**Report of AFREPREN/FWD**

“AFREPREN/FWD Cogen for Africa” – Mission to Tanzania

26th March, 2008

<table>
<thead>
<tr>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project</strong></td>
</tr>
<tr>
<td>Mufindi Cogen</td>
</tr>
<tr>
<td>Small Hydro</td>
</tr>
<tr>
<td>Forest Expansion</td>
</tr>
<tr>
<td>Wood Pellets</td>
</tr>
<tr>
<td>Mafia</td>
</tr>
<tr>
<td>Tanga Cement</td>
</tr>
</tbody>
</table>

**1.0 Introduction**

Following the decision by the PSC to support cogen projects with potential for investment (the initial opportunity at Tanganyika Planters Company-TPC, a sugar factory, did not involve new investments), there was need to identify other potential cogen investment projects in Tanzania. Based on recommendations from an AFREPREN/FWD contact based in Tanzania, the AFREPREN/FWD Cogen for Africa team learnt of opportunities for cogeneration in Tanga Cement Company, Mafia Island and the Mufindi Paper Mills. The Cogen Team therefore organized a mission to Dar es Salaam to follow-up on these opportunities.

The mission team first met with the AFREPREN/FWD contact who is based at the National Environmental Management Authority in Tanzania, NEMA, who provided a background on the various potential cogen plants including the Mufindi Paper Mills Cogen Project, the Mafia Group Coconut Cogeneration plans and the Tanga Cement Cogen project. The team later met with Mr. Y. V. Choudary, the Managing Director of Mufindi Paper Mills and the company’s financial controller. In addition, the AFREPREN/FWD cogen team was able to contact the MD of Tanga Cement by phone. The mission team compiled this report.

**2.0 Key Discussion Points**

**Cement Industries**
The AFREPREN/FWD contact informed the AFREPREN/FWD Cogen Team of potential for cogen in various cement factories in Tanzania, namely: Tanga Cement Company, Wazo Hill Cement Company and Mbea Cement Company. The most advanced opportunity was at Tanga Cement Company, who were in discussion with Tanesco regarding a PPA for cogenerated power.

AFREPREN/FWD Cogen Team also managed to talk on phone with the Tanga Cement contact (Mr. Karlston), in charge of the cogen initiative. He mentioned that currently, their main problem is dealing with excess heat generated by the cement process which could be harvested and used to run a power cogen plant. It was agreed that AFREPREN/FWD follow up for additional information on their plans.

**Mafia Island**

Mafia Island is located within the Indian Ocean and out of the mainland of Tanzania. Therefore, it is not connected to the Tanzanian national grid but has an isolated grid powered by old and unreliable diesel generators and run by Tanesco. The Island’s main economic activities include fishing (hence has a fish packing facility), tourism and coconut processing. The Mafia Group is involved in coconut processing and fish processing.

Due to the unreliable supply of power from Tanesco, there are plans by the Mafia Group to develop a cogeneration project from the coconut waste so as to have a sustainable energy for the island. The Mafia group owns over 3000 hectares of coconut plantation and 3 fish processing plants. The Mafia Group also own a saw mill that processes coconut trees for making furniture. The group has prepared a full feasibility study for power generation using coconut husks and is in the process of finding financing for the power plant. They intend to invest USD 0.5 million in the project and will be looking for financiers to raise the remaining investment amount. They intend to purchase a refurbished steam turbine (1MW) from Kigoma for the power plant.

The Mafia group has initially considered gasification as the technology for the power plant but they opted for steam turbines due to the following challenges with the gasification technology:
- The technology is not mature/proven hence is prone to be problematic
- Incessant maintenance problems
- can not ensure availability
- there is not enough experience on the technology in the region

**Mufindi Paper Mills**

Mufindi Paper Mills is currently at advanced stages of developing a 35MW cogen plant which will be commissioned in early 2009. The Managing Director of the Mufindi Paper Mills indicated that he however has three potential energy project ideas that he was currently been developing. Below is a brief of the three potential projects.
Project 1: Cogeneration

Mufindi Paper Mills was originally designed to import power from the national grid for its processes. The experts that developed the project did not foresee the need for self generation of power as there was little demand for power in the country then and TANESCO had surplus power. They identified the Kiwira power plant (a nearby coal fired power plant) as the energy source for the project. An electric power boiler was built for the Paper Mill as there was enough excess power in the grid and TANESCO was prepared to give 25MW to the factory. However, over the years, there has been rising demand for power from the Mining industry and expansion of the Mufindi Paper Mill hence the need to invest in power generation. The electric boiler was not commissioned as there was no longer enough power to run it from the Tanesco grid.

Status of Cogen project at Mufindi

The factory modified the in-filling system of the existing boiler from consuming coal to 100% wood so that they could use wood chips only. To ensure fuel availability, Mufindi Paper Mills signed a contract with TANWAT (a neighboring company that produces tannin from wattle trees) to purchase wood waste that they currently burn in the forest.

The boiler is connected to an extraction backpressure turbine which produces 10.5MW. This capacity meets 95% of electricity needs of the factory; hence the factory imports 5% from national grid.

The factory has 2 product lines but only one of the lines is currently operating. For the 2nd line to operate, there will be need for additional power of about 18MW hence the plan to expand their current cogen power plant to 35MW from the current 10.5MW using technology from Europe (SIEMENS).

The boiler and turbine for the 35MW plant have already been ordered and are expected to be shipped in November 2008. The boiler has been purchased from India and the financing of USD 80 million for this project was secured from the PTA Bank, Ugandan NSSF and EADB.

The plant is set to be commissioned in March 2009 and the plant will export 18MW to the grid during the initial 3years but with the expected factory growth, the internal demand for power will increase and the excess power for selling will reduce. However, there is a possibility of adding an additional turbine later to ensure continuity in exporting power to the grid.

The factory is connected to the national grid through a 20KV transmission line which is capable to transmit the 18MW of power.

Fuel Sustainability
To ensure fuel sustainability, the company has embarked on an aggressive re-forestation programme. In 2008, the company planted 1,000 hectares (300 hectares in the community – provided free seedlings to community) of trees and supplied 800,000 seedlings.

The Company is currently discussing with the Government of Tanzania to be the sole logger at the Mufindi forest so that they provide timber to the existing saw mills. This is to ensure better management of the forests, ensure improved quality of timber, sustainability of supply of timber, do away with illegal loggers as well as make the small saw millers more efficient - some of the saw millers are too small to invest in modern logging technology.

As an alternative, the company is also considering collecting wood waste (which is a risk for forest fires plus generates methane gas) from other loggers in the forest to ensure availability of fuel.

According to Mr. Choudary, the company is not tied up with any financier yet, hence they can work with the AfDB. In addition, the forest expansion project can be modularized, e.g. done every 3 years in bits. The company’s target for the forest expansion project is 100,000 hectares for between 10-15 years.

The African Development Bank (AfDB) can assist with funding the forest expansion programme of 20,000 hectares of land. The company needs the capital to develop (roads, equipment, modern nurseries etc).

**Project 2: Small Hydro**

The Mufindi mill is located in a valley that has a potential for small a hydro plant. The mill is located in a valley where the land drops by 800 meters and sits at 1,250 meters above sea level. Above the valley is a swamp filled by 5 streams from which narrow spillways can be built for the power plant. Estimates indicate that the site can support a 6-7MW (2 to 3 units) power plant.

The rainfall in the area is between 800ml to 1200ml per annum and the water flow speed is between 140-260m³/s. The water flow can be regulated to around 10m³/s using spillways with a gradient drop of 50-60 meters and this can easily support a 4-5MW plant.

**Status of Small hydro project**

The Mufindi Company have discussed a possible small hydro project with the community who are supportive of the initiative because of the potential benefits, which include rural electrification, regulated water for irrigation downstream and protection of the water catchment and regulating the water falls. Other potential off-takers for the power produced include the forest industry, the tea industry and the Tanzanian southern grid.

The company is currently looking for financing for the project. The project is expected to have a lifespan of approximately 30 years. Mufindi can be the project sponsor and can
involve the government in the rural electrification component. The expected capital cost is approx. USD 7-8 million (Max 10 million).

The MD will send AFREPEN/FWD a concept note on the small hydro project, for possible forwarding to the “Greening Tea” project.

**Project 3: Domestic Fuel Project – wood pellets**

The company intends to develop wood pellets through “tourification” (concentrating energy content per unit mass) of the inefficient wood and charcoal for household heating by using the wood waste collected from the forest. The project is still in the concept stages and the company is looking for financing to be used in collecting wood branches for developing pellets. The target off-takers include public institutions, industries, schools and households.

The expected capital cost is approximately USD 4 million. The MD will send AFREPEN/FWD a concept note.

In addition to the three project ideas, the company has a long term road-map plan of expansion with a target to achieve 1 billion USD investments by 2028 which will provide between 20,000 to 25,000 employment opportunities. Presently, the paper mill has an annual turnover of 100 USD million with 130,000 tonnes of paper and pulp produced. The company intends to have expanded the forest cover to between 40,000 to 50,000 hectares of forest cover to be able to mill 500,000 tonnes/year milling (market pulp future) with a turnover of USD 315 million by 2014.

**3.0 Next Steps**

- Mufindi to send AFREPEN/FWD concept note for the three potential projects after two weeks.
- AFREPEN/FWD to review concept notes and discuss with PSC for possible support.
- The AFREPEN/FWD Cogen for Africa could assist the Mufindi Group in market transformation by working with RAI as a group for knowledge exchange within the group. This is to ensure that the Group does not duplicate its efforts. I.e. a small group of think tanks to ensure synergy within the group can be developed who offer expert services to all the group’s factories in the region and could offer/sell their services to other companies in the region.
- AFREPEN/FWD to follow up with the Tanga Cement contact for additional information.
- AFREPEN/FWD to contact the Mafia Group management to discuss possible collaboration between the two projects.
Annex 1: Potential for Cogeneration – Ratios for Forest Industry

According to the Mufindi Managing Director, 1 tonne of wood chip can produce 1MW of power. For a 30MW plant, 30 tonnes of wood chips are required which can be sustained by a 10,000 hectares of forest plantation of 13 years of age (7 years rotation with a 30% contingency assumed).

Therefore, theoretically, each district in Tanzania has enough land to sustain the 10,000 hectares of wood plantation hence each district can have decentralized power plants that has a potential to offer employment opportunities to the locals as well as reduce transmission losses.

A related cogen computation is based on a market pulp mill. About 4m³ of hard wood produces 1 tonne of bleach pulp. The pulp mill has a potential of producing 850kW/tonne of pulp and has a captive consumption of about 550kW/tonne of pulp use during pulp processing hence a net exporter of power of 300kW/tonne of pulp.

With 500 TPD (tonnes per day) production capacity mill, 500*300/24 ~6.25MW of electricity can be exported.
Total mill power production = 500*850/24 ~17.7MW.