Report of AFREPREN/FWD
“AFREPREN/FWD Cogen for Africa” – Mission to Uganda (James Finlays Muzizi Tea Factory and JN Agritech International
22\textsuperscript{nd} – 24\textsuperscript{th} August, 2007
Introduction

AFREPREN/FWD was invited to attend a workshop in Kampala, Uganda between 19th and 21st August by the Overseas Development Institute (ODI) as part of a collaborative project between the two institutions. As the two AFREPREN/FWD representatives at the ODI event (Stephen Karekezi and Nicholas Owino) are members of the AFREPREN/FWD Cogen for Africa project team, it was decided that the AFREPREN/FWD representatives use this opportunity of being in Uganda to respond to an invitation from James Finlays Tea Company to visit their cogen gasification (a process that uses heat, pressure, and steam to convert materials directly into a fuel gas composed primarily of carbon monoxide and hydrogen) based project at their Muzizi Tea Factory in Western Uganda as well as an invitation from JN Agritech International - a Kampala-based company that intends to produce fuel ethanol from sweet sorghum plus electricity from sorghum waste using cogeneration.

This mission report presents the findings of the AFREPREN/FWD Cogen for Africa project team visits to the James Finlay Tea Company cogen-gasifier installation in Western Uganda and to the JN Agritech International Kampala offices.

a.) James Finlays Muzizi

1.0 Introduction

James Finlays is a UK based company which owns 8 tea estates/factories in Kenya and 5 tea estates/factories in Uganda of which Muzizi Tea Factory is one of them. The company has additional tea estates/factories in Sri Lanka. The Muzizi Tea factory is situated 600 Kms from Kampala in western part of Uganda (about half the distance is on very poor roads that are often inaccessible or very difficult to traverse during the rainy season). The factory currently uses a wood-fired 250kW cogen-gasifier and a diesel generator to generate power for its use in the factory processing of tea. Process heat is provided by both the gasifier (which is, primarily used to pre-heat the air) and a separate wood fired boiler). Of interest to the Cogen project was the cogen-gasifier as it is the only fully-functional gasifier in the region known to the authors.

In addition to the mission team being taken through an extensive tour of the factory tea processing by the processing manager and through the power house by the factory engineer, the team met with the following key representatives:

1. Mr. Milton Muwadi (The factory estate manager)
2. Mr. Andrew Gawaya (factory engineer responsible for the gasifier)
2.0 Summary of Mission

Although tea processing is an energy intensive process (about 40% of total cost of processing tea is on energy), the Muzizi Tea Factory is not connected to the Uganda national power grid due to its remote location from the central grid. The factory initially installed 5 diesel generators to generate electricity for the factory and a wood-fired boiler to provide heat for tea processing but due to the high and rising diesel fuel prices, this option proved excessively costly and factory management decided to find an alternative power generation option.

The factory installed a cogen-gasifier in 2002 which was commissioned in 2005. The gasifier has an installed capacity of 250kW but currently produces about 200kW of electric power. The gasifier uses wood fuel as feedstock to generate carbon monoxide and hydrogen (syngas) which is used to power a gas fired electricity generator engine to produce electricity. The exhaust gas is used for pre-heating air that is used in the tea drying process.

Due to the success of this pilot project (as per information availed by the Finlay’s technical team), the AFREPREN/FWD Cogen for Africa team was informed that factory management plans to install an additional 250kW gasifier to replace the existing diesel generator and further replicate the technology in other tea factories in Kenya and Uganda.

To sum up, the Mission Team was informed by the engineer in charge of the cogen-gasifier unit that the technology is proven and viable and should be considered for replication in other James Finlay tea factories. Based on discussions held with Factory Management, the following were identified as potential follow-up tasks as well as potential areas that the AFREPREN/FWD Cogen for Africa project could assist the James Finlays project subject to discussion with the company’s Regional Technical Director and Cogen Project Steering Committee:

**Organize a meeting with James Finlay’s Regional Technical Director:**
The AFREPREN/FWD Cogen for Africa project team intends to meet with James Finlay’s Regional Technical Director to assess top management’s commitment to replicating the cogen-gasifier technology within the James Finlay’s group as well as its interest in collaborating with the AFREPREN/FWD Cogen for Africa project.

**Capacity Building:** Limited exposure to cogen-gasifier technology and absence of skilled engineers with experience in the technology proved to be a major challenge to introducing the cogen-gasifier option to James Finlays Company. Consequently, the initial period of operations of the gasifier unit proved to be difficult with the installation recording very low levels of capacity utilization. The AFREPREN/FWD Cogen for Africa project could assist James Finlays build up a critical mass skilled engineers able to operate and maintain such units within the Company’s regional operations. This can be organized through training courses for staff of James Finlays involved or interested in being involved in the promotion of the cogen-gasifier technology within the James Finlays group operations.
Pre-feasibility/Feasibility Study: Given the interest that James Finlays Group have in replicating the technology to its other tea factories, the AFREPREN/FWD Cogen project could assist in the preparation of a concept note for the roll out plan as well as follow up with pre-feasibility and full feasibility studies for the proposed replication.

Documentation of Cogen-Gasifier Case Example: The factory engineer in-charge of the cogen-gasifier unit informed the AFREPREN/FWD Cogen for Africa team that the commissioning of the unit initially faced many difficulties partly due to limited expertise on cogen-gasifier technology within the James Finlay’s group. There is also very limited documentation of this case example that can be used by other factories planning to install cogen-gasifier units in their factories. The AFREPREN/FWD Cogen for Africa project could assist in documenting lessons learned in the design, installation, commissioning and maintenance of the Muzizi cogen-gasifier unit as well as compiling a handbook of troubleshooting best practices.

Increase Efficiency: AFREPREN/FWD Cogen project could assist the factory audit its energy consumption demand and analyze the efficiency of the current configuration and propose ways of optimizing use of energy from the cogen-gasifier unit.

Rural Electrification: The AFREPREN/FWD Cogen project, in conjunction with the COOPENER/PACEAA project, could also advise the management of James Finlays on how to design and implement a rural electrification program for the local community.

3.0 Key Discussion Points at James Finlays

The first meeting was with the factory manager in charge (Mr. Milton Muwadi) who introduced the AFREPREN/FWD Cogen for Africa project team to the cogen-gasifier initiative at his factory. Mr. Muwadi also provide a brief background review of the Muzizi tea factory to the mission team. The factory was established in 1963 and has a handling capacity of 6,000 tonnes of green leaves per year (42 tonnes per day). It produces between 1,200 and 1,300 tonnes of tea per year.

The estate has an area of 636 hectares in total with 371 hectares being under tea and 105 hectares under eucalyptus forests while the remaining 159 hectares are dedicated to infrastructure (factory, houses, roads etc).

Tea processing is a labour intensive activity. The factory employs around 800 permanent staff and 200 casual laborers. The factory uses both manual and mechanical harvesting currently deployed at a ratio of 70:30, manual to machine harvesting. However, due to the insufficient supply of manual labour (labourers are sought from as far as 600 miles from factory), the factory plans to expand mechanical harvesting to 50% of the total annual harvest.

The factory also provides a market to out-growers who contribute 10% of the tea leaves to the factory. The out-grower farmers are small holders who are located within a radius
of 60kms. As part of their corporate social responsibility, the factory provides extension services to the out grower farmers at no cost. In addition, the factory provides housing, meals to workers and looks after their dependents.

The second meeting was with the factory engineer (Mr. Gawaya) who led the AFREPREN/FWD Cogen Mission Team through a technical guided tour of the power house to view the gasifier currently in operation. Mr. Gawaya informed the mission team that the factory had analysed the hydro power option but found it unviable due to the absence of suitably rivers with sufficient head in the surrounding area. Prior to installation, an analysis of the viability of a gasifiers was undertaken in all James Finlays tea estates and Muzizi proved to be the most favourable due to the absence of a grid connection, availability of abundant fuel wood (factory has enough forest wood) and the high cost of diesel in Uganda (plus high cost of transporting the fuel to Muzizi Tea Factory).

He mentioned that the management had initially planned to install 2 gasifiers each of 250kW capacity but later settled for one installation as a pilot test plant to first establish the viability of the technology before further replication can be considered. Based on its in-house viability analysis, the installation of a gasifier at Muzizi required an initial investment of USD 440,000 resulting in a payback period of 5 to 6 years and was expected to run for 10 years. The factory sourced its equipment from an Indian supplier.

Subsequent additional installations are expected to have a lower installation and commissioning costs as James Finlay would have developed the required in-house expertise and skills required to keep costs down.

The gasifier has an ideal consumption rate of 1.3Kg of wood per kWh but, in practice, its consumption rate is about 1.4kg/kWh. The gasifier uses a “Down Draft Fixed Bed Technology” as shown in the following figure using three simplified processes, namely:

1. Generate gas in chamber – wood inlet as fuel
2. Filter generated gas
3. Burn gas in engine to generate power
The main power demand for the factory is from motors, conveyor drives and the fan drives. The motors used are not the most efficient – many of the motors are not of a variable frequency drive (VFD) - type which consumes less power. In addition, power loads of VFDs are more stable which would, in turn, stabilize the power demand on the gasifier. VFDs would also reduce the overall system peak power demand thus reducing the power generation investment needs of the factory.
Current Energy System

Energy Producers:
- Boiler
- Gasifier
- Diesel Generator

Main Energy Consumers:
- Dryer
- Mortar
- Withering Plates

1. Inefficient use of energy (high energy loss)
2. High fuel use
3. High investment

Proposed Energy System

Energy Producers:
- Gasifier I
- Gasifier II

Main Energy Consumers:
- Withering Plates
- Mortar
- Dryer

1. Eliminates boiler and diesel generators
2. Improves efficiency by recovering heat from gasifier
3. Saves on fuel
4. Reduction in manpower

Key:
- Power: Green line
- Heat: Red line
As shown in previous figure 2, if the factory invested in a 2\textsuperscript{nd} gasifier and ensured proper heat recovery from the jackets of the gasifiers (which is currently not recovered) through the heat exchanger for pre-heating purposes, it would overall system heat demand from the boiler and hence reduce its fuel consumption. However, it is important to note that the heat from the gasifiers is not enough for the tea dryer and hence the need to always have the boiler in operation.

4.0 Summary of Key Follow-up Tasks

To sum up, based on discussions held with Factory Management, the following were identified as potential follow-up tasks as well as potential areas that the AFREPREN/FWD Cogen for Africa project could assist the James Finlays project subject to discussion with the company’s Regional Technical Director and Cogen Project Steering Committee:

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b.) JN Agritech International

As a follow-up to a formal request from JN Agritech International to the AFREPREN/FWD Cogen for Africa project, the AFREPREN/FWD Cogen for Africa project team undertook a fact finding mission to JN Agritech International to assess its cogeneration plans.

JN Agritech International Ltd is a private company based in Kampala, Uganda. The Cogen team met the Directors of the company (Mr. Kabuchu Alfred and Mr. Geoffrey Kamuntu) as well as an expert from India (Prof. N. S. Reddi) and a local agricultural expert.

The AFREPREN/FWD Cogen team was introduced to the work of JN Agritech which includes agricultural production of sweet sorghum for ethanol production which started in 2004 and production of rice.

Sweet Sorghum for Ethanol

JN Agritech intends to produce fuel ethanol from sweet sorghum stalks using a patented technology from ICRISAT India. The company intends to install a co-generation plant, primarily to meet its own energy (power & heat) requirement, with the possibility of exporting excess power to the grid. The proposed capacity of the CHP plant is 1.5MW.

According to its senior management team, JN Agritech has already bought 510 hectares of captive farmland in Kayunga (70 miles from Kampala) for sweet sorghum production and intends to increase the area under sweet sorghum to 10,000 hectares.

Sweet sorghum can be harvested twice a year and the estimated productivity is 15 to 20 tonnes of biomass/stalk per hectare of sorghum. JN Agritech indicated that it has already undertaken a feasibility study and has experienced experts on agricultural production and processing of sweet sorghum and intends to harvest sweet sorghum stalks that are 100 days old. However, the grain from overgrown crops can also be used as feedstock for ethanol production.

According to the company management, sweet sorghum is not a major food crop in Uganda and the land that it intends to use for its production is not currently in use. Hence, JN Agritech believes that its operations would have no conflict with food production. In addition, the byproducts of its ethanol production process can be used as organic fertilizer.

According to JN Agritech senior management, the company is already licensed to produce ethanol in Uganda and with the recent inclusion of fuel blending of up to 40% in the energy policy of Uganda, it believes that there is a ready local market for the ethanol produced. Oil companies are however skeptical of the sustainability of ethanol supply to the whole country as it is estimated that it would require a minimum of 100,000 hectares to meet currently ethanol blending demand for the whole country. JN Agritech current
planned production of 750 liters of ethanol per day will only account for about 2-5% of the daily market demand.

Accordingly to JN Agritech senior management, the company has an additional market for ethanol in Ethiopia (although sugar companies in Ethiopia are also gearing to produce ethanol). In addition to using the by-products of ethanol production as feedstock for cogeneration, the by-products can also be used as animal feed or for production of cardboards.

According to the company officials, the project plans have been finalized and the only pending item is financing. The company has been in touch with AfDB (specifically Mr. Ernest Tettey) and the key pending issue is equity commitment - AfDB proposed an equity commitment of 40% of the total investment amount (USD 20 million) but the company was only willing to provide 20% equity. This issue is still under discussion. According company officials, JN Agritech principal financial partners, Spencon Group, (a regional construction firm) and Secure holdings has the required capital and turnover to underwrite the equity requirements.

Rice Production

According to company officials, in addition to the sweet sorghum project, JN Agritech has invested in rice production and has already acquired 5,000 hectares of land of which 3,000 are on rice with ongoing demonstration projects. The total project cost is estimated at US$ 36 million and will require a funding of US$ 12 million. They are using the service of an expert consultant from India who has produced the first hybrid rice in India. The company intends to have a small cogen plant as part of a planned rice milling plant.

Next Steps

Obtain Additional Information: It was agreed that AFREPREN/FWD will request JN Agritech for details of their planned cogeneration initiative envisaged in their two projects of rice and ethanol production. JN Agritech agreed that they can send a copy of the feasibility studies for two projects.

Follow up with AfDB: AFREPREN/FWD to follow up with the AfDB contact (Mr. Ernest Tettey) on financing of the planned projects and learn more about the discussion on equity commitment.
Annexes: Pictures of Muzizi Tea Estate

Figure 3: Arial View of Muzizi Tea Factory
Figure 4: Gasifier Plant House at Muzizi
Figure 5: Diesel Generator House
Figure 6: Timber Yard