly efficient cogeneration systems. Today, the electricity produced by these cogeneration plants in the sugar industry is supplying 40% of the total consumption of the whole country. The revenues coming from this business venture represent more than half of the total revenues of the sugar factories.

The success of the cogeneration industry in Mauritius stems from the investments in, and use of, high pressure boiler systems (up to 82 bar pressure) and highly efficient condensing/extraction-condensing turbo-generators which allow the project owners to implement much higher capacities than what the factories need, thereby giving them opportunity to sell excess power to the grid. The sale to the grid has been facilitated and encouraged by the favourable buyback tariffs and terms reflected in a transparent and long-term Standard Power Purchase Agreements (PPA).

The revenues earned by the sugar factories from the sales of electricity to the grid are shared among the farmers using an agreed sharing mechanism. This effectively increases the earnings of the farmers from the same amount of sugar cane produced because bagasse which had been traditionally considered as wastes is now being paid as fuel. The positive impact of this development to the economic situation of the farmers is not negligible and had engendered widespread support for the cogeneration industry.

Because of these experiences, Mauritius has recently started to provide expertise in developing and implementing cogeneration systems in other countries in the region through consultancy work and management contracts.

A regional approach: The Cogen Asia model

The cogeneration program which has been successfully operated for many years in Southeast Asia and has directly and indirectly promoted the implementation of up to 600 MW of cogeneration projects in the region was implemented as a regional program involving nine countries within the Association of Southeast Asian Nations (ASEAN). The regional nature of the program allowed the resources to be used at an optimum level by setting up a single Executing Agency in the region which hosted the Programme Management Unit where the activities of the program emanate from. Country Coordinators which act as focal points in the participating countries have been selected and provided support to the program. They also provided the link and had been in constant contact with the stakeholders in their respective countries.

This approach created a synergistic effect due to the conduct of regional seminars and training which were attended by participants from different countries, organization of forums and study tours for policy makers in the region, and visits by regional participants to demonstration projects which have been successfully installed and operated in the region. These regional activities provided avenues for the participants to learn from the experiences of other countries, exchange lessons and ideas policy issues, and even conduct joint projects on cogeneration.

3.5.3 The Africa Cogen Centre: a center of excellence for cogeneration

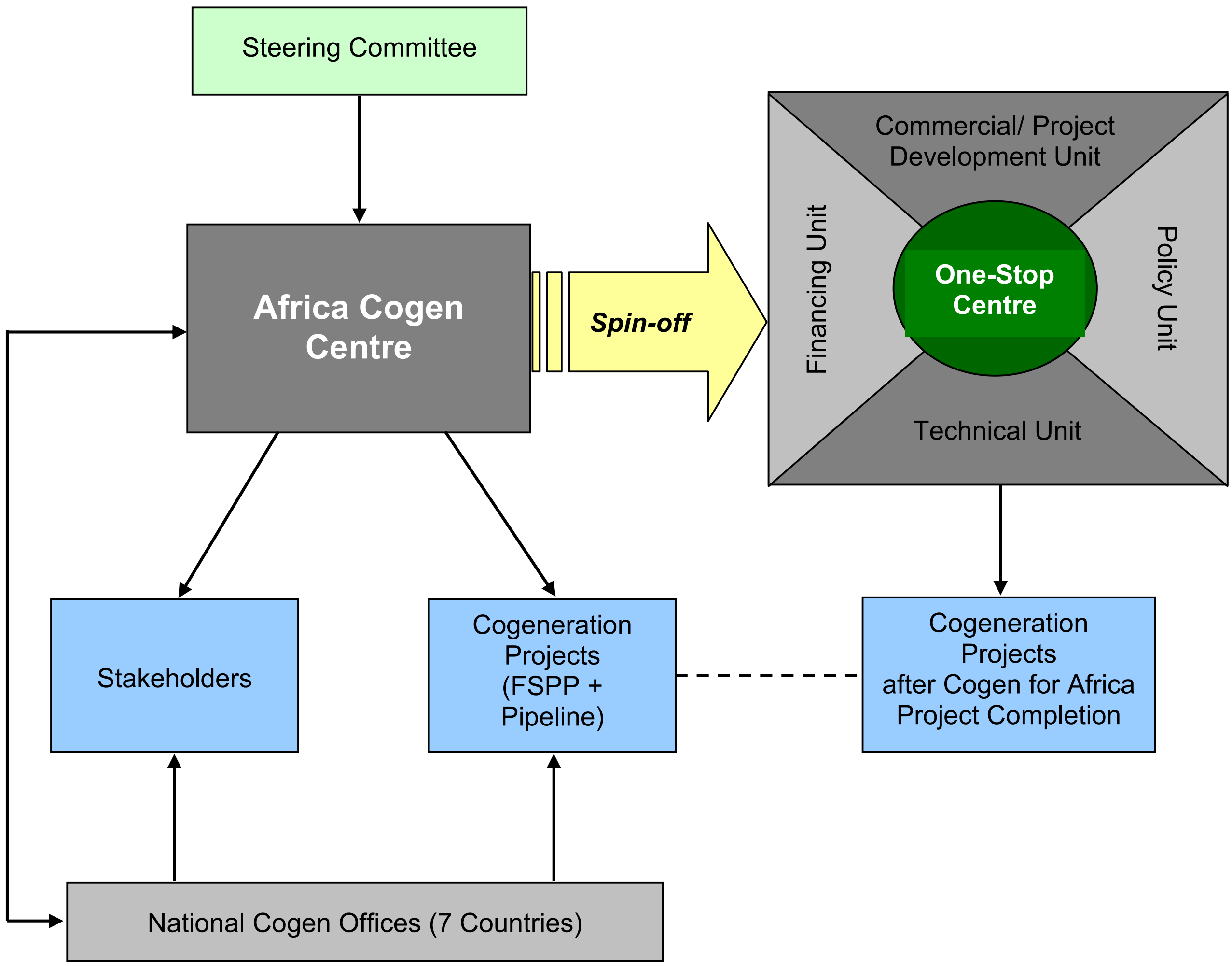
A major platform for the implementation of the Cogen for Africa Project is the creation of a regional center of excellence to be called the Africa Cogen Centre which will act as the project management unit of the Project. This center will be modeled on the Cogen Asia Model but taking into account some of the region's specific needs and characteristics, as well as build on the successful Mauritius' experience. It will operate as the center of excellence for cogeneration in the African region. The Africa Cogen Centre will 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. Support will be provided by the private sector during years 4 to 6 of the Project implementation.

The Africa Cogen Centre will report and will be accountable to the Project Steering Committee (described in Section 5.3.1) while being supported n 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 Figure 3.5.

Figure 3.5: Overview of the Cogen for Africa Project concept



It is proposed that AFREPREN/FWD (for details on AFREPREN/FWD, please refer to Annex O) 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 cogeneration opportunities for financing
- Support in the assessment of cogeneration 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 cogeneration and power 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

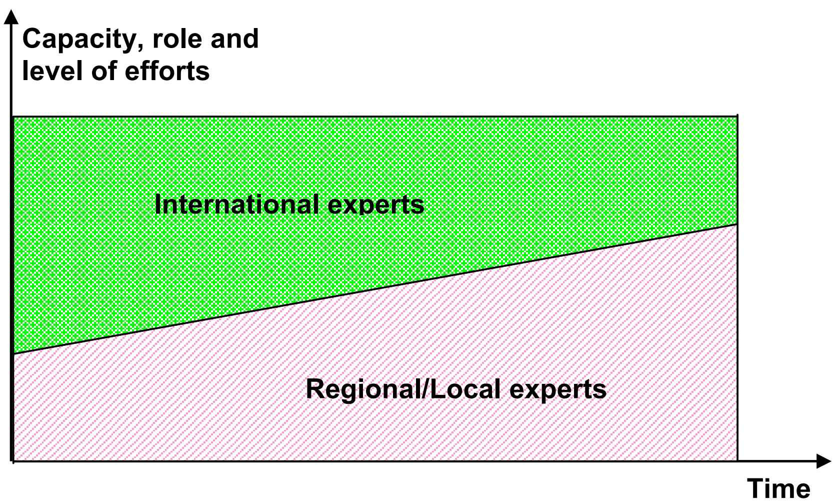
The proposed personnel of the Africa Cogen Centre will consist of both International Experts and Regional/Local Staff. Details of the qualifications and responsibilities of the personnel are provided in Annex T.

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. Figure 3.6 illustrates this idea.

Figure 3.6: Contribution and involvement of International Experts vis-à-vis Regional/Local Experts



The personnel will be 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 to 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 to be employed on a part-time basis for the duration of the Project, and three Regional Experts working on a short term basis. The capacity, involvement and responsibilities of the Regional/Local personnel to increase in time.
- The International Experts to consist of one full time (75%) 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.

Below are the proposed personnel for the Africa Cogen Centre within the Cogen for Africa Project:

Regional/Local Personnel

A. Part Time

- Africa Cogen Centre Director
- In-charge of Project Development Unit
- In-charge of Financing Unit
- In-charge of Policy Unit
- In-charge of Technical Unit (Mechanical Engineer)
- Power/Electrical Engineer
- Finance/Administrative Staff

B. Short Term

- Regional Cogeneration Expert
- Regional Policy Expert
- Regional Environmental Expert

International Experts

A. Part Time

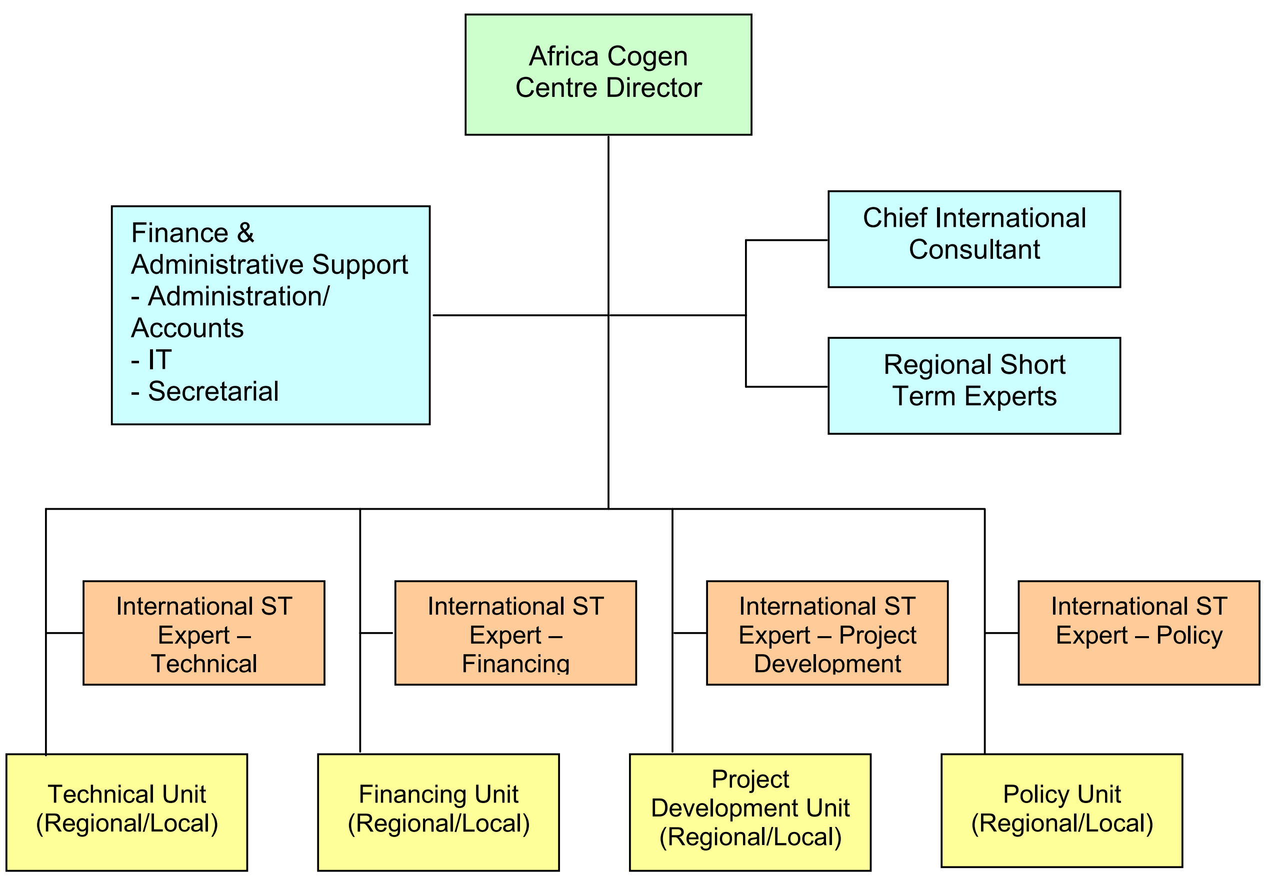
- Chief International Consultant

B. Short Term

- Business/Project Development Adviser
- Financing Expert
- Policy Expert
- Cogeneration Expert
- Environmental Expert

The organizational structure of the Africa Cogen Centre and the distribution of the personnel according to their roles and functions are given in Figure 3.7.

Figure 3.7: Organizational structure of the Africa Cogen Centre



Notes: IT = Information Technology

ST = Short-Term

The Full Scale Promotion Project (FSPP) concept

During the early and PDF-B stages of project preparation, as part of the needs assessment among stakeholders, discussions were held with potential developers of cogeneration projects to find out, among others things, the support and services these companies require outside their in-house expertise to develop, implement and operate high pressure cogeneration systems.

The following required support and services which will be provided by the Africa Cogen Centre have been identified:

A. Project development stage:

- Business model and project structuring
- Fuel supply availability and energy potential calculations
- Pre-feasibility study/Feasibility study
- Electricity sales framework (Standard PPA)
- Conceptual engineering design
- Financing plan

B. Project implementation stage:

- Assistance in selection of technology and equipment suppliers
- Advice in project management and supervision during construction and commissioning
- Advice in the design of O&M framework and training of operators
- Assistance in PPA formulation and seeking approval from authorities
- Assistance in funds mobilization and financial packaging to attain financial closure
- Assistance in accessing environmental and carbon finance support

The requirement for the above support and services by the companies are dependent on the type of company and the level of operational efficiency of the company. To illustrate, Figure 3.8 shows a matrix of the classifications of the sugar factories (which is one of the major industries using cogeneration) in Kenya, according to their ownership and degree of operational efficiency. These four types of companies require different levels of support and services. This spectrum of services vis-à-vis the type of company is captured in Figure 3.9.

Figure 3.8: Matrix showing the types of sugar factories in Kenya according to ownership and degree of operational efficiency

Privately-owned	State-owned	
Mumias West Kenya	Chemilil	**High operational efficiency**
Busia	Muhoroni Nzoia Sony	**Low operational efficiency**

Figure 3.9: Matrix showing the level of support required according to ownership and degree of operational efficiency

	Privately-owned	State-owned
High operational efficiency	• Fuel supply availability • Assistance in PPA formulation and seeking approval from authorities • Assistance in funds mobilization and financial packaging to attain financial closure • Assistance in pursuing CDM opportunities	• Business model and project structuring • Fuel supply availability • Pre-feasibility study/Feasibility study • Financing plan • Assistance in PPA formulation and seeking approval from authorities • Assistance in funds mobilization and financial packaging to attain financial closure • Assistance in pursuing CDM opportunities
Low operational efficiency	• Fuel supply availability • Conceptual engineering design • Assistance in selection of technology and equipment suppliers • Advice in project management and supervision during construction and commissioning • Advice in the design of O&M framework and training of operators • Assistance in PPA formulation and seeking approval from authorities • Assistance in funds mobilization and financial packaging to attain financial closure • Assistance in pursuing CDM opportunities	• Business model and project structuring • Fuel supply availability • Pre-feasibility study/Feasibility study • Conceptual engineering design • Financing plan • Assistance in selection of technology and equipment suppliers • Advice in project management and supervision during construction and commissioning • Advice in the design of O&M framework and training of operators • Assistance in PPA formulation and seeking approval from authorities • Assistance in funds mobilization and financial packaging to attain financial closure • Assistance in pursuing CDM opportunities

Notes: CDM = Clean Development Mechanism
PPA = Power Purchase Agreement
O&M = Operation & Maintenance

To get these services, a potential project developer or owner of the project would have to contract the services of a competent company/consultant at a fee. And since expertise of this kind is limited in this region, hiring a foreign consultant would be rather expensive. Considering that these expenses would have to be spent without the assurance that the project would be technically feasible or economically viable, potential project developers are normally not willing to spend resources upfront. Moreover, because of the absence of examples of successfully operating modern cogeneration technologies, there is a need to demonstrate the technical reliability and economic benefits of implementing modern and efficient cogeneration systems.

In order to reduce the risks of the potential project developers in spending upfront development costs in a venture that is considered new such as high-pressure cogeneration systems, the Cogen for Africa Project will provide support that limits their development costs, and provides concrete examples of successful projects. One of the major activities that the Project will execute is the implementation of Full Scale Promotion Projects (FSPP) within the seven participating countries. These FSPPs will act as show cases aimed at convincing other potential end-users to implement these technologies by demonstrating the technical reliability, economic viability and environmental friendliness of modern and efficient cogeneration technologies.

The benefits that owners of cogeneration projects will get by applying for an FSPP status for their projects are:

- Assistance in development aspects through the preparation of Cogeneration Investment Packages consisting of services mentioned in (A) Preparatory Stage above
- Assistance in implementation aspects through provision of specialized services mentioned in (B) Project Implementation Stage above
- Financial support, whenever available and appropriate

In order to become an FSPP, projects will be evaluated using approved criteria which will be defined and announced during the initial stage of the Project implementation. These criteria could consist of the following major aspects:

- Technical reliability
- Financial viability
- Environmental impact
- Replication potential

To attain FSPP status, project developers/owners must agree, by signing an MOU with the Africa Cogen Centre, to comply with certain obligations. These obligations consist of permission for:

- Visits to the cogeneration installation by other industries/potential project owners
- Monitoring of the performance of the cogeneration project
- Promotion of the cogeneration plant to potential users of cogeneration technologies

3.5.4 National Cogen Offices

A National Cogen Office shall be established in each of the seven participating countries. These offices shall act as focal points in the different participating countries and will liaise with both public and private sector stakeholders on a national basis (industry associations, individual industries, project developers, relevant government agencies, financial sector, community and civil groups, etc.). The National Cogen Offices shall work on a sub-contract basis against a service fee. These offices are to be established in energy sector-related companies in the respective participating countries.

The tasks of each National Cogen Office are, but not limited to, the following:

- Manage the Project on a national level and attend Project Management Council (PMC) meetings (see Section 3.4.3)

- Create/raise awareness of cogeneration as a clean and efficient energy solution among various industrial sectors of the country such as the sugar industry and other agro industries, pulp and paper industries, food, textile, cement, chemical, petroleum and metallurgical industries, and also to (potential) equipment manufacturers, engineering companies, project developers, financiers and banks as well as government agencies in the energy, industrial and environment sector

- Identify potential projects or projects under development and follow up tangible business opportunities with emphasis on projects that may qualify as FSPPs or may become projects in the pipeline

- Maintain and develop contacts with all relevant public and private sector organisations

- Liaise with public sector and relevant government agencies and implement advocacy activities aimed at influencing policy makers to formulate and/or enhance regulations, policies and support measures to encourage the development of cogeneration and sales of power to the grid from cogeneration projects at favourable terms

- Facilitate matchmaking between local and international stakeholders such as end-users, engineering companies, equipment suppliers and local manufacturers

- Assist in mobilization of funds by facilitating contacts between the project developers and the Africa Cogen Centre Experts assisting them on one hand, and the financing institutions based in the country on the other hand

- Implement promotion and dissemination activities at the National level
- Provide existing documentation and developments on policy matters
- Provide initial information/data for the Cogen Database and updates thereafter
- Organise field trips/ study tours/ site visits, seminars/workshops and other meetings in the country
- Regularly collect information on the energy sector, electricity supply industry data, fuel resource assessment, national energy/environmental trends and regulations, trade fairs, exhibitions, conferences and other events, press cuts, etc. The information shall be sent to the Africa Cogen Centre on a regular basis
- Submit Quarterly Reports to the Africa Cogen Centre using the standard template to be provided at the initial stage of the project implementation

Annex U provides a list of potential organizations which could host the National Cogen Offices in the seven participating countries.

3.5.5 Stakeholders, their involvement and commitments

Relevant stakeholders have been identified at the early stage of the preparation and their role/involvement both during the Project preparation and Project implementation has been clearly defined. Stakeholders' Meetings in different countries were conducted and face-to-face discussions were held with many of them to assess their needs and ascertain their commitment to the objectives of the Project. Moreover, a website was developed (http://cogen.unep.org/) for the stakeholders to access information, monitor the progress of the document preparation and discuss issues relevant to the Project. As these stakeholders are also beneficiaries of the Project outcomes, their participation and commitment are ensured which adds assurance to the success of the Project. A table showing the different stakeholder groups and their involvement in the Project as well as the benefits they can expect to receive is presented in Table 3.11.

The Steering Committee, which is the highest level of supervision during the Project implementation, will be comprised of representatives from the Funding/Co-funding agencies, senior representatives of the most relevant industries or industry associations of participating countries and senior representatives of relevant government agencies or electric utilities. This will ensure an integrated approach to dealing with the challenges and opportunities that considers the interests of all stakeholders, including cross-cutting concerns/activities that incorporate and support gender and marginal group participation.

The regional Africa Cogen Centre will be in direct and day-to-day communication with all stakeholders in the cogeneration sector while exposing itself through the active participation in relevant occasions and organizing its own workshops, training seminars, etc.

The envisaged National Cogen Country Offices shall work as an extension of the Africa Cogen Centre on a national level by liaising with government agencies, industry participants and prospective end-users of cogeneration systems.

Table 3.11: Stakeholder groups, their involvement and role in, and benefits from, the Project

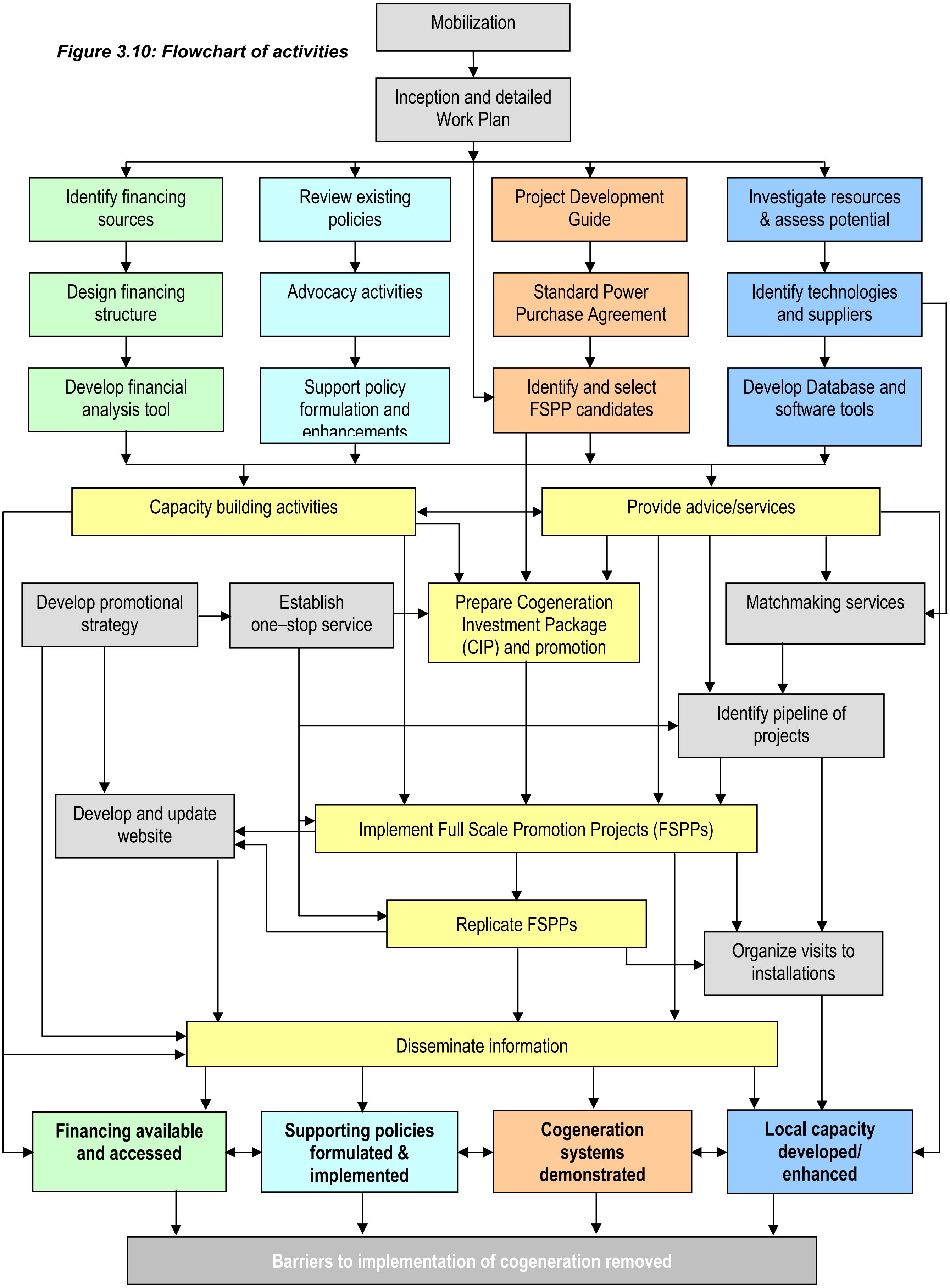
Stakeholder/ beneficiary	Reason for involvement	Role/Nature of involvement		Benefits to stakeholders
		Project preparation	Project implementation	
(Potential) End-users of cogeneration systems	Potential owners and hosts of cogeneration projects	Consultations; discussions on cogeneration potential; provision 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 stakes in projects; assistance in sourcing of bilateral and export credit support	Opportunity for equipment supply; opening up of market; matchmaking opportunity with local manufacturers; delocalization of manufacturing; participation in FSPPs
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	Direct & indirect recipients of economic, social &	National stakeholders' meetings	Regular consultations; source of labor market for the employment requirements of	Job creation; economic/social benefits of electrification for projects with rural electrification component; cleaner air compared to existence of inefficient systems; information from website

& marginal groups	environmental impacts of cogeneration		projects	

3.5.6 Outcomes, outputs and detailed activities

Figure 3.10 shows the flowchart of the activities of the Cogen for Africa Project. The details and descriptions of these activities together with the outputs for the different outcomes mentioned earlier are also explained in this section.

Figure 3.10: Flowchart of activities



***Outcome 1**: Capacity of project developers, technical service providers and local manufacturers of modern and efficient cogeneration systems developed and enhanced*

<u>Outputs:</u>

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

<u>Activities:</u>

1.6 Investigate availability of biomass resources and assess their potential for cogeneration

Having reliable data on the availability of biomass resources is an important first step in understanding the potential of using biomass for cogeneration purposes and informing the potential project developers and the relevant stakeholders of this potential. During the PDF-B stage, a survey of the sugar industries has been conducted. However, there are other agro-industries that generate residues and have potential to implement cogeneration systems.

The steps involved in this activity are as follows:

- Identify the sectors that generate biomass wastes
- Map out the biomass waste generation for each relevant sector
- Identify and quantify the current usage of these biomass resources
- Investigate and estimate costs for buying, selling and transporting of biomass wastes
- Assess the industry structure, trends and competitiveness of the industry producing the biomass wastes and their future prospects

From the availability of biomass resources investigated, the next part is to assess and calculate the energy potential of the biomass resources, both in its primary energy form and after conversion to electricity and heat. This should take into consideration the amount of biomass already used for other purposes and are not available for energy conversion. This activity is important to ascertain the realistic potential that could be realized for biomass cogeneration. The specific sub-activities to be conducted include the following:

- Conduct laboratory analyses of some samples to determine the fuel composition and properties
- Analyze the energy consumption patterns and needs of the industries producing biomass wastes
- Establish conversion efficiencies of different technologies for the different biomass fuels
- Estimate primary energy and generation potential of available biomass resources

1.7 Identify applicable technologies for cogeneration, relevant suppliers of equipment and their capabilities

In this activity, a survey to review and assess the technologies applicable for cogeneration will be conducted. Particular emphasis will be given to identifying technologies that have been implemented successfully in similar environments such as in Asia, South America, other parts of Africa like Mauritius, South Africa, etc. An identification of suppliers of cogeneration components from the most active countries globally, an assessment of their capabilities and the applicability of their technologies in the African cogeneration market will be conducted. From this, an inventory of the suppliers, their products and capabilities will be inputted in the Cogen Database which will be developed in the

Project (Act. 1.3). These equipment suppliers will be contacted during the tendering process of the projects to be implemented.

In parallel, this activity will also identify local equipment suppliers and manufacturers who currently are or who could become joint venture partners of foreign equipment suppliers.

1.8 Design and develop a database consisting of foreign equipment suppliers and local manufacturers

A Cogen Database will be designed to contain information useful for matchmaking purposes and other activities of the Project. The Cogen Database shall be programmed using a standard database software and shall contain user-friendly features for inputting, editing and reporting, among others. It shall contain information such as:

- Suppliers of cogeneration equipment/components and their capabilities
- Local manufacturers/potential partners and their capabilities
- Project developers
- Relevant industries and industry data
- Financing institutions
- Relevant government agencies
- Utilities
- Electricity sector data
- Relevant documents
- Other useful information and data

The information and data on Cogen Database shall be gathered with the assistance of the Cogen Country Offices and shall be updated regularly.

1.9 Design and implement a matchmaking service between foreign equipment suppliers and local manufacturers

The aim of this activity is increase the local capability and involvement of local manufacturers in the manufacturing and construction of cogeneration systems by creating opportunities for partnerships and encouraging joint ventures and other similar activities between foreign equipment suppliers and local manufacturers. Using the information in the Cogen Database to identify potential partners and concrete projects as the basis to initiate partnerships, the matchmaking service will assist foreign and local companies to initiate contact and work together in manufacturing efficient cogeneration systems.

As the capability of local manufacturers in the participating countries, is not high, the initial partnerships could start with non-pressure parts of the cogeneration system, but this is expected to gradually move on to a higher proportion of local manufacturing and to more important components.

1.10 Develop and/or adapt software tools for technical analysis to be used for analysis of projects and training purposes

At the initial stage of Project Implementation, an assessment of the software tools that are needed for both training purposes and analysis of projects as well as the availability of software from commercial and non-commercial sources will be assessed. These will vary from simple calculation tools to a more sophisticated engineering and design software. The software that will be procured from external providers will be customised and adapted whenever necessary. Some others may need to be developed in-house or their development sub-contracted to relevant service providers.

The areas where software tools that are expected to be used in the Project are:

- Power/cogeneration plant design and engineering
- Energy and mass balance analysis
- Techno-financial analysis
- GHG mitigation calculations
- Cogeneration plant efficiency and monitoring

1.11 Conduct capacity building activities through seminars, workshops and training

Capacity building activities will be targeted first of all to develop capability and expertise of Regional/local staff of the Project and the staff of the National Cogen Offices in the seven participating countries. As mentioned earlier, this training will consist of different modules covering all aspects of cogeneration development, financing, implementation and operation, and ideally a hands-on training in an operating cogeneration plant using high-pressure systems.

With the trained Regional/local staff and the International Experts as resource persons, seminars, workshops and other forms of training will be conducted with local stakeholders as participants. As these activities require to be done in the different participating countries and in different sectors with varying needs, a comprehensive capacity building program will need to be well designed.

The organization and conduct of the capacity building activities in the technical area will be coordinated with those in other areas so that synergy will be maximized while minimizing the costs incurred.

1.12 Provide technical advice and services to project developers and potential owners of cogeneration systems

As there is lack of in-house and in-country expertise and experience in implementing biomass cogeneration projects, the Africa Cogen Centre will provide technical assistance and services to project developers and potential owners of cogeneration systems. These services will, among others, include the following aspects:

- Fuel aspects (availability, supply, storage, preparation, etc.)
- Estimation of energy potential from biomass fuel
- Technology selection
- Optimal system configuration
- Major equipment components and scope of supply
- Technical issues and considerations in contractual matters
- Project implementation and management
- Training of operators
- Operation and maintenance aspects

1.13 Organize visits and study tours to successful cogeneration installations

Examples of modern and efficient cogeneration projects that are successfully operating currently exist in neighbouring Mauritius. Bringing key individuals from relevant sectors/industries, project developers, financing institutions and other relevant organisations to these installations and letting them see for themselves these technologies, would go a long way in changing their perception regarding the risks involved in these projects. Once the FSPPs are operating in this region, the visits will be organized to FSPP installations.

In these visits, the organization, preparation of materials, local group transportation and other administrative costs will be borne by the project, but transportation, accommodation and incidental costs of the participants shall be borne by the individual participants themselves.

The Project will organize about 3 visits to Mauritius during the first 4 years of the Project Implementation with different participants in each visit.

Once the FSPPs start operating in any of the seven participating countries, visits will also be organized at least once for each operating FSPP.

Outcome 2: *Financing for cogeneration projects made available and accessed at terms and conditions that are favorable for investments.*

<u>*Outputs:*</u>

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

Activities:

2.6 Identify and review existing financing sources and mechanisms relevant for the sector and the region

In order for the Africa Cogen Centre so assist in mobilizing funds for the cogeneration projects, there is a need to identify the financing sources that meet the needs of identified investment projects, the sector and the countries involved. This activity will involve meetings with the most relevant financing institutions in the region, understanding their financing schemes, modalities and requirements, and providing them with appropriate information that will lead them to a better appreciation of the benefits, advantages and realistic risks of biomass cogeneration projects. This will lead to a creation of a portfolio of financiers who should be approached for funding of projects at different stages of development (pre-CIP, CIP and FSPP).

2.7 Design and recommend financing structure appropriate for cogeneration projects

From the information gathered during Activity 2.1, and understanding the nature of cogeneration projects, as well as the industries and developers that sponsor these projects, financing structure models that will be used as a guide for the Africa Cogen Centre advisers and project developers will be developed. Included in this will be working closely in liaison with the banks to develop bankable proposals and meeting the banks procedures and eligibility criteria and the preparation of typical term sheets that can be proposed by project developers for consideration of, and eventual negotiation with, the financing institutions.

The Africa Cogen Centre, through the guidance of the short-term international specialist on financing, will also facilitate the creation, and/or sourcing, of financing support mechanisms that could stimulate investment decisions for cogeneration or buy down some risks related to high costs of financing. These financing schemes may include new and flexible mechanisms that have not been advanced in this region.

For instance, during consultations with financing institutions, Triodos Bank of the Netherlands has indicated their interest in establishing a Fund to finance cogeneration and small hydro investments in eastern and southern Africa. The Fund could provide equity particularly to holding-type companies which have the strategy to develop a few or several energy generation projects. It could also participate in individual projects, in which case, the financing will be most likely in the form of loans. Similarly, the European Investment Bank (EIB) indicated that they would be willing to establish a credit line facility for cleaner energy projects via an intermediary bank or institution which will on-lend the funds to individual projects.

With the Africa Cogen Centre acting as a catalyst and provider of technical support, different financing mechanisms could be formulated and/or tapped to support the financing of cogeneration projects. These could be in the form of:

- Grants
- Concessional/soft loans
- Seed capital
- Subsidies
- Provision of credit guarantees
- Other financial incentives

2.8 Design and develop financial analysis software tool to be used for project analysis and training

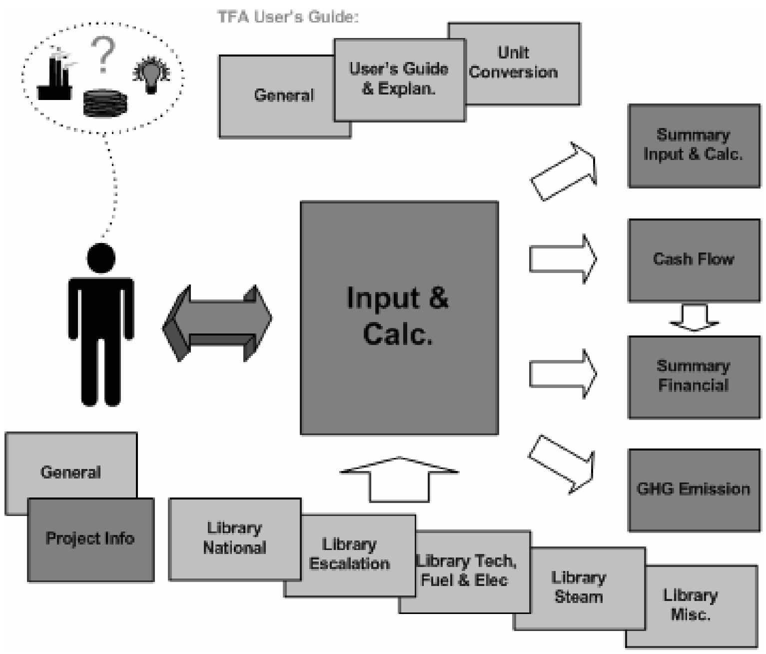
A general financial analysis software will be developed and used as a tool in analyzing the profitability of cogeneration projects during the pre-feasibility study and feasibility study stages of project development. Depending on the necessity and complexity of the project, this software may be customized on a case-to case basis. The software will also be used in the training of local personnel identified to be relevant in the development, investment and financing of projects.

The financial analysis software should typically contain the following information:

- Inputs and assumptions
- Discounted cashflow analysis
- Income statement
- Balance sheet
- Profitability results: IRR, NPV, payback period
- Financing costs, terms and payment regime
- Ratio analysis: Debt service coverage ratio (DSCR)
- Sensitivity analysis
- Summary of results

The software should be structured in a user-friendly manner so that it could be used by as wide an audience as possible. A possible structure that of this model is illustrated in Figure 3.11 below.

Figure 3.11: Possible structure of the financial analysis model



2.9 Conduct training of project developers and financing institutions

Because of the lack of experiences and understanding of advanced high-pressure cogeneration investments by many project developers and financing institutions, it is important to conduct training catered to the needs of these groups of stakeholders.

The building of the capability of the staff of financial institutions involved in the evaluation and approval process of projects would lead to enhanced confidence to consider cogeneration projects that might otherwise be perceived to be too risky, while building of skills for project developers in the financial packaging of projects could improve their chances of getting reasonably favourable terms for loans from financing institutions.

A detailed analysis of the training needs will be conducted during the implementation of the Cogen for Africa project. However, preliminary investigation suggests that the training components could cover, but not be limited to, the following aspects:

- Training and capacity building to project developers in matters related to:
    - investment appraisal and decisions
    - financial analysis and financing concepts
- Training and capacity building to financing institutions in matters related to:
    - fundamentals of biomass fuels and cogeneration technologies
    - assessment of cogeneration technologies

2.10 Assist project developers and financing institutions in the financing of projects

The Africa Cogen Centre will also provide assistance to both project developers and financing institutions in fulfilling the requirements for the projects to reach financial closure. Among others, this will entail:

- Assistance to project developers in:
    - preparation of information memorandum
    - financial packaging
    - presentation of projects to financing institutions
- Assistance to financing institutions in:
    - conducting due diligence of projects
    - technical evaluation of projects

Depending on the requirements and the appropriateness of the situation, assistance may only be given to either the project developer or to the financing institution for a particular project.

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.*

Outputs:

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

3.4 Technical assistance provided to pipeline of projects (i.e. non-FSPP projects)

Activities:

3.6 Develop a project development guide for reference and training purposes

One way of enhancing the capability of local project developers and building their confidence in developing projects is to provide them with information on the best practices that have been successfully tested and implemented in a similar environment. To this end, a Cogeneration Project Development Guide that is contextualized to the needs and conditions in the African region will be developed. The Guide will not only be disseminated but will be used as a training material in capacity building activities with the relevant stakeholders in the participating countries.

The Guide should ideally contain the following subjects:

I. Pre-Investment Phase, containing aspects such as:

- Project concept and objectives
- Pre-Feasibility and Feasibility Studies
- Investigation of fuel resources
- Evaluation of energy requirements

- Assessment and selection of technologies
- Assessment of off-takers
- Financial analysis and commercial viability
- Environmental and social impact assessment

II. Investment Phase, containing aspects such as:

- Contractual structuring and risk mitigation
- Tendering of EPC/Equipment supply
- Financing of cogeneration projects
- Financial packaging/Financial closure
- Design, engineering and construction

III. Operating Phase, containing aspects such as:

- Testing and commissioning
- Operation and maintenance

3.7 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

Among the relevant industries for cogeneration such as biomass wastes producing industries (a sugar factory, for example), the appropriate sites will be identified and most suitable candidates will be selected for further development. A set of criteria for screening and selecting the sites shall be created. As a guide, at least one site from each participating country shall be selected.

It is important that for the site to be selected, the potential owner/developer of the project should agree and commit that if the feasibility study reveals the project to be viable and the market package is done, the owner must proceed with the investment of the project as an FSPP.

For the selected sites, the Africa Cogen Centre will prepare Cogeneration Investment Packages (CIPs) to be offered to the private sector for investment and project implementation. A CIP, as defined and explained in the preceding section, is a set of documentation resulting from services and activities conducted to develop a project into a stage where a project developer/investor could be in a position to make a decision for investment based on the information provided by the package.

The services and activities involved in the preparation of the CIP are given below:

- Fuel supply availability
- Pre-feasibility study/Feasibility study
- Electricity sales framework (PPA)
- Conceptual engineering design
- Financing plan

A Memorandum of Understanding (MoU) can then be signed between the Cogen Centre and the facility owner agreeing that the above services shall be provided by the Cogen Centre and in return, if the project is found to be viable and the CIP is completed, the owner is expected to proceed further with the investment. It should be noted that only the commercially viable projects, as revealed by the Pre-FS/FS, shall be developed into a full-blown CIP.

Once a CIP is completed, the owner of the host facility where the site of the project will be located, will be presented with the details of the CIP. Normally, it can be expected that because a facility owner has agreed to proceed with the investment once the project is viable and the CIP is completed, the host facility will be ready to implement the project. Alternatively, the facility owner may prefer that a third party will pursue the cogeneration investment and implement the project. In this case, a promotional campaign will be undertaken to identify and encourage third party investors to implement the project. A summary brochure giving the salient features of the CIP shall be prepared for this purpose.

3.8 Select, support and implement FSPPs

The implementation of Full Scale Promotion Projects (FSPPs) is one of the major activities of the Cogen for Africa Project. This activity is expected to produce at least one FSPP in each participating country. The FSPPs, once completed and operational, will act as showcases for other biomass-producing facilities in the same or similar industries to implement the same technologies. Because of their technical reliability, economic benefits and positive environmental impact, the FSPPs aim to convince other potential developers to use modern, high-pressure and efficient biomass cogeneration equipment in meeting their energy needs in their facilities.

In order for the FSPP to be successfully implemented, supporting activities and services will be provided by the Africa Cogen Centre during its development and implementation stages. The major services to be provided to the FSPPs are:

- Assistance in selection of technology and equipment suppliers
- Advice in project management and supervision during construction and commissioning
- Advice in the design of O&M framework and training of operators
- Assistance in PPA formulation and seeking approval from authorities
- Assistance in funds mobilization and financial packaging to attain financial closure
- Assistance in accessing environmental and carbon finance support

The concept and mechanics of the FSPP is explained within Section 3.5.3.

3.9 Identify a pipeline of projects for replication

Some projects may not be mature or advanced enough in their development to become FSPPs. Such projects will be entered into the database and given the required support to advance to CIP and eventually FSPP status.

As it takes time and significant support for such projects to progress to the CIP stage, the Africa Cogen Center, will organize the required follow up meetings with decision makers, invite key stakeholders to training and capacity building workshops, organize site visits for interested investors, and offer project development and technical assistance that is required to move the project to CIP status.

3.10 Provide assistance and services to project developers for projects in the pipeline

Once a project in the pipeline has advanced to a level where the project developer decides to start the development of the project, services identical to the components of the CIP will be offered by the Cogen Centre. Once the CIP is completed, the project could become an FSPP if the developer agrees with the conditions, in which case, the standard FSPP services shall be made available to the project.

Outcome 4: *More favourable policies and institutional arrangements that support cogeneration promoted*

Outputs:

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 drafted and the stage set for approval

Activities:

4.8 Review and analyze existing policies and regulations, and recommend policy interventions and enhancements to support cogeneration

The seven countries involved have different level of policy development and implementation. At the initial stage of project implementation, a review of the policies and regulations affecting cogeneration as well as the effectiveness of their implementation will be conducted for the seven participating countries. The review will focus on:

- Legislations, programs and incentives promoting cogeneration and decentralized energy systems
- Legislations, programs and incentives promoting biomass and other renewables
- Legislations, programs and incentives regarding independent private generation, sales of excess electricity to the grid, and interconnection issues

After the review, the identified gaps will be analyzed and policy and regulatory options for promoting cogeneration identified. Finally, recommendations related to formulation of new policies, enhancements of existing policies, or improvement of implementation procedures will be provided.

4.9 Design and implement advocacy activities to influence policy reforms and implementation

Advocacy activities have important roles in creating awareness, effecting change and influencing decisions, especially in maters that require government intervention and action. The design of advocacy activities will aim to convince relevant government agencies to adopt and implement policies and support mechanisms favourable for the implementation of biomass cogeneration, through dialogues, fora and appropriate media channels.

4.10 Support policy makers and relevant agencies in policy formulation and enhancements

Once the need for policy formulation and enhancements is established and the policy makers agree to adopt some measures, the policy experts within the Cogen Centre will provide support to the policy makers particularly on the technical soundness of the policies and the experiences of other countries/regions in implementing certain polices.

Moreover, in many countries in the region, the issues related to permitting and consents for the construction and installation of projects such as biomass cogeneration are not clear and straightforward until one actually starts to process these permits. The extra effort invested to understand how the system works and go about the approval process from the different agencies increase transaction costs of developing projects, thereby increasing the overall project costs.

One of the barriers mentioned earlier which hinders developers from pursuing cogeneration investments is the high capital, development and transaction costs. If governments can structure their policies so that there is a centralized agency responsible for the planning, promotion, approval and monitoring of some specific project categories – say, biomass cogeneration, renewable energy and energy efficiency projects – the efforts and costs involved in developing and implementing projects could be substantially reduced, thereby helping in reducing the barriers related to high transaction costs.

4.11 Design and establish a one-stop information and service center within the Africa Cogen Centre

Currently, whenever a project developer has an intention to start a biomass cogeneration project, there are no institutions that provide complete services to guide and assist the developer in making the right investment decision, selecting the best and most appropriate technology and equipment, understanding and going through the permitting requirements, mobilizing and obtaining funds, and providing expertise during the construction, commissioning, operation and maintenance of the project.

Within the Africa Cogen Centre, a structure which will act as a one-stop information and service provider will be designed and established. Four small units with independent but interrelated functions will be set up. These units correspond to the main categories of the barriers experienced and identified in this sector, namely:

- *Project Development/Commercial Unit* – to take care of providing information, advice/service and capacity building support related to investment decisions, feasibility and viability of projects, project structuring and other project development issues. This unit will prepare the Project Development Guide for project developers of biomass cogeneration systems, prepare the Cogeneration Investment Packages with the support from other Units, and coordinate the selection and implementation of the Full Scale Promotion Projects, with the support and assistance from other Units.
- *Financing Unit* – to take care of providing information, advice/service and capacity building support related to financial analysis, financial structuring, funds mobilization, financial packaging, and evaluation/assessment of projects for financing institutions. The financing unit will design and develop the financial analysis tool to be used for advice and training purposes.
- *Policy Unit* – to take care of providing information and advice/service related to policies, support measures and incentives for cogeneration, and providing support to policy makers in policy formulation and enhancements. The unit will also design and implement the advocacy activities intended to influence policy reforms and execution.
- *Technical Unit* – to take care of providing information, advice/service and capacity building related to technical feasibility of projects, technology and equipment selection, construction, project management, operation and maintenance, and environmental aspects. This unit will develop technical software tools and also design and implement the matchmaking activities between foreign equipment suppliers and local manufacturers.

Further refinements of the scope and responsibilities of the different units should be done during the detailed elaboration of the Work Plan at the inception stage of the project implementation.

The above set-up will become the basis for future sustainability structure at the completion of the project. In order to test and prepare for the financial sustainability of the Africa Cogen Centre at project completion, at certain point in time during the project implementation, fees for the services to be provided by the different units shall be charged to the clients availing the services.

4.12 Develop a promotional strategy for the whole project, prepare promotional and other relevant materials and disseminate them to relevant stakeholders

A comprehensive promotional strategy will provide guidance and direction to the Africa Cogen Centre and the different constituent units of the one-stop information and service centre on the areas/activities to be promoted, the media channels to be used, the quality and quantity of the materials produced and dissemination methods.

This activity will entail preparation of information materials and, in turn, will support the different units in disseminating information. The preparation, write up and production of the promotional materials shall be prepared with inputs from the different experts and units concerned.

This activity will also design visibility actions to promote the funders and co-funders of the projects.

4.13 Develop a project website for internal and external audience and update continually

A website which will contain information for all parties involved will be developed and continually updated. The website will also contain all reports produced by the Project that are for public consumption. These reports and other supporting material will be made downloadable to interested parties.

The contents and use of website will support the promotional strategy that will be developed and described in Activity 4.5.

4.14 Assist utilities and relevant agencies to draft and set the stage for the approval of a Standard Power Purchase Agreements (PPAs)

Experiences in the region and elsewhere suggest that without a standard PPA that has a long term duration and reflects tariffs that make a biomass cogeneration project viable, there are no interested investors who will be willing to make capital intensive investments in projects such as biomass cogeneration that do not assure a long term off-take of electricity.

This activity will entail working closely with relevant government agencies and the utility to develop standard provisions of a Standard PPA and a consistent, transparent formula for calculating the feed-in tariff for sales of excess electricity from independently generated power using environmentally friendly sources such as biomass cogeneration. The aspect of selling electricity to third parties, through say, mini-grids for rural electrification will also be explored.

Assumptions and risks

The success of the Project hinges on certain assumptions that are external to the Project and yet have strong influence on the performance of its operations. Below are the major assumptions considered in the design of this Project:

- Recognition of the participating governments of the importance of reducing GHG emissions and their continuing commitment towards doing it
- Key stakeholders such as government agencies, project developers and financing institutions receptive to the support, training and services to be provided by the Africa Cogen Centre
- Existence of local manufacturers relevant for cogeneration and interested in establishing partnerships with foreign suppliers
- Availability of external funds for the African region
- Existence of potential cogeneration projects that could become Full Scale Promotion Projects and could fulfill eligibility criteria for accessing funds
- Cogeneration seen by commercial financing institution as a viable lending portfolio
- Operation of the industries where cogeneration is relevant remains viable
- Cost of kWh production below purchase price of utilities
- Off-taker of electricity remains reliable and financially viable
- Government continues to recognize renewable energy and energy efficiency as priority
- Stable political and economic situation
- The case and benefits of Standard PPA accepted by key stakeholders

The Cogen for Africa Project faces risks that are outside the control of the Implementing Agency and the Executing Agency of the Project. Table 3.2 lists the risks that the Project could face during its implementation, the level of these risks and the measures that have been taken during the preparation and design of the Project and/or will be taken during the implementation phase so that the risks will be mitigated.

Table 3.12: Project risks and their mitigation

Risk	Level of risk	Mitigation
Risk 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	Moderate	• Commitment from governments through endorsement letters • Stakeholders' meetings • Concept of the Cogen for Africa Project is in conformity with the policies and programs of the governments
Risk that key stakeholders are not willing to use the support and services to be provided by the Africa Cogen	Low	• Commitment letters from stakeholders • Individual discussions with many stakeholders during the project preparations phase

Centre		• Stakeholders' meetings to discuss needs and requirements of beneficiaries • Well-designed services and activities that cater to the needs of the stakeholders • Dissemination of Project information during preparation phase through the website; access by stakeholders to the website during project preparation
Risk that the Africa Cogen Centre will not have the competence to provide the required support and services to the stakeholders	Low	• Presence of skilled part-time International and Regional Consultants • Involvement of short-term international experts • Capacity building program for local/regional experts
Risk that funds from project developers/owners and financing institutions are not available for investments in cogeneration systems	Moderate	• Commitment letters from potential project developers/owners • Commitment letters from relevant financing institutions • Indications of interest and support during discussions and stakeholders' meetings
Risk that the available fuel resources for cogeneration will diminish in the medium to long term	Low	• Availability and adequacy established through statistics and initial survey • Use of residues from sustainable crops such as sugar cane which have existed for a very long time in the participating countries • Industries generating the residues to be used as fuel are relatively stable and progressive
Risk of technological failure with high pressure cogeneration systems	Low	• Use of high pressure cogeneration technologies are proven and are successfully operated in other regions • Availability of suppliers of cogeneration components in the global market well established

The development, financing, construction and operation of cogeneration projects has specific risks that need to be addressed if the project has to be implemented successfully. The key is to identify these risks and apply mechanisms to mitigate them and allocate the remaining risks to the parties most competent to manage them.

Table 3.13 gives the possible risks faced by cogeneration projects and the some ways that could be used in mitigating them and allocating them to the different parties involved.

Table 3.13: Risk allocation and mitigation matrix for cogeneration projects

Risk	Allocation							Mitigation
	Government	Sponsors	Project Company	Third Party Contractor***	Project Lenders	Insurers	Other guarantee providers	
1. Political/Country								• Political risk insurance from Export Credit Agency (ECA) or multilateral development agencies
Change in law			✓					
Development/permitting issues	✓	✓	✓					
Adverse govt. action/inaction	✓	✓	✓			✓	✓	• Regulatory framework supporting cogeneration and renewable energy projects
Corporate taxation			✓					
Expropriation			✓			✓	✓	• Board of Investment (BOI) privileges for green projects
Political force majeure events	✓					✓	✓	
2. Sponsor								• Sponsors to provide equity and pre-completion guarantee
Competence and reliability		✓						
Equity at risk		✓						• Experience in supporting renewable energy projects
Pre-completion guarantees		✓					✓	
3. Construction								• Fixed-price turnkey (EPC) contract with provision for liquidated damages
Cost over-runs			✓	✓	✓		✓	
Timeliness and quality			✓	✓				• Construction time insurance
Contractor default			✓	✓			✓	• Choice of reputable contractors
Default by project development company			✓	✓				
Work changes and variations				✓	✓			
Increase in financing costs		✓	✓		✓			
Environmental damage	✓		✓			✓		
Force majeure						✓	✓	
4. Technical/technology								• Use of proven technology
Reliability of process and equipment		✓		✓			✓	• Turnkey supplier with good operating references from similar plant configuration
Technological failure		✓		✓				
Failure to meet performance/specifications		✓		✓			✓	• Performance guarantees
Accidents during construction						✓	✓	• Liquidated damages
5. Environmental								• EIA from reputable institution
Environmental impact assessment (EIA)		✓	✓					• Implementable operational environmental plan
Operational environmental management			✓	✓				• Awareness campaign

Risk	Allocation							Mitigation
	Government	Sponsors	Project Company	Third Party Contractor***	Project Lenders	Insurers	Other guarantee providers	
6. Fuel								• Fuel supply availability study • Long-term fuel supply contract • Storage during lean season • Use of appropriate secondary fuel
Supply availability			✓	✓				
Price and future escalation			✓	✓				
Competing usage			✓	✓				
7. Financial/Legal								• Power Purchase Agreement (PPA) from national grid including provision for foreign exchange and fuel price fluctuation • Equity from sponsors • Fixed rate loans • Hedging mechanisms such as interest swaps • Joint venture/shareholders agreement
Inflation	✓	✓	✓		✓			
Interest rate	✓	✓	✓		✓	✓		
Foreign currency exchange rate	✓	✓	✓	✓	✓	✓		
Ownership of assets			✓					
Security structure			✓		✓			
Insolvency of company		✓	✓		✓			
Breach of financing documents		✓	✓		✓			
Enforceability of security	✓		✓		✓			
8. Operation								• Hiring of competent Operation and Maintenance (O&M) contractor • Sound O&M contract • Insurance during operating life of project
Company default		✓					✓	
Performance of O&M contractor			✓	✓				
Environmental damage			✓			✓		
Force majeure event			✓			✓		
Change in law			✓	✓				
Labor problems and disturbances			✓					
9. Market and Revenue								• Long-term PPA from reliable off-takers • Established scheme for sales of power to the national grid
Insufficient income			✓		✓			
Off-taker default			✓	✓			✓	
Insufficient demand		✓	✓		✓			

Source: Gonzales, A.D., 2001

*** Includes equipment supplier, fuel supplier and O&M contractor

Logical framework

The logical framework is provided in Annex B.

Schedule and milestones

The schedule and milestones for the Project implementation are reflected in the detailed work plan which is attached in Annex I.

3.6 Sustainability (Including Financial Sustainability)

A major aspect of the Project is geared toward the transformation of the cogeneration market into a sustainable and profitable industry. The main actor in this endeavour is the private sector who will develop and own the projects and provide a major portion of the required financing to implement them. Thus, the commercial orientation of the cogeneration projects is expected to enhance the sustainability of the Project.

Once it is shown through concrete examples (via the Full Scale Promotion Projects, for instance) that high pressure cogeneration systems are viable alternatives to the existing arrangements of continuing with the use of inefficient systems, and other barriers related to their implementation and adoption are removed, it is expected that the market mechanism will allow more investments to take place.

Discussions with financing institutions in the African region have given an indication that enough funds and liquidity are available for projects that can show evidence of viability and provide the proper security arrangements.

The initiative by Triodos Bank to create the "Clean Energy for Agro-Industries in Africa" (CEFA – see Annex X) specifically to participate in the financing of the potential projects to be developed and implemented within the framework of the Cogen for Africa Project and another project being developed by UNEP/DGEF for small hydropower plants in the tea industry, is expected to ensure the financial sustainability of the cogeneration industry.

The design of the Cogen for Africa Project also ensures that institutions are established to support the requirements of cogeneration project developers for information, expertise and services even after the completion of the Project. For this, a cogeneration center of excellence to be called the Africa Cogen Centre will be established. As explained earlier, the Africa Cogen Centre will provide services free-of-charge at the initial phase of the Project implementation but will gradually charge its services towards the end of the Project completion to prepare for the sustainability of the institution. It is expected that the Africa Cogen Centre will spin-off into a self-sustaining institution to provide a one-stop service facility to the stakeholders in the cogeneration industry. The detailed mechanics of the future organizational, business and financial sustainability of the Africa Cogen Centre will be studied and documented comprehensively in a Business Plan that will be conducted during the Project implementation.

> The concept of transforming a donor-funded project into a self-sustaining entity has been proven to work successfully in the case of the Cogen Programme in Asia. When the EC-ASEAN COGEN Programme ended at the end of 2004, two institutions were spun-off. The AIT* Cogen Center, which carries on the tasks related to the conduct of studies, researches, training and capacity building related to cogeneration, among others; and Full Advantage, a regional network of cogeneration experts, which provides advisory and consultancy services to the cogeneration industry in Asia.
>
> *(*The Asian Institute of Technology (AIT), based in Bangkok, Thailand was the host and Implementing Agency of the EC-ASEAN COGEN Programme during 1990-2004)*

To support the Africa Cogen Centre on the country level are the National Cogen Offices which will directly work with and through the industries and industrial associations in the respective countries. They will also liaise and coordinate with relevant government agencies for the activities of the Project related to policy aspects. As they develop capacity and experience, these institutions are expected to carry on with the provision of support and services to the cogeneration industry in their respective countries.

As the enabling environment through proper and attractive policies that support and encourage investments in efficient cogeneration systems is important in creating a sustainable cogeneration industry, the Project will provide institutional support for policy formulation as one of its activities. The long-term objective is that ultimately, governments of the countries participating in this Project would implement policies and regulations that support cogeneration and the sales of excess power from cogeneration systems at favourable conditions. The existence of a Standard Power Purchase Agreement would ensure long-term viability and sustainability of the projects.

The end-result that can be expected from the interventions of the Project will be an outfit that will continue to promote and realize new Cogen facilities in the participating countries beyond the set target of 200 MW and possibly in other nations of the African region, at no further cost to the GEF.

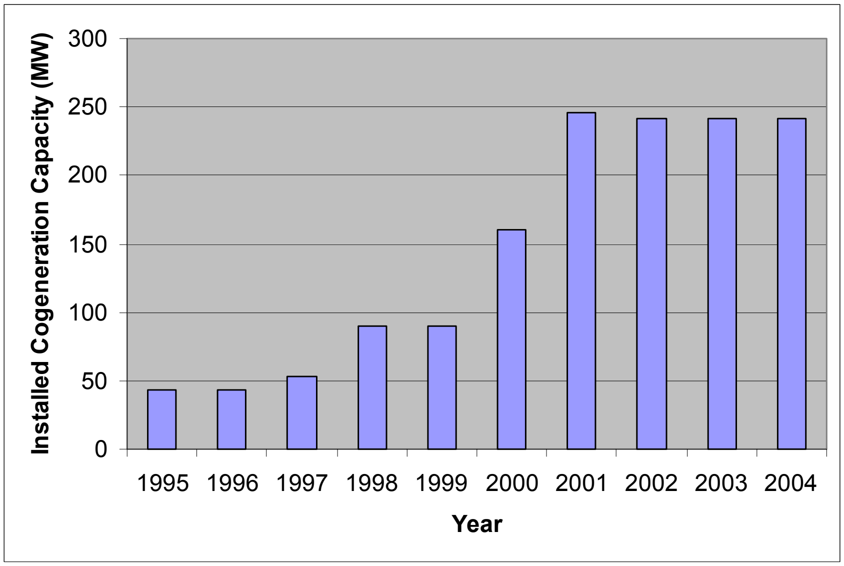
3.7 Replicability

In concept, the proposed Cogen for Africa Project itself is a replication of activities successfully implemented in the Far East. It is anticipated that cogeneration will not only be relevant for the countries that will participate in the proposed Project, but will be relevant for all African nations. The proposed mid-term review could allow additional countries to participate in the second half of the Project, if budget and conditions allow. A francophone replication or Project extension could be initiated for Western Africa as soon as positive signs of Project success become visible. Replication is likely to take place if the right policy environment exists. By including AFREPREN/FWD as the host of the proposed program, it is envisaged that Cogen experiences and successes will be disseminated to all nations that are part of the AFREPREN/FWD network, thus creating interest and a receptive climate for cogeneration in additional countries. The circulation of AFREPREN/FWD communications through its network plus the physical presence of the network in all energy sector-related activities in the region will warrant an effective dissemination of information and experiences.

The proposed GEF intervention for the Cogen for Africa Project realization is necessary to scale up cogeneration development in Africa, subsequently paving the way for many more Cogen projects to be realized without further Cogen Project intervention. Whereas the proposed Cogen for Africa Project should initially concentrate on industries and fuels with the highest potential in the region such as the sugar industry, the Project will explore other fuels and industries with additional Cogen potential and design and implement appropriate interventions.

The implementation of Full Scale Promotion Projects (FSPPs) or an expected total installed cogeneration capacity of 40 MW together with supporting activities on the capacity building, advisory, financing, institutional and policy aspects are expected to encourage project developers to replicate these FSPPs in other factories, sectors and even countries. Additional 20 MW of direct post-project replication and another 180 MW of indirect replication are expected to be implemented within 5 to 10 years after the project completion. It must be noted that the potential for high-pressure cogeneration in the sugar industry alone in the seven participating countries is over 500 MW of additional capacity. In comparison, the Cogen Programme in Asia has directly supported more than 150 MW of cogeneration capacity and has stimulated investments in other cogeneration investments for a total of about 600 MW. In Mauritius, the replication of cogeneration systems in the sugar industry over a period of 20 years has resulted in an additional 200 MW of cogeneration capacity (see graph in Figure 3.12).

Figure 3.12: Growth of cogeneration capacity in Mauritius



3.8 Global environmental benefits of the project

The main fuel that has been identified in the participating countries for the cogeneration systems to be promoted is biomass. It has been acknowledged that for cogeneration plants using biomass as fuel, there is no net CO_2 emission resulting from biomass combustion in the boiler. This is because biomass is considered as CO_2 neutral. When the plant grows, it absorbs CO_2 from the atmosphere. When the biomass is combusted in the boiler, it emits the same amount of CO_2 it absorbed during the plant's growth.

The expected additional cogeneration plants that will be implemented within the Project duration will be hosted by the industries which are generating biomass residues from their processes. Most of these industries have existing systems producing power and steam for their factories using these biomass residues as fuel, although these systems are inefficient and outmoded. Thus, the CO_2 emission reduction will only be calculated on the additional cogeneration capacities that will be implemented over and above the existing plants. The steam generation for process application before and after implementing the new cogeneration system is the same.

The emission mitigation potential of the biomass cogeneration system in this context is the difference in emissions from the cogeneration plant compared to the alternative supply of electricity to be replaced by the cogeneration system, called the baseline.

The following table shows the methodology to be used for calculating the greenhouse gas (GHG), mainly CO_2, mitigation potential.

Table 3.14: Methodology for emission mitigation potential

Cogeneration emission (A)	Baseline emission (B)	Emission mitigation potential
CO2 emissions from biomass boiler	CO2 emissions from alternative source to be replaced	B - A

Since the CO_2 emission from a biomass boiler used in cogeneration is zero, therefore:

CO_2 emission mitigation potential = emissions from alternative source of electricity replaced

It was shown in the previous sections that based on the existing power supply, current trends and/or Power Development Plans of the participating countries, it can be assumed that the cogeneration plants will replace the thermal power plants using diesel and coal as fuel. Taking the more conservative figure of the emission factor for diesel (instead of coal) which is 0.8 ton CO_2 /MWh, the direct project, direct post-project and indirect project emission mitigation potential are calculated below. If the actual replacements are made for coal thermal plants, the CO_2 mitigation will be higher.

Direct Project-related emission mitigation potential

The Project has a target to implement an additional cogeneration capacity of 40 MW as Full Scale Promotion Projects (FSPPs) during its 6-year duration. Considering a lifetime of 20 years for the cogeneration equipment, the yearly and accumulated lifetime CO_2 emission for replacement of either diesel thermal power plants are given in Table 3.15.

Table 3.15: CO_2 emission mitigation potential for 40 MW installed capacity (direct project-related)

Description	Replacing diesel (Emission factor = 0.80 ton CO_2 /MWh	
	Annual*	Lifetime (20 years)
MWh of electricity generated	204,000	4,080,000
Tons CO_2 emission abated	163,200	3,264,000

* Operating at an average of 6,000 hours and load capacity factor of 0.85.

Direct post-project emission mitigation potential

Other than the FSPPs, another 20 MW of projects would have been directly supported by the Project through technical, financial and regulatory advice/services and have reached implementation stage or an advance stage of project development at the end of the Cogen for Africa Project implementation. As these projects may only be completed after the Project duration, their emission mitigation potential are reckoned as direct post-project and are quantified as follows:

Table 3.16: CO_2 emission mitigation potential for the direct post-project installation of 20 MW installed capacity

Description	Replacing diesel (Emission factor = 0.80 ton CO_2 /MWh	
	Annual*	Lifetime (20 years)
MWh of electricity generated	81,600	1,632,000
Tons CO_2 emission abated	65,280	1,305,600

* Operating at an average of 6,000 hours and load capacity factor of 0.85. A factor of 0.8 is further applied to account for other forces influencing the replication process.

Indirect (project replication) emission mitigation potential

Based on the assessment of the potential reflected in Table 1.4, the implementation of FSPPs and the supporting activities provided by the Africa Cogen Centre are expected to stimulate further investments in cogeneration projects of up to 200 MW. This includes the 20 MW considered as direct post-project replication and explained in the previous section. A small portion may already start to happen during the Project implementation , but a significant portion of this quantity is expected to be realized beyond the duration of the Project. The potential CO_2 emission reduction of the remaining 180 MW is given in Table 3.17.

Table 3.17: CO_2 emission mitigation potential for 180 MW installed capacity (indirect project-replicated)

Description	Replacing diesel (Emission factor = 0.80 ton CO_2/MWh	
	Annual*	Lifetime (20 years)
MWh of electricity generated	734,400	14,688,000
Tons CO_2 emission abated	587,520	11,750,400

* Operating at an average of 6,000 hours and load capacity factor of 0.85. A factor of 0.8 is further applied to account for other forces influencing the replication process.

Local environmental benefits

The use of inefficient cogeneration systems using biomass could produce particulates and other harmful substances such as dioxins and furans that could go with the fly ash and affect the local inhabitants near the cogeneration plant. These normally occur due to factors such as: incomplete combustion of biomass, unregulated excess air in the furnace, and the reaction that happens due to the presence of chlorine in the bagasse, presumably from the washing process of the bagasse in brackish water.

The prevention of particulates and harmful substances in cogeneration systems largely depends on the design of the boiler, particularly by good combustion and effective dust collection by Electrostatic Precipitator or Bag Filter. If a bag filter is used, this presents an opportunity to remove the dioxins and furans very effectively with active carbon injection.

To prevent dioxin formation in the furnace, the furnace must have a residence time at a consistent temperature of 850^0C above the last injection of secondary air. If the furnace does not have a consistent temperature profile, insufficient residence time, poor mixing or other combustion deficiencies, then dioxin will be formed in the furnace.

Old bagasse boilers also tend to hold flyash in the boiler rear passes in areas such as the bottom drum, or anywhere else that the flyash collects. This static flyash often coated with carbon compounds may rest in an area of the boiler lower than ~ 300^0C where the Denovo effect operates. This tends to form or reform dioxins and furans if the precursors are present and there is sufficient residence time to effect the reformation. The dioxins tend to stay on the particulate and during soot-blowing will be passed out of the boiler usually attached to the flyash.

Modern and efficient cogeneration systems to be promoted in this Project are well designed and are fitted with good air/dust cleaning systems that by implementing these measures, harmful substances present in existing inefficient systems would be avoided.

3.9 Incremental costs

The Projects' overall cost is 67,486,088 USD. Without the implementation of the Project, there would be some baseline activities estimated to cost 10,350,000 USD. The incremental activities will be funded from different sources, of which GEF is requested to finance 6,032,488 USD. The details of the incremental costs and the corresponding sources of financing are presented in the Incremental Cost Matrix in Annex A.

3.10 Monitoring and Evaluation

The Monitoring and Evaluation (M&E – Annex F) will be an important element in the design for the successful operation of the Project. Built into the Project's operations are activities and reporting mechanisms that allow regular and transparent monitoring of the different aspects of the Project implementation.

At the start of the Project, a Project Implementation Manual (PIM) will be prepared. The PIM will detail the administrative, financial and reporting policies of the Project which will guide the actions of every person involved in the execution of the Project.

The Project will also procure or commission the development of a Financial and Management Information System (FMIS) which will act as an integrated tool for financial management and reporting, resource data tracking; monitoring and control of expenditures, etc. The FMIS will ensure up-to-the-minute access to the Project's financial and resource information by the Africa Cogen Centre Director and the Implementing Agency, whenever necessary. It will also ensure a well-designed and transparent financial reporting mechanism to the Implementing Agency.

The following Table shows the M&E plan of the Project.

Table 3.18: 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 & After 6 years (final audit)	Auditing of accounts and financial management; use of international accounting standards	External auditor	IA
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	ExA	PSC

		implementation arrangements; recommendation on adaptive measures; extensive and transparent consultation with all key stakeholder groups		
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

4. FINANCIAL MODALITY AND COST EFFECTIVENESS

4.1 Financing Plan

4.1.1 Financing mechanisms for cogeneration projects

As the bulk of the financing of the individual cogeneration projects is expected to come from the private sector, it would be best to describe this section by explaining the existing mechanisms used in the financing of these projects.

Typically, a cogeneration energy project can be financed using the following three major financing routes:

- Self-financing

Self-financing means that the company uses its own internal funds to finance the investment. Usually, this will come from the retained earnings or from existing cash reserves. Where a project is being developed by individuals or a small/new company without reserves, it may be necessary to raise funds from private entities/individuals, either to provide equity or to fund the whole project. For example, because of the high costs of borrowing in Uganda (interest rate of up to 20 % p.a.), the Sugar Corporation of Uganda Limited has recently purchased a 6 MW steam turbo-generator using its own funds.

Normally, however, since the cost of equity is higher than the cost of debt, self-financing is not the most efficient route to finance a project, except for some circumstances where it is not attractive to leverage the project, or when the project is small enough for the company to pay for the whole project cost from its own funds. Usually, the investments in cogeneration projects are too huge for investors to use their own funds alone in building the plant. Moreover, industries like the sugar industry in the African region are experiencing low liquidity because of the low price of sugar in the world market while incurring high production cost.

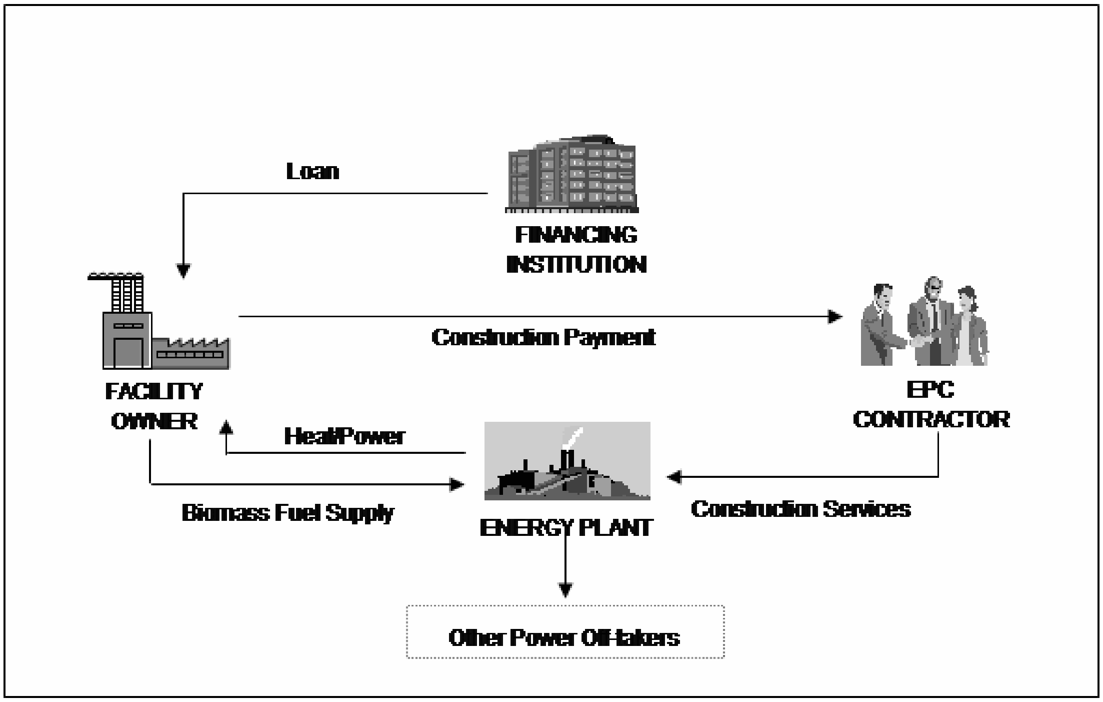
- On-balance sheet (corporate finance)

On-balance sheet finance is generally the simplest means of raising finance. However, it is likely to be used only by strong corporate sponsors. Although corporate finance can be raised by the issuance of shares or bonds or internal reserves, in most cases it involves raising debt based on the full corporate strength of the borrower at a price that reflects the corporate creditworthiness.

Corporate loans are generally easy to arrange if the borrower is considered creditworthy, but repayment periods are short, normally less than ten years. The structure of the project and the project risk profile would not influence the price of the loan as the corporate borrower accepts all the project risks. The arrangement fees and interest margins over base rate will vary considerably depending on the standing of the borrower.

Figure 4.1 illustrates an on-balance sheet financing model for a small biomass energy project.

Figure 4.1: On-balance sheet financing model: Facility owner-operated and financed



- Project finance basis

Project finance is a means of raising the funds required for a capital investment project wherein the providers of equity rely primarily on the cash flow of the project for the return on their investment, and the providers of debt for the payment of interest and repayment of the principal borrowed by the project.

Projects using the project finance route are developed by borrowing funds based on the creditworthiness of the project alone rather than of the sponsor. All project assets such as the plant hardware and the equity shareholding, would be pledged in support of the loan, as a security in the event of default. As the loan is not borrowed directly by the sponsor of the project, this transaction is not recorded on the balance sheet of the sponsor. Figure 4.2 illustrates the relationships among some project participants and the flow of funds among them.

Experience in the implementation of small-scale renewable energy projects in other regions shows that using the project finance route for these types of projects is difficult to arrange.[13] Lenders normally perceive renewable energy projects to have high risks and thus require very stringent security arrangements. This often requires the project sponsors to borrow on their balance sheet, or to provide corporate (sometimes personal) guarantees. However, experiences in other regions have shown that there are two ways where energy efficiency or renewable energy projects can attain off-balance sheet financing:

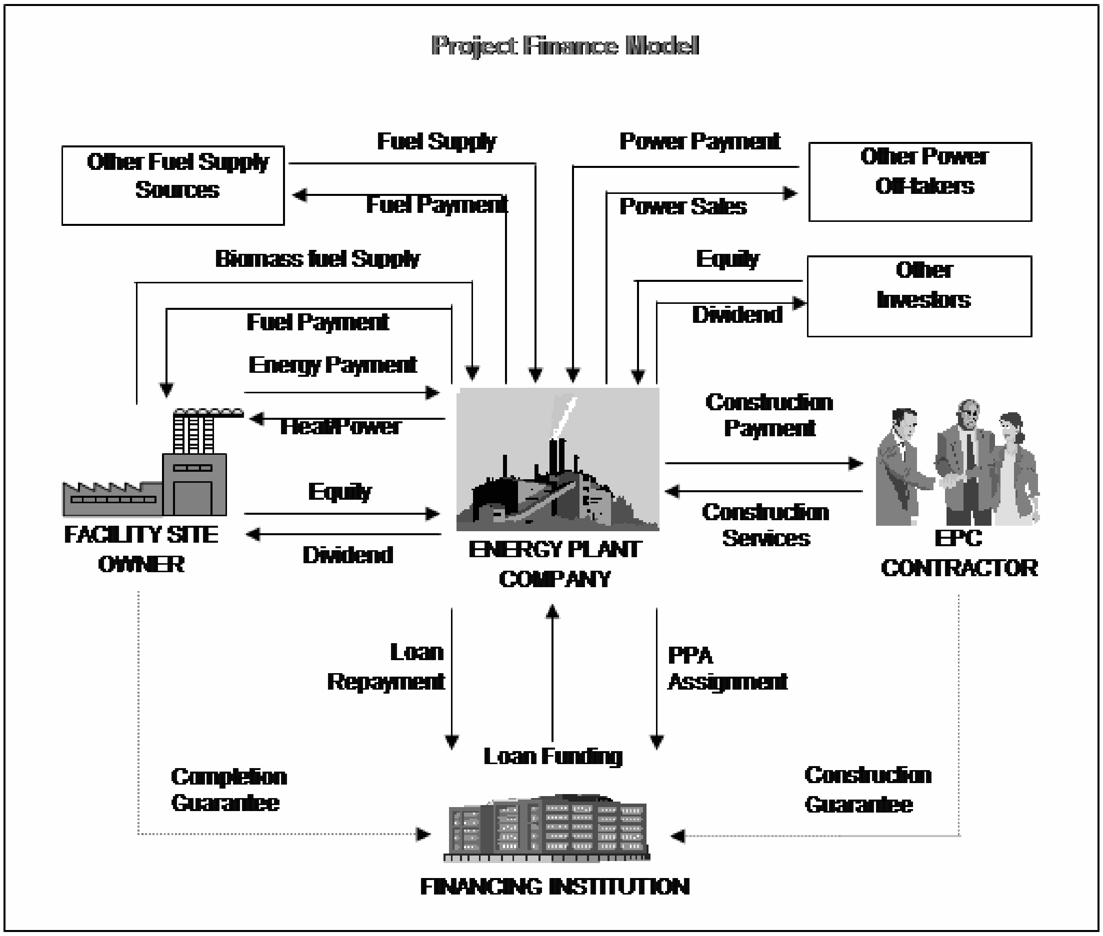
a) set up a Special Purpose Company (SPC) that would hold the assets related to the cogeneration project but this would require the shareholders put in the SPC a level of equity deemed sufficient by the financial institutions in addition to providing a certain percentage of funding to the project;

b) finance through a third party financing company or an Energy Service Company (ESCO).

[13] The EC-ASEAN COGEN Programme supported 14 industrial-scale biomass energy projects in South East Asia between 1993-1999. All of the projects have been financed on the balance sheet of the companies. During the Phase III of the Programme (2002-2004), some of the 8 projects implemented have been financed using the Project Finance route.

The Africa Cogen Centre, through the services of its international financing expert will assist and guide project developers in applying such structures, whenever applicable, within the context of the targeted countries.

Figure 4.2: Project finance model: Financing directly to project



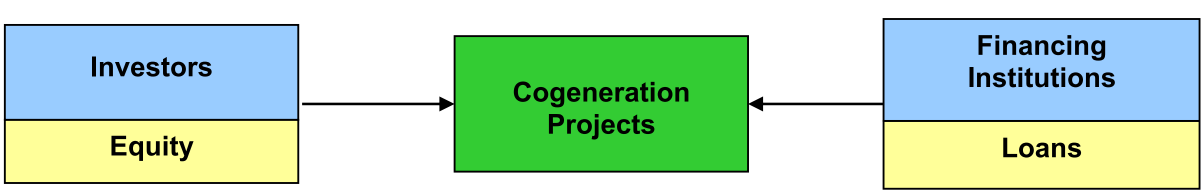
In the current conventional arrangements, the major parties involved in the financing of the projects are:

a) The investors/shareholders of the project who provide the equity in the form of cash, land, and other development expenses. In the African region, this ranges from 35 % to 50 % of the project cost.

b) The financing institutions/lenders who provide for the remaining portion of the project cost typically in the form of a commercial loan. As a security for the loan, collaterals and other forms of guarantees will be required by the financing institutions from the investors.

This conventional financing structure is illustrated in Figure 4.3:

Figure 4.3: Conventional financing participants



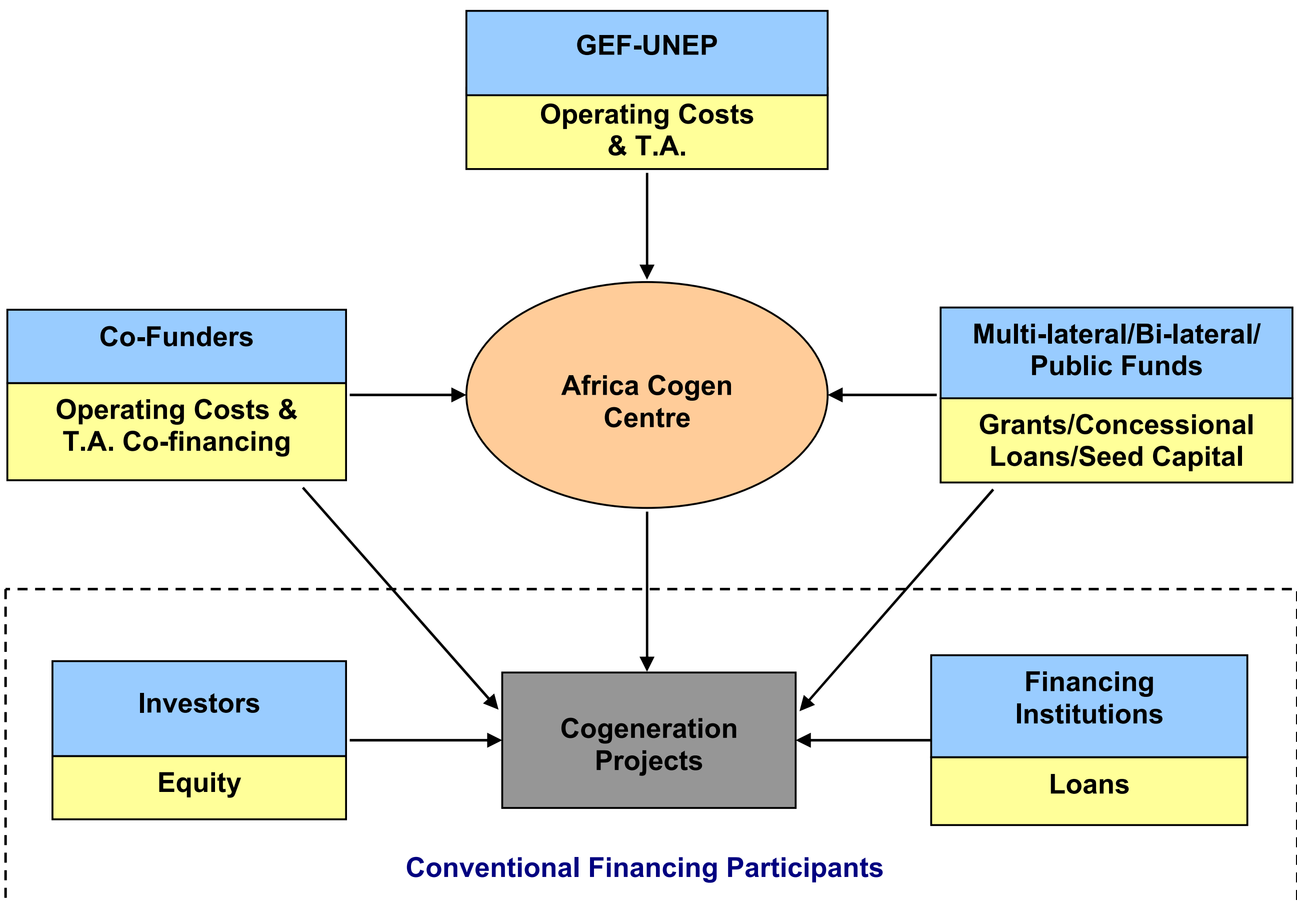
Because of the financing and other barriers mentioned in an earlier section, the growth of biomass cogeneration investments through conventional means is much lower than what could be potentially achieved.

The capital markets in most countries in Africa are still at an early stage of development. Although there are apparent endeavours to promote their efficient growth, such endeavours seem to lag behind other development priorities.

According to recent statements from East African Development Bank (EADB) officials the underlying financial sector lacks depth as it is characterised by dominance of commercial banks that tend to focus on the provision of debt of short term maturities and extremely low savings relative to other low income countries, implying that domestic investments rely extensively on foreign savings, thereby constraining growth potential.[14]

The Cogen for Africa project intends to support the project developers/owners in mobilizing funds at terms that are favourable to the projects to reduce financing constraints by implementing an innovative structure which will stimulate investments through institutional, technical and financial support to investors and financing institutions. This structure is illustrated in the figure below:

Figure 4.4: Innovative structure to stimulate investments in biomass cogeneration



TA – Technical Assistance

[14] Daily Monitor, Uganda, 23 January 2006

4.1.2 Structure of financing requirements

As illustrated in the figure above, there are two major financing requirements that the Cogen for Africa Project needs in order for it to operate successfully. These are:

A. Funds for the operating costs of the Africa Cogen Centre and for Technical Assistance;

B. Investment Funds for the FSPP and other cogeneration projects.

Operating costs and Technical Assistance

As mentioned earlier, a regional Cogen Centre to be based in one of the participating countries will be established. This will be staffed by international, regional and local experts who have experience and expertise in providing financial, technical, institutional and policy support to biomass cogeneration and similar projects (details of the management and organization of the Cogen Centre are given in Section 3.5.3). Funds for Technical Assistance will be required to hire these experts who will provide technical assistance activities and services to the different stakeholders in the Project. Furthermore, the Project will need funds to cover for the operating costs such as salaries of supporting staff who will assist in the day-to-day operations of the Project, remuneration and operating expenses of the Cogen Country Offices, travels and per diem, local transportation, equipment and office supplies, etc. The details of the budgetary requirements are provided in Section 4.1.3.

The sources of these funds are expected to come from:

- Global Environment Facility (to cover for the incremental costs)
- International co-funding agencies
- National governments and public funds of the participating countries in Africa

The details and commitments of the co-financing sources are given in Section 4.3.

Funds for cogeneration projects

As described earlier, the developers of cogeneration projects normally need to put up an equity from its own funds as investment in the project. The equity is normally spent towards the development costs and part of the equipment and construction costs of the project. In this region, for this type and scale of projects, the equity that is usually required is between 35 % to 50 % of the total project costs.

The remaining portion of the total project costs is expected to come wholly or partially from commercial loans to be provided by local and international financing institutions. Initial discussions with several relevant institutions providing this type of financing indicated that viable cogeneration projects with attractive fundamentals and sound security arrangements are high in their list of projects qualified for funding. The Uganda Country Office of the African Development Bank (AfDB), a regional development bank for the African region has indicated that since cogeneration projects are implemented by the private sector, financing these projects are in line with the bank's commitment to expand their support to the private sector, hence, they are within the priority of the AfDB. The bank is also willing to provide specialized credit lines to qualified intermediaries for cogeneration and small hydro projects and to fund up to 1/3 of the project costs.

The East African Development Bank (EADB), a development bank covering the three countries of Kenya, Tanzania and Uganda, has a wide range of financial resources including locally raised funds from Corporate Bonds as well as credit lines from larger financing institutions such as the African Development Bank; DBSA (South Africa); FMO (Netherlands); and, DEG (Germany). According to the EADB representatives, the bank's strong features include flexibility and longer repayment periods of up to 14 years. Furthermore, EADB has had an experience in funding a cogeneration project, the Kakira Sugar Works cogeneration system.

The German DEG which is the subsidiary of KfW supporting the private sector, had already been approached by project developers and sugar companies regarding their financing needs for new projects such as cogeneration. DEG could participate as an equity provider or lender, depending on the needs of the clients and the organization's assessment of the project. DEG indicated that it is possible for them to participate on a Project Finance basis.

The South African-based regional banks such as the Amalgamated Bank of South Africa (ABSA), Standard Bank, and the Development Bank of South Africa (DBSA), all have indicated interest in funding the non-equity portion of the qualified cogeneration projects that will be developed with the support of the Cogen for Africa Project. Even banks in Mauritius that have funded Cogen projects and are familiar in evaluating them could be approached for funding.

However, since the capital market in the participating countries is not very well developed, in some circumstances loans from commercial sources could be limited, expensive and require heavy collateral and security arrangements. To reduce the costs of financing from commercial sources and the burden of more rigorous security arrangements, concessional sources of funds and appropriate flexible financing mechanisms will be sought out and arranged for the projects. The Africa Cogen Centre, as part of its Technical Assistance activities, will work closely with projects developers in liaison with the banks to develop bankable proposals and meeting the banks procedures and eligibility criteria and will provide services to structure and package the projects and bring them into financial closure at terms and conditions that are favourable for, and meet the financial objectives of, the projects.

There are different financing schemes that could be tapped (or created) for cogeneration projects. Table 4.1 provides an indication of the different types of financing mechanisms that could be tapped for cogeneration projects as a function of their sizes.

Table 4.1: Ranges of cogeneration projects and possible financing mechanisms

System	Scope/Feature	Financing mechanisms/schemes
Small-Scale/ Off-Grid/Captive	▪ Small size cogeneration systems (< 1 MWe) ▪ Developers possibly no/weak track record and no/have difficulty to provide collateral ▪ Possible sectors: small agro-processing industries such as rice, coffee, …	Should develop and/or adopt financial mechanisms to cascade affordable financing to the end-users, and seek assistance for institutional, infrastructure and capacity building. Applicable schemes include: ▪ Self-financing ▪ On-balance sheet ▪ Micro-credit ▪ Grant/subsidy ▪ Specialized/green funds ▪ Seed capital ▪ Renewable Energy Service Company (RESCO) ▪ Leasing ▪ Financial incentives ▪ Supplier's credit ▪ Dealer's credit ▪ Financial bundling ▪ Concessional/soft loans
Medium-Scale/ Isolated-Grid/ Grid-Connected	▪ Cogeneration systems in the range of 1-15 MWe ▪ Facility-owned or third party developer ▪ Developers with some track record and possibly adequate collateral	Should adopt flexible and less conventional mechanisms, while exploiting the benefits of financing schemes applied to conventional energy. Applicable schemes include: ▪ On-balance sheet ▪ Equity financing (private/public)

	▪ Possible sectors: sugar, rice, wood processing	▪ Venture capital ▪ Project finance (limited recourse) ▪ Corporate guarantee ▪ Grant/subsidy ▪ Specialized/green funds ▪ Seed capital ▪ RESCO ▪ Leasing ▪ Supplier's credit ▪ Financial bundling ▪ Concessional/soft loans
Large-Scale/ Grid Connected	▪ Cogeneration systems with capacity greater than 15 MWe ▪ Special Purpose Company or facility-owned ▪ Developers with proven track record and known risk ▪ Possible sectors: sugar, pulp & paper and other industries ▪ Fuel: biomass, natural gas, coal	Should operate within the same financing rules applied to conventional energy projects. Applicable schemes include: ▪ Project finance (limited/non-recourse) ▪ Venture capital ▪ Multilateral agency lending ▪ Export Credit Agencies ▪ Political risk guarantee ▪ Bonds issuance ▪ Supplier's credit ▪ Public debt ▪ Concessional/soft loans

Currently, a specialized Fund is being set up by Triodos Bank of the Netherlands with the particular aim of participating in the financing of cogeneration and small hydro projects that will be developed during the implementation phase of the Cogen for Africa Project and another project being proposed for GEF funding, the "Greening of Tea Industry in East Africa" Project. The Fund, to be called the "Clean Energy for Agro-Industries in Africa" (CEFA – see Annex X) will focus on the pipeline of bankable projects that will be screened and assisted by the two Projects.

The principal sponsor of CEFA is the Triodos Renewable Energy for Development Fund (TRED Fund) which is an investment vehicle managed by the Triodos Bank (headquartered in Netherlands). TRED Fund is funded by the Dutch Ministry of Foreign Affairs, the World Bank and Hivos Foundation, among others.

TRED Fund strategy comprises:

- 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 TRED Fund proposes to sponsor the establishment of CEFA.

Triodos Bank, being the principal promoter for CEFA will provide:

- Seed capitalisation of the Fund
- Fund set-up expertise
- Fund-raising leadership

Triodos has confirmed willingness to commit a seed money of about 2 mil. USD and leverage it to bring in other participants to the Fund The Fund aims to have an initial amount of 20 mil. USD, but could be expanded once the demand is established. The features and modalities of the Fund will be included in the next draft.

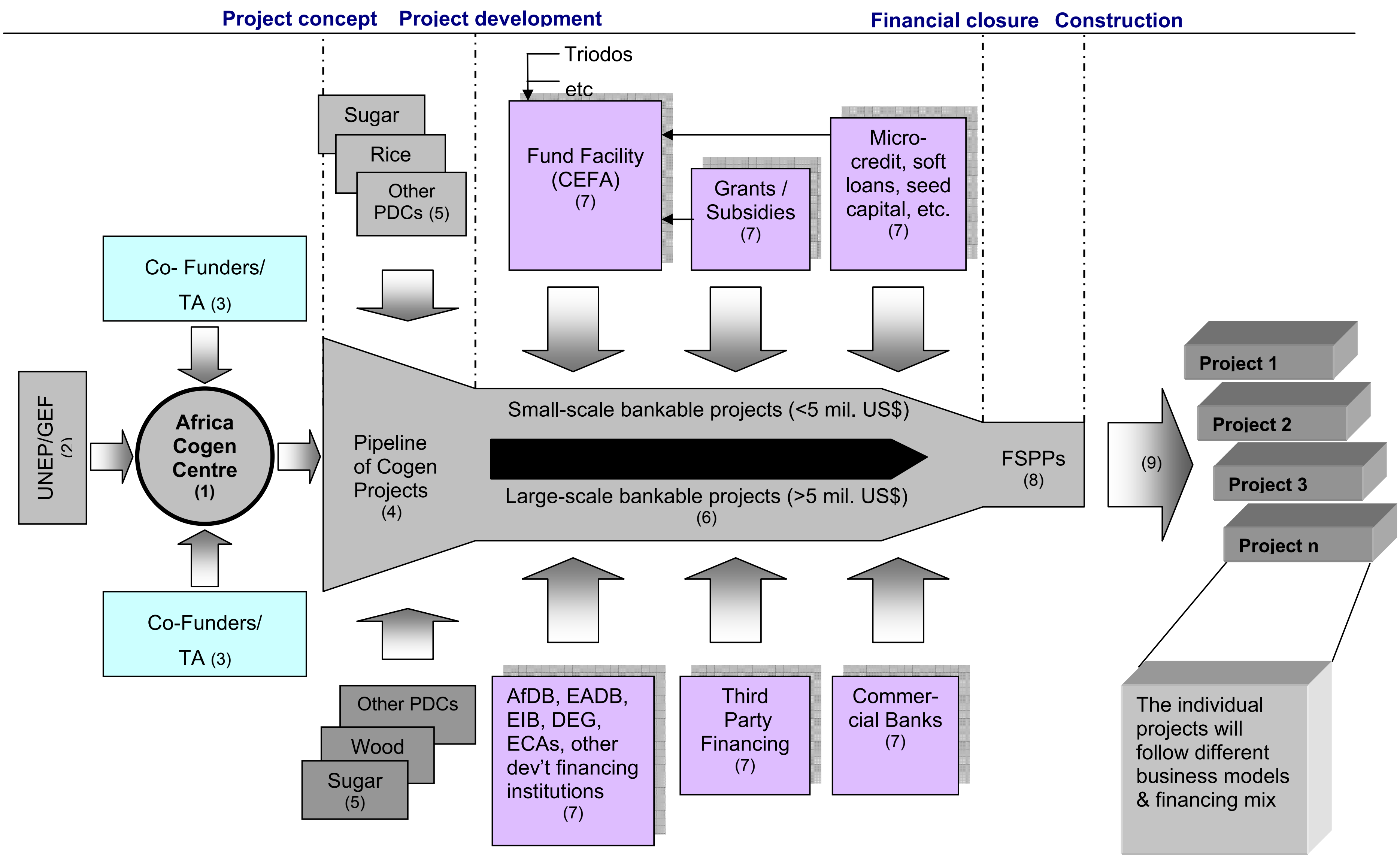
The different financing sources and their potential participation in the Cogen for Africa Project and the individual cogeneration projects in relation to the project development continuum are illustrated in Figure 4.5. The numbers in the figure refer to the explanations in the following paragraphs.

The Operating and Technical Assistance costs of the Africa Cogen Centre (1) are expected to be provided by the GEF (2) and potentially by other co-funders (3).

One of the activities of the Africa Cogen Centre is to identify potential cogeneration projects in the industries that generate their own biomass residues which can be used as fuel. This pipeline of cogeneration projects (4) will be assisted by the experts in the Africa Cogen Centre through the conduct of Pre-Feasibility/Feasibility Studies, project structuring, and other forms of advice and services. The services to be provided by the Africa Cogen Centre for each project will be valued in monetary terms. During the first few years of the Cogen for Africa Project implementation, the services of the Africa Cogen Centre will be provided for free, while the costs incurred outside these services will be covered by the Project Development Companies (5) or by the project owners in the different industrial sectors. Towards the middle and end of the 6-year Project implementation, the Project Development Companies will be required to pay a portion of the value of the services provided by the Africa Cogen Centre. The percentage of the contribution by the Project Development Companies will gradually increase to 100 % at the completion of the Cogen for Africa Project as part of the plan for the Project's sustainability.

At this stage of project concept formulation and preparation, it is expected that some cogeneration projects will progress to a stage where more advanced project development efforts are required, while others will need further investigations or stimuli before proceeding into the next stage. The projects that proceed to the more advanced stage of project development will be assisted further by the Africa Cogen Centre in order to bring them to a level where they can be considered bankable projects (6). For the sake of determining the appropriate efforts and support mechanisms to be provide to projects, the pipeline of bankable projects will be categorized according to the size of the projects. Projects that have total project costs of 5.0 million US dollars or less will be categorized as small-scale projects, while projects with total project costs of more than 5.0 million US dollars will be considered large-scale projects. During this stage, the different sources of funds and financing mechanisms (7) will be matched with the requirements of this pipeline of bankable projects. By conducting initial due diligence on the projects and assisting them in preparing bankable proposals/documentation, it is expected that the development and financing costs of the projects will be reduced, the time to reach financial closure will be shortened and the confidence of the financing institutions to lend to the projects will be enhanced. The projects that will reach financial closure will be designated as Full Scale Promotion Projects (8). These Full Scale Promotion Projects are expected to be implemented in the different industries in different countries and will be used as showcases of efficient and modern cogeneration systems in the African region (9).

Figure 4.5: Financing sources and options for the financing of Cogen for Africa Project and the individual cogeneration projects



Notes: PDC = Project Development Company
CEFAA = Clean Energy Fund for Agro-Industries in Africa
FSPPs = Full Scale Promotion Projects

4.1.3 Project costs and financing

The total costs of the Cogen for Africa Project amounts to 67,486,088 USD for a Project duration of six (6) years and covering seven (7) Eastern and Southern African countries. Out of this amount, GEF will cover an incremental financing of 6,032,488 USD, while the remaining portion of 61,453,600 USD will come from non-GEF resources. The breakdown of the GEF contribution according to the different outcomes and components of the Project is given in Table 4.2 below.

Table 4.2: Breakdown of GEF incremental financing

Budget Items	GEF incremental financing	Remarks
Outcome 1: Capacity of project developers, technical service providers and local manufacturers of modern and efficient cogeneration systems developed and enhanced	943,836	The GEF financing will be used for the conduct of feasibility studies, provision of technical advice and services to project developers, and training activities of local engineers and other stakeholders. The private sector starting from year 4 onwards will contribute by paying fees for the services gradually increasing up to 100% of the value of the services upon Project completion.
Outcome 2: Financing for cogeneration projects made available and accessed at terms and conditions that are favorable for investments.	1,071,356	Assistance in mobilizing funds for cogeneration projects and in financial packaging will be provided to project developers and financing institutions. This GEF financing will also be used for capacity building and training on financing aspects of projects.
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.	1,551,306	GEF financing will be used to fund the creation of the Cogeneration Investment Packages and to support the development and implementation of Full Scale Promotion Projects leading to the installation of up to 40 MW of highly efficient cogeneration systems. An additional of 20 MW direct post-project and another 180 MW indirect target is expected. The private sector developers and financing institutions will put up the investments worth 60 mil. USD.
Outcome 4: More favourable policies and institutional arrangements that support cogeneration promoted	1,304,356	Support to policy makers will be provided on policy formulation and enhancements. Advocacy activities will be conducted to influence policy makers to formulate and implement regulations that encourage the implementation of high-pressure cogeneration systems. Contributions in financing will come from the National governments of the participating countries and from Coopener program of the EU.
Project Management (including establishment of Africa Cogen Centre and coordination of National Cogen Offices	911,635	A regional cogeneration center of excellence to be called the Africa Cogen Centre will be established. National Cogen Offices in the 7 participating countries will also be set up.
Monitoring and Evaluation	250,000	
GRAND TOTAL	**6,032,489**	

As of end-February 2006, the following co-funders have committed to provide co-financing for the portion of the costs outside GEF financing:

Private sector/utilities:

During the first half of the Project implementation the Africa Cogen Centre, with its team of international and regional/local experts will provide services to the private sector project developers and cogeneration plant owners. These services will be valued but provided on a free-of-charge basis. At the second half of the Project duration when the viability of the cogeneration projects have been established and the cogeneration market becomes more sustainable, the Africa Cogen Centre will start to charge fees for the services it will provide. Fees will be charged at 25% of the costs at year 4, 50% of the costs at year 5 and 75% of the costs at year 6. The companies in the sugar industry have indicated the need for such services as evidenced by some letters exhibited in Annex H. It is estimated that this contributions will reach a total of 625,000 USD.

A major contribution from the private sector will be in the form of investments in Full Scale Promotion Projects (FSPPs) equivalent to 60 million USD for an installed cogeneration capacity of 40 MW (at a total project cost of 1.5 million USD per 1.0 MW of installed capacity). About 35% of the total project costs will be provided as equity by the project developers/owners, while about 65% will come as loans from different commercial/development financial institutions. Other than the sugar companies who have expressed commitments to implement and provide equity for the projects, the Real Energy Developments, Ltd. of ESD Ltd. (UK) and the Kenya Electricity Generating Co., Ltd. (KENGEN), an electric utility in Kenya, have strongly expressed their intention to provide 50% of the investment costs for the cogeneration projects which they could implement through the Cogen for Africa Project (please see Annex H for letters of commitment).

Triodos Bank, as mentioned earlier, is initiating the creation of the "Clean Energy for Agro-Industries in Africa" (CEFA) which is aimed at meeting the specific funding needs of a portfolio of investments and deal flow to be generated by two UNEP/DGEF energy initiatives in Africa: the "Cogen for Africa Project" and the "Greening The Tea Industry in East Africa".

Triodos Bank is a European bank with presence in Netherlands (Head 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 BV" (TIFM) already manages several funds, among them are three funds that provide finance, both debt and equity, to more than 50 microfinance institutions in approximately 25 developing countries:

- Triodos-Doen Foundation: Total portfolio at the end of 2005: EUR 32.5 million.
- Hivos-Triodos Fund Foundation : Total portfolio at the end of 2005: EUR 24 million.
- Triodos Fair Share Fund: Total portfolio at the end of 2005: EUR 16 million.

National governments:

National Cogen Offices will be established in each country participating in this Project. These offices will act as the representatives of the Project at the country level and will liaise with the national government agencies, project developers and other stakeholders in the country. The rental for the office spaces of these National Cogen Offices and the operating costs such as mailing, communications, utilities, etc. will be contributed as in-kind contribution by the national governments.

Coopener:

An application for co-funding has been submitted to a European Commission program for Co-operation with developing countries (COOPENER). COOPENER aims to boost energy efficiency and the use of renewables and concentrates on the creation of favourable market conditions, international transfer of experience and promotion of best practices, institutional capacity building, accelerating learning curves, information dissemination, education and training of market actors.

When approved, a fund amounting to 375,000 USD will be used to support the policy aspect of the Cogen for Africa Project particularly related to rural electrification of the surrounding areas of the cogeneration project sites.

Table 4.3 shows the sources of the co-financing according to the different outcomes and components of the Project.

Table 4.3: Project budget summary and corresponding sources of funds (in USD)

Budget Items	Total costs	GEF financing	Co-financing		
			National gov'ts	Coopener	Private sector/ Utilities
Outcome 1: Capacity of project developers, technical service providers and local manufacturers of modern and efficient cogeneration systems developed and enhanced	1,568,836	943,836			625,000
Outcome 2: Financing for cogeneration projects made available and accessed at terms and conditions that are favorable for investments.	1,071,356	1,071,356			
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.	61,551,306	1,551,306			60,000,000
Outcome 4: More favourable policies and institutional arrangements that support cogeneration promoted	2,132,956	1,304,356	453,600*	375,000	
Project Management (including establishment of Africa Cogen Centre and coordination of National Cogen Offices	911,635	911,635			
Monitoring and Evaluation	250,000	250,000			
GRAND TOTAL	**67,486,089**	**6,032,489**	**453,600**	**375,000**	**60,625,000**

* Note: The contribution of National Governments to the Project Management were incorporated under Outcome 4 where most of the National Government contributions are expected.

4.2 Cost Effectiveness

Cogeneration is a very cost-effective way of reducing primary fuel consumption for the same of amount of energy produced. It is also an extremely cost-effective measure of cutting down on transmission losses and costs as most of these systems are installed at the point of need of energy. Hence, it is a very cost-effective means of reducing greenhouse gasses.

A least cost comparison between bagasse-fired cogeneration plants and diesel power plants which it assumes to replace for 40 MW direct project, 20 MW direct post-project and 180 MW indirect targets, reveals that the discounted levelized cost per kWh of electricity generation is 0.052

USD/kWh for bagasse-fired cogeneration plants compared to 0.207 USD/kWh for diesel power plants. This translates to a negative cost incrementality of 0.155 USD/kWh. On top of this, the steam requirements of the sugar factory has been covered without additional cost to the cogeneration plant. The following table summarizes these figures while Annex W presents the detailed least cost analysis calculations.

Table 4.4: Cost incrementality

Costs (USD)	Bagasse-fired Cogen	Diesel power plant	Cost incrementality
Discounted levelized cost per kWh	0.052	0.207	(0.155)

Actual figures from countries like Tanzania and Kenya have shown that the price of electricity offered to Independent Power Producers (IPPs) particularly those producing electricity using diesel as fuel go as high as 0.335 USD/kWh and 0.16 USD/kWh respectively. There is therefore clear negative cost incrementality in the use of bagasse-fired cogeneration systems.

The Cogen for Africa Project has been designed to optimize the costs and leverage funding from the private sector and other donors for the implementation of clean and highly efficient cogeneration projects. With the GEF incremental cost funding of 6,032,488 USD, another 61,453,600 USD will be brought into the project for a total Project cost of 67,486,088 USD. This translates to a leverage ratio of over 10:1.

In Table 4.5 below, it is shown that the GEF incremental funding decreases from year 4 towards the completion of the Project in year 6. There are two major reasons for this. Firstly, the involvement of the International Experts will gradually reduce from year 4 as the responsibilities and involvement of the Regional/local experts are increased. Secondly, the co-funding from the private sector for the Technical Assistance will start from year 4 as the Africa Cogen Centre will begin to charge fees for the services it provides to the private sector. Fees will be charged at 25% of the costs at year 4, 50% of the costs at year 5 and 75% of the costs at year 6. This is also in line with the plan for sustainability of the Africa Cogen Centre in particular, and the sustainability and transformation of the cogeneration industry in general.

Table 4.5: Projected yearly costs and funding (in USD)

Project funding	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Total yearly costs	1,461,098	1,343,967	13,402,242	13,178,363	19,061,340	19,039,080
Co-funding	250,600	175,600	12,175,600	12,197,075	18,301,250	18,353,475
GEF incremental funding	**1,210,498**	**1,168,367**	**1,226,642**	**981,287**	**760,090**	**685,605**

4.3 Co-Financing

The list of other institutions with their indication of funding commitment is given in Table 4.6. A more detailed table is provided in Annex J.

Table 4.6: Sources (and potential sources) of co-financing and status of negotiations

Name of organization/Fund	Type of financing	Geographical coverage	Commitment
1. Triodos Bank	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)	Long term financing for start up or expansion projects	Africa-wide	To prepare
3. E+Co	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)	Co-financing on cogeneration investments projects	Kenya, Uganda, Tanzania, Malawi, Ethiopia, Swaziland, Sudan	Submitted letter of interest
5. GTZ (German Technical Cooperation)	Project investment and Technical Assistance	Africa-wide	To confirm interest
6. AICAD/JICA	Project investment and Technical Assistance?	Africa-wide	To request
7. EIB (European Investment Bank)	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)	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)	Co-finance small hydro projects	Africa-wide	Submitted letter of interest
10. AfD/Proparco	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 Banks of South Africa)	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)	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)	Financing small hydro projects in the tea sector	Kenya	Submitted letter of interest for Small Hydro
14. Stanbic Bank - Kenya	Financing small hydro projects in the tea sector	Kenya	Submitted letter of interest for cogen
15. Standard Chartered Bank Structured Trade Finance Africa	Financing small hydro projects in the tea sector	Africa	Submitted letter of interest for Small Hydro and Cogen
16. K-REP Bank	Loans to tea factories for energy projects	Kenya	To request
17. COOPENER	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	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

Name of organization/Fund	Type of financing	Geographical coverage	Commitment
19. PROINVEST/CDE	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 individual companies.	Africa-wide	To prepare
20. Swaziland Industrial Development Corporation	Co-financing for cogeneration projects in sugar factories	Swaziland	To prepare
21. Standard Bank Swaziland Limited	Co-financing for cogeneration projects in sugar factories	Swaziland	Submitted letter of interest for Cogen
22. EU office	Technical Assistance	Africa-wide	To prepare
23. ORET/FMO	Project investment	Africa-wide	To prepare
24. International Finance Corporation	Project investment and Technical Assistance	Africa-wide	To prepare
25. Danida	Mixed credit - Technical Assistance	Africa-wide	To prepare
26. GroFIN	SME financing	East and southern Africa	To prepare
27. Actis	Project investment	Africa-wide	To prepare
28. BASE	Technical Assistance	Africa-wide	To prepare
29. DBSA (Development Bank of Southern Africa)	Project investment	Southern Africa	To prepare
30. USAID (United States Agency for International Development)	Investment & TA	Africa-wide	To request
31. IN-SHP (International Network for Small Hydro Power	Technical Assistance and co-finance of demo projects	Africa wide	Submitted email of interest for Small Hydro

5. INSTITUTIONAL COORDINATION AND SUPPORT

5.1 Core Commitments and Linkages

The New Partnership for Africa's Development (NEPAD) recognizes that energy plays a critical role in the development process, first as a domestic necessity but also as a factor of production whose cost directly affects prices of goods and other services, and the competitiveness of enterprises. In view of the fact that small market sizes and low purchasing power have been the main barriers to universal access to modern energy for development, NEPAD recognizes that the "business as usual" approach will not meet Africa's energy demand, and adopted a partnership strategy to promote development of the African energy infrastructure. With its aim of addressing Africa-wide electricity problems, this Cogen initiative clearly falls within the NEPAD agenda.

The objectives for the Energy Sector under NEPAD, as stated in the NEPAD document are:

- To increase Africans' access to reliable and affordable commercial energy supply from 10 to 35 per cent or more within 20 years;
- To improve the reliability and lower cost of energy supply to productive activities in order to enable economic growth of 6 per cent per annum;
- To rationalize the territorial distribution of existing and unevenly allocated energy resources;
- To strive to develop the abundant solar resources;
- To reverse environmental degradation that is associated with the use of traditional fuels in rural areas;
- To exploit and develop the hydropower potential of the river basins of Africa;
- To integrate and transmission grids and gas pipelines so as to facilitate cross-border energy flows;
- To reform and harmonize petroleum regulations and legislation on the continent.

The NEPAD document identifies actions that need to be taken to address these objectives: the establishment of an African Forum for Utility Regulation and regional regulatory associations; the establishment of a task force to recommend priorities and implementation strategies for regional projects, including hydropower generation, transmission grids and gas pipelines; the establishment of a task team to accelerate the development of energy supply to low-income housing; and broadening the scope of the program for biomass energy conservation from the Southern African Development Community (SADC) to the rest of the continent.

NEPAD has drawn up a short-term Action Plan, which identifies its priorities in the Energy Sector. The Summary Action Plan (SAP) provides a wide range of activities, some in more detail, than others. It comprises of 23 energy projects: 7 power systems projects, 3 gas/oil projects, 4 studies, 3 capacity building projects, and 6 facilitation projects. This SAP is being revised and a medium term action plan is being developed. This Cogen for Africa initiative fits within the overall theme of facilitation projects.

The Renewable Energy and Energy Efficiency Partnership (REEEP) aims to accelerate and expand the global market for renewable energy and energy efficiency technologies particularly in the reforming power sector. With the key objectives to identify and remove market barriers to the deployment of renewable energy and energy efficient technologies in the reforming power sector and increase access to financing, REEEP is, by definition, interested in cogeneration. As the Africa Cogen Center is designed to focus on the support of the realization of actual cogeneration plants, synergy with REEEP activities could be achieved.

With regards to both present and future GEF supported projects, there appears to be hardly any overlap. In some countries, current activities may pave the way for future Cogen projects and sales of excess power to national grid by addressing the regulatory or institutional framework.

5.2 Consultation, Coordination and Collaboration between IAs, and IAs and ExAs

GEF has activities in related sectors and involving countries which are participating in this Project. These are implemented by different Implementing Agencies (IAs). An inventory of other GEF activities in the past and present is presented in Table 5.1. Initiatives in the GEF pipeline are provided in Table 5.2. The relevance of all activities for the proposed Cogen for Africa Project and to the implementation of cogeneration projects are briefly discussed in both tables.

Table 5.1: Relevant GEF-related projects in Southern/Eastern Africa (January 2006)

Country	Project Name	Project Type	Implement-ing Agency	Approval Date	Relevance/Comments
Mauritius	Sugar Bio-Energy Technology	Full Size	IBRD- The World Bank	May 1, 1991	This project was instrumental in the promotion of cogeneration in Mauritius (T.A. to Bagasse Energy Development Program) making Mauritius the leading African nation in cogeneration. Experiences and expertise to be tapped in formulation of Cogen for Africa Project.
Mozambique	Energy Reform and Access Project	Full Size	IBRD- The World Bank	Dec 07, 2001	Grid electrification and power sector reforms; renewable energy promotion; institutional strengthening and capacity building will all be addressed. As such, it may facilitate future cogeneration initiatives, although this project itself will basically focus on Solar PV, Wind, Micro hydro and biomass gasification. Project sets the stage for private sector participation.
Zambia	Renewable energy-based electricity generations for Isolated mini-grids	Full Size	UNEP	CEO endorsed Nov.2005	a). Cogen development in region may have an impact on future (isolated) power generation in Zambia. b). Regional cogen experience may be of relevance to the project.
Kenya	Removal of Barriers to Energy Conservation and Energy Efficiency in Small and Medium Scale Enterprises	Full Size	UNDP	Jul 1, 1998	Within the current execution of this project, cogeneration has been mentioned with great interest but so far no Cogen related activities have been undertaken. The proposed Cogen for Africa would be complementary to GEF- KAM activities.
Ethiopia	Renewable Energy Project	Full Size	IBRD- The World Bank	May 16, 2003	Although the main emphasis is on Solar Home Systems and Hydro mini grids, issues such as policy and institutional support, urban electricity distribution, biomass (stoves) and environmental mitigation are supposed to be addressed. No overlap with Cogen Project.
Uganda	Rural Energy for Development	Full Size	IBRD- The World Bank	May 1, 2000	Capacity building and technical assistance cover a wide range of energy technologies, including (bagasse-based) cogeneration. As such, the project stands to benefit above all from technical expertise provided by the Cogen Project.
Malawi	Barrier Removal to Malawi Renewable Energy Program.	Full Size	UNDP	May 7, 1999	The project appears to essentially focus on Solar PV. However, the project might support also the introduction of other renewable energy options in addressing institutional, information and investment barriers.

South Africa	Renewable Energy Market Transformation	Full Size	The World Bank	Apr 06, 2005	Cogeneration is included in program for self-generation by sugar and paper industries. In proposed the Cogen Project, RSA is considered as a resource country for expertise and equipment.
Zambia, Tanzania	Africa Rural Energy Enterprise Development (AREED)	Full Size	UNEP/UN Foundation	PDF-B for global expansion June, 2003	Currently AREED is implemented in five African Countries and provide early stage funding and expertise development services supplying clean energy technologies. Budgets in AREED are more appropriate for small scale approaches.

Table 5.2 Relevant GEF Pipeline Data (January 2006)

Project ID	Country	Agency	Title	Amount (USD)	Relevance/Comments
2017	Madagascar	World Bank	Integration of Renewable Energy in Rural Electrification	320,000	Cogeneration could be considered in the "promotion of power generation for renewable energy within emerging rural electrification program including policy support, investment support, guarantees and subsidies, business support and technology transfer". Regional Cogen experience may be of relevance to the Cogen Project
1613	Malawi	World Bank	Energy Access, Expansion and Development Project	285,000	Cogeneration may well fit into a program that "enhances access to modern energy, especially for the rural population with the expansion of electricity access (in a commercially viable manner), while helping to reduce environmental damage". For Malawi supporting the policy and institutional process and the development of on-grid biomass IPPs for main or mini grid will be an area of future collaboration.
2119	Regional; Kenya, Ethiopia, Djibouti, Tanzania, Uganda, Eritrea	UNEP	African Rift Geothermal Development Facility	700,000	Cogeneration of Geothermal Power Plants can be only considered for grid connection. Geothermal will, generally speaking, be larger in capacity where as Cogeneration might be more appropriate for rural electrification. Overlap in Kenya, Ethiopia, Tanzania, Uganda. Cogeneration projects will generally require shorter lead time and they can accommodate immediate power shortages.
1607	Zambia	World Bank	Power Sector Reform for Increased Access to Electricity	240,000	Cogeneration might be considered in addition to small hydropower. Proposal only singles out Small Hydro and Solar PV. Developing enabling policies, institutional environment, private sector participation for economic growth and poverty reduction are all relevant for cogeneration development.
3126	Lesotho, Malawi, Mozambique, Namibia, South Africa, Zimbabwe	UNDP	Removing Barriers to Biomass Energy Conservation in small and medium sized enterprises and institutions in Southern Africa Development Community	25,000	The project to remove market barriers to the adoption of sustainable biomass energy practices and technologies by institutions and small and medium enterprises by promoting improved, highly efficient biomass-burning stoves. Not relevant to Cogen.

During the preparation of this Cogen for Africa Project, stakeholders dealing with cogeneration have been consulted. Furthermore, during the initial phase of the Project implementation, there will be detailed discussions with these stakeholders to deliberate on the practical ways to collaborate on specific activities of the Project. Some of the institutions involved in cogeneration are listed in the following table (Table 5.3).

Table 5.3: Institutions dealing with cogeneration in selected African Countries

Country	Institution
Ethiopia	Ethiopian Electric Agency
	Ethiopian Electric Power Corporation
	Finchaa Sugar Company
	Metahara Sugar Company
	Wonji/ Shoa Sugar Company
Kenya	Busia Sugar Company
	Electricity Regulatory Board
	Kenya Association Of Manufacturers
	Kenya Electricity Generating Company
	Kenya Power And Lighting Company
	Kenya Sugar Board
	Muhoroni Sugar Company
	Muhoroni Sugarcane Outgrowers Company Limited
	Mumias Outgrowers Company (1998) Limited
	Nzoia Sugar Company
	South Nyanza Sugar Company (Sony Sugar Company)
Mauritius	Central Electricity Board
	Mauritius Sugar Authority
	Centrale Thermique de Savannah
	Centrale Thermique de Belle Vue
Tanzania	Kagera Sugar Company
	Kilombero Sugar Plant K1
	Mtibwa Sugar Estate
	Sao Hill Saw Mill
	Tanganyika Planting Company
	Tanganyika Wattle Company (TANWAT)
	Tanzania Electricity Supply Company
Uganda	Kinyara Sugar Works
	Kakira Sugar Works Limited
	Uganda Electricity Board
	Sugar Corporation Of Uganda Limited

5.3 Project Implementation Arrangements

5.3.1 Organization and management of Cogen for Africa

In order to guarantee optimal transparency at all levels and all times during program implementation, it is proposed that the management structure of the Cogen for Africa Project is kept relatively simple and straightforward with UNEP as Implementing Agency.

The project shall report and be accountable to the ***Project Steering Committee (PSC)*** which shall convene every six (6) months. The functions of the PSC are to:

- Provide direction and guidance to the Project
- Monitor and supervise implementation of the Project
- Approve selection of Full Scale Promotion Projects and corresponding support
- Endorse adaptations to the Project components during the Project execution
- Evaluate the performance and impacts of the Project
- Approve Progress, Midterm and Terminal Reports of the Project

The PSC shall be composed of the following full and voting members:

- A representative from UNEP-GEF who shall be the Chairman of the PSC
- One representatives from each Co-Funding agency
- Three representatives from each participating country, who shall be from the Ministry in-charge of energy, the National power utility or energy regulator, and the relevant industry such as the sugar industry, financing institution or local manufacturing.
- The Africa Cogen Centre Director who shall represent the Executing Agency of the Project and shall act as the PSC Secretary

The PSC may invite observers to its regular meetings (e.g. Experts involved in the Project implementation, representatives from National Cogen Offices, …) who may be invited to speak or report on certain aspects of the Project.

Reporting to the PSC is the ***Project Management Council (PMC)***, the function of which is to:

- Provide technical and operational guidance to the Programme
- Select the Full Scale Promotion Projects
- Monitor and evaluate the progress of the activities and approve quarterly planning of activities

The PMC shall convene every six (6) months in the different participating countries on a rotational basis. In order to optimize resources and save time for preparations, the PMC meetings shall be organized in conjunction with PSC meeting. The members of the PMC shall be as follows:

- Africa Cogen Centre Director
- International Team Leader
- Heads of Units of the Cogen Centre (4)
- Head of Finance and Administrative Support Unit
- One representative from each National Cogen Office

Figure 5.1 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.

Figure 5.1: Project management structure of the Cogen for Africa Project