From cane to sugar and electricity

Kakira Sugar Works
Cogeneration Project

Presentation by Farhan Nakhhooda,
Projects Director - Madhvani Group

Partners for Africa :
Policy Dialogue Conference,
23-June-2005, Dar-es-Salaam
The Role of Renewable Energy Policy in
Africa for Poverty Alleviation and
Sustainable Development
The Madhvani Group’s economic flagship, the sugar complex at Kakira, Uganda, has grown from:

- the original factory capacity of 150 tons of cane per day in the 1930s
- to over 3,500 tons of cane per day
- and is now expanding to 6,000 tons of cane per day (TCD).

**Kakira Sugar Works**

**Kakira – Location**

In rural South Busoga in Eastern Uganda, on the shores of Lake Victoria

- 100 km from Uganda’s capital - Kampala
- 15 km from Jinja, the source of the Nile and the Owen Falls Dam, the country’s major source of electric power.
Kakira overview

The Kakira Complex is comprised of:

- The sugar factory and ancillary units
- A company-owned Nucleus Estate of 8,700 Ha encircling the factory, which provides over 50% of the sugarcane
- Over 3,500 small and large farms of independent Outgrower Farmers who supply the balance sugarcane
- The supporting infrastructure – which includes cogeneration of steam and electricity
Kakira’s nucleus cane estate

Ploughing

Sprinkler irrigation

Mech. weeding

Pivot irrigation
Mature cane Harvesting

Loading Unloading

Kakira sugar factory
Milling Juice extraction

Cane handling Cane carrier

Milling Juice extraction

Kakira milling train + steam turbines
A sugar factory is usually very efficient in utilising all resources optimally. These resources include:

- Sugarcane
- Water
- Steam
- Power

The basic resource of sugarcane can itself be used to co-generate steam and power.
**Co-generation**

- **Bagasse** (the dry fibrous residue from sugarcane crushing) is burnt in a *boiler* to produce
- **high pressure steam**, which is
  1. used to drive mills, etc. and
  2. passed through a turbo-alternator to generate
     - **electric power**, after which the *low pressure steam* is used in the sugar manufacturing process.
- Steam and Electric Power are generated from a *renewable energy source* which does not deplete irreplaceable fossil or mineral resources.

**KSW present 20 bar boilers**
KSW existing turbo-generator sets

Franco Tossi 3 MW
Blohm & Voss 1.5 MW

Kakira old power house
The Future

A study commissioned by the Government and African Development Bank, independent consultants SOFRECO of France examined the agricultural options for development in the South Busoga Region in an area contiguous to the Kakira Nucleus Estate and concluded in 1996 that:

- **Sugarcane** is the **ideal** crop, which is highly remunerative to prospective farmers with an assured market in the area.

The SOFRECO study recommended:

- **expanding the Outgrowers Area** by planting over 10,000 Ha with sugarcane under the direction of KSW's Agricultural Department.

- Considering the market for sugar in Uganda, **expanding the Kakira factory** to a capacity of up to 5,000 TCD.

- Installing a **co-generation plant** to produce steam as well as power.
The three project components are:

1. Increase in cane supply – **Agricultural Development**
2. Increase in sugar production – **Factory Expansion**
3. Optimal utilisation of resources – **Co-generation** of steam and power.
KSW’S on-going expansion

- **expanding the Nucleus Estate cane supply** by adding 1,000 Ha of new land, improving cane varieties and husbandry, and increasing irrigation.

- **expanding the Outgrowers Area** to 10,000 hectares in phases for over 6,000 farmers to supply over 1.25 million tons of cane / year.

- **expanding the Kakira factory** in phases to (a) 4,000 TCD, (b) then 5,000 TCD and (c) eventually 6,000 TCD.

Co-generation

- **At present**, utilising its old boilers with the 3 MW Franco Tossi turbine and the Blohm & Voss 1.5 MW turbine, Kakira is able to generate **4.0MW of electricity from bagasse**.

- The Kakira factory is hence **self-sufficient** for its in-house-power needs.

- Since these are low-pressure boilers with small back-pressure turbines, Kakira is left with **surplus bagasse** – which has to be disposed by **open-field burning**.

- The **proposed new KSW co-generation plant** will optimally utilise the bagasse available.
Uganda: Power Sector

- **Uganda presently** has a significant shortage of power – resulting in load shedding.
- The **present generation facilities** are as follows:
  - Owen Falls – Nalubaale 10 x 18 MW = 180 MW
  - Owen Falls extension - Kiira
  - Designed for 5 x 40 MW
    - Installed 3 x 40 MW = 120 MW
    - 300 MW
    - Operational capacity 265 MW
  - However, due to low water-levels in Lake Victoria actual generation dropped to 215 MW

Uganda: Power Sector

- **Uganda’s present peak demand is 330 MW**
- There is hence a significant shortage of power – resulting in load shedding.
- At present only 8% of households are connected to the national grid (only 3% rural)
- **Annual growth in demand is 24 MW**
- The Ministry of Energy’s proposals to address this situation include:
  - Short-term diesel-fuel generation 50 MW
  - Owen Falls extension – Kiira 40 MW + 40 MW
  - Rural electrification projects 70 MW
  - Bujagali hydro-power project 250 MW
  - Karuma Falls hydro-power project 250 MW
Kakira Co-generation - 1

- In **June 1998**, based on the SOFRECO study, Kakira proposed to the Ministry of Energy & Min. Devpt [“MEMD”]:
  - A new single high pressure boiler 160 T/h - 60 bar
  - A new 30 MW Turbo-Alternator
    - with **18 MW** supply for **24 h/d** for 10 m/y (136 million kWh/y) to the national grid
    - balance 12 MW for captive use and parasitic load.
- However, **MEMD was focused on the larger 250 MW Bujagali project and deferred any decision on KSW’s proposal.**

Kakira Co-generation - 2

- In **April 2001** under the World Bank’s Energy for Rural Transformation Project, **KSW submitted a revised/downsized plan** –:
  - A new single high pressure boiler 160 T/h - 60 bar
  - A new 20 MW Turbo-Alternator
    - with **7 MW** supply for **24 h/d** for 10 m/y (52 million kWh/y) to the national grid
    - balance 12-13 MW for captive use and parasitic load.
- However, **MEMD / UEB still had very conservative demand forecasts and optimistic supply forecasts**
- **MEMD requested KSW to further downsize its project to provide 7 MW of power only for the 6 h/d peak period** – 6 p.m. to midnight (13 m kWh/y).
Kakira Co-generation - 3

- KSW therefore had to entirely reconfigure the project and also review Kakira's Agricultural Expansion Plan schedule.
  - a change in technology
  - reorganizing of sugar complex operations to improve efficiency of utilisation of equipment.

- **KSW revised plan – November 2001**:
  - expansion to only 4,000 TCD
  - low-pressure boiler (50 T/h - 20 bar)
  - a smaller new 14-15 MW Turbo-Alternator

Kakira Co-generation - 3

- **During the 10 month crushing season**:
  - Kakira needs **steam 24 h/d** for sugar manufacturing
  - Kakira needs **power**
    - 5 MW for its own operations (24h/d)
    - Extra 3 MW for irrigation (210 d/y for 18 h/d)

- **During the 2 month shut-down period,**
  - Kakira needs only **power**
    - 2.5 MW for its own operations (24 h/d).
Kakira Co-generation - 3

(a) **During the crushing season** (305 d/y)

(a.1) **Non-peak hours** (0000 hrs-1800 hrs)
- 210 d with irrigation 8 MW *own use*
- 95 d without irrigation 5 MW *own use*

(a.2) **Peak hours** (1800 hrs-2400 hrs) *(no irrigation)*
- 305 days 5 MW *own use*
- 305 days 7 MW *for grid*

A new **14-15 MW TG set** with a parasitic load of about 1.2 MW - 1.4 MW would be **adequate for this.**

(b) **During the shut-down period** (60 d/y)

- 24 h/d all 60 days *(no irrigation)*
- 2.5 MW *own use*

The **existing back-pressure Franco Tossi turbine** would be **adequate for this.**

It is intended that this program will **fully utilise all the bagasse available.**

In case of bagasse shortfall, any balance power required during the off-season will be bought back from UEDCL.

During this period there will be **no sale to the grid,** and Kakira may actually have to **buy-back power.**
Kakira Co-generation - 3

- MEMD and the unbundled utility companies – UETCL and UEDCL were initially not geared to undertake a private-sector bagasse-based power supply project.
- A tripartite agreement was required since:
  - Under the Uganda Electricity Act only UETCL can purchase bulk power
  - Only UEDCL can handle power at 33kV – for sale to consumers.
  - Also UEDCL must sell power back to KSW during annual factory shut-down.
- **KSW submitted its first draft of the Energy Purchase Agreement to MEMD in February 2002.**

Kakira Co-generation - 3

- **KSW Energy Purchase Agreement**

  **Major discussion points:**
  - MEMD considered proposed KSW **Tariff** too high – despite only 25% incremental capacity utilisation
  - UEDCL unwilling to allow **buy-back of power** (during KSW shut-down) at **same tariff**
  - UETCL did not appreciate **inter-linking** of sugar factory operations and electricity generation
  - Electricity supply during gradual **ramping-up** and **ramping-down** of peak-period supply to grid
  - **Liquidated damages** for non-supply
  - UEDCL required KSW to build a **14 km New Distribution Line** to connect to the grid.

- **KSW Energy Purchase Agreement finally signed after 17 months: 31-July-2003**
Kakira Co-generation - 3

As per the Energy Purchase Agreement between Kakira, UETCL and UEDCL of 31 July 2003

- **SUPPLY**
  - Kakira will provide to UETCL for onward distribution by UEDCL on **take-or-pay basis during peak hours**.
    - In year 1: 5 MW
    - Year 2 onwards: 6 MW
  - KSW can provide **additional power on energy basis**.

- **FUNDING**
  - **Global Environmental Facility [“GEF”] Grant of US$ 3.3 million** to reward petro-carbon saving and to compensate for project cost for idle capacity.
  - **World Bank refinancing of US$ 8 million** (through Bank of Uganda) of PFI (EADB) loans for Kakira co-gen project.
  - **Kakira agreed to arrange balance funding** – including finance for KSW agriculture and factory expansion
In late 2003, AES withdrew from the Bujagali power project. Envisaging a continuing power shortfall in Uganda, KSW decided to expand its cogeneration capacity.

KSW had to change a few critical parameters:
- **Factory expansion** in phases to **6,000 TCD**
- Intermediate-pressure boilers: **2 x 50 TPH – 45 bar**
- Increased new **turbo-alternator capacity - 16 MW**

As an interim measure to meet increased in-house demand, KSW has procured and installed an **additional 3 MW turbo-alternator.**

This would also provide flexibility for additional power sale.

The Madhvani Group decided to provide KSW **incremental financing** from its own resources.

**KSW has now offered MEMD:**
- up to **12 MW on 24 h/d basis**
- an option to expand to 15 MW on 24 h/d basis

KSW is still discussing with UETCL and MEMD: the quantum of supply, timing and tariff.
Kakira Co-generation - 4

New Power House

Kakira Co-generation - 4

New Power House 40T Crane

New 3 MW Belliss TA in Power House
Kakira Co-generation - 4

New Power House
Bus-ducts

New Power House Steam Piping

Kakira Expansion & Co-gen Project
Implementation Schedule

- Considering the time required for:
  - plant design (and redesign) + ordering
  - boiler + turbine manufacturing / assembly (18 m)
  - delivery and installation (6 m)
  - integration with the existing sugar manufacturing process during the annual factory shutdown in April-June each year

the Kakira project would be on-stream by late 2006.

This will also provide time to increase sugar-cane supply.

- If MEMD had accepted KSW’s original proposal, KSW’s cogen plant could have been completed by 2001.
Kakira Expansion & Co-gen Project

Environmental Considerations

- Control of all discharges
- Treatment of factory effluents
- Ash control of boilers with wet scrubbers
- Reduced open-field burning of bagasse
- Generation of up to 20 MW to augment national supply – which would reduce current peak-hour power generation from petro-carbon based fuels.

Kakira Excess Bagasse Disposal
Kakira - Rural Development & Socio-economic Benefits

- KSW provides agricultural extension services to over 3,500 Outgrower Farmers - increasing to 6,000.

- Kakira currently has over 6,200 employees, who along with their families, benefit from KSW’s operations.

- In addition, outgrowers and ancillary support industries offer gainful employment to thousands.

- KSW provides social infrastructure in a rural area – worker housing, a 100-bed hospital, schools (3 nursery, 8 primary and one secondary), etc.
Kakira - Rural Development & Socio-economic Benefits

- Agricultural advice
- Worker housing
- 12 Schools
- 100-bed Hospital

Kakira Expansion & Co-generation Project

KAKIRA SUGAR WORKS

Lessons Learned
A recent *World Bank* review of the Kakira cogeneration project came to the following conclusions:

- **Private firm** - Kakira Sugar Works - highly capable to undertake project preparation and implementation
- **Power purchase agreement** a major issue:
  - Electricity Sector reform did not account for small power producers
  - The Grid needed only peaking power, although cogen capability is much broader
  - First-of-a-kind PPA requires capacity building for all parties
  - Multi-year negotiation required seller with ‘staying power’

**Kakira’s suggestions**:

For successful Rural Electrification using renewable resources, the concerned Govt. agencies must:

- Commit to a policy to *diversify sources of power*
- Recognise that *small co-generation projects are very different* from large hydro or thermal power projects.
- Appreciate that *renewable energy may initially be more expensive* than hydro-electricity, but projects can be *implemented much faster* and *reduce dependence on single energy source* (e.g. water levels).
- Be more transparent re. *energy costs*
- **Assist in financing** – particularly for independent projects, which are not part of established business enterprises.
- **Develop standardised packages for renewable energy projects** (power purchase agreements + tariffs) – to reduce implementation time and investor fatigue.
The Madhvani Group

Telephone: +256 (0) 41 259390/4/5 Kampala
+256 (0) 41 444000 Kakira

Fax: +256 (0) 41 259399 Kampala
+256 (0) 43 130040 Kakira

E-Mail: Kakira @ KakiraSugar.com
Projectm @ Infocom.co.ug

Web-site: www.KakiraSugar.com
KAKIRA SUGAR WORKS
UGANDA

From cane to sugar and electricity