# KAKIRA SUGAR WORKS UGANDA


*From cane to sugar and electricity*

# Kakira Sugar Works Cogeneration Project

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The Role of Renewable Energy Policy in Africa for Poverty Alleviation and Sustainable Development

# Kakira Sugar Works

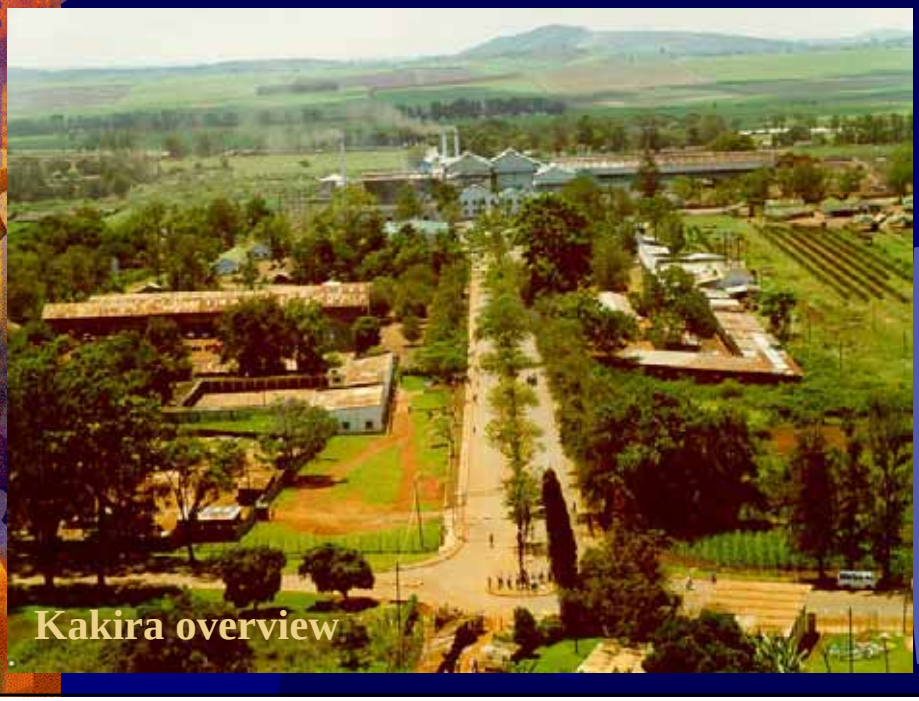
The Madhvani Group's economic flagship, the sugar complex at Kakira, Uganda, has grown from :

- 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 – 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.




## 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





# Kakira sugar factory





# Kakira milling train + steam turbines





**B a g a s s e**

# Optimal Resource Utilisation - Co-generation

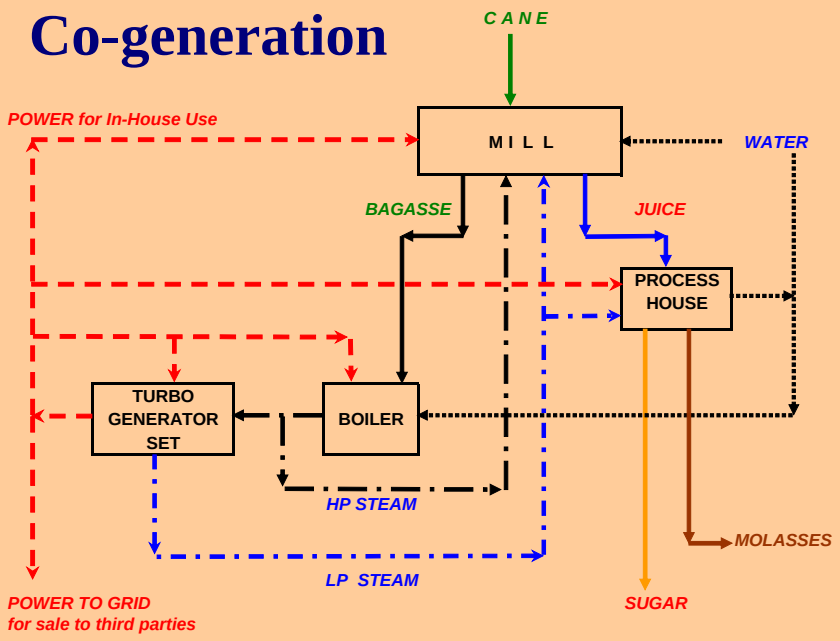
A sugar factory is usually very efficient in utilising all resources optimally.

These resources include :

- **Sugarcane**
- **Water**
- **Steam**
- **Power**

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

# Co-generation



# Co-generation

- **Bagasse** (the dry fibrous residue from sugarcane crushing) is burnt in a ***boiler*** to produce
- ***high pressure* steam**, which is
  (i) used to drive mills, etc. and
  (ii) 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.

# Kakira Expansion & Co-generation Project


*Planning for success through innovation*

# Kakira Expansion & Co-generation Project

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**.

# Kakira Co-generation - 3

(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**.

# Kakira Co-generation - 3

- ***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

# Kakira Co-generation - 4

***SUBSEQUENT DEVELOPMENTS***

- 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***

# Kakira Co-generation - 4

- 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**




## KSW standby diesel generator sets


## Kakira - Rural Development & Socio-economic Benefits

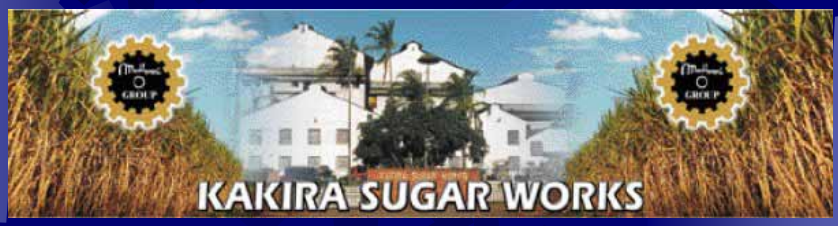
- **KSW** provides agricultural extension services to ***over 3,500 Outgrower Farmers - increasing to 6,000***.
- Kakira currently has ***over 6,200 employees***, who along with their families, benefit from KSW's operations.
- In addition, ***outgrowers and ancillary support industries offer gainful 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





# Kakira Expansion & Co-generation Project




*Lessons Learned*

# Kakira Cogen : 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 Cogen : Lessons Learned

***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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