



Methane, Peat and Waste-to-Power Projects in Rwanda

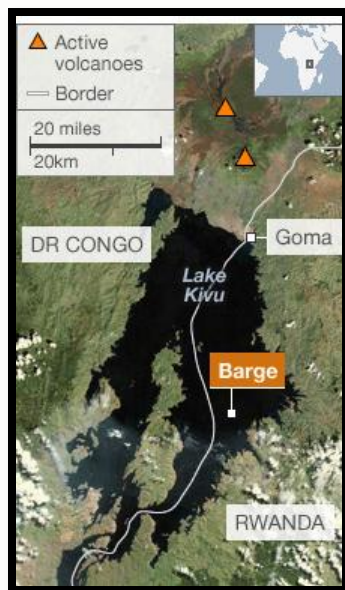
Opportunities for Investment in Rwanda

Energy Investment Forum
Kigali, Rwanda, February 29, 2012



Lake Kivu Methane in Rwanda

Background



- Lake Kivu is located in the East African Rift Zone between Rwanda and the DRC
- The 2,400 sq.km. lake contains high concentrations of naturally occurring CH_4 and CO_2 , with the highest concentrations at depths ranging from 270m to 500m
- The oxygenated upper layer of the lake from the surface to a depth of 60m supports the lake's biology
- The resource is shared equally between Rwanda and the DRC
- The PMP (Peat, Methane and Petroleum) Unit, at EWSA is developing methane projects

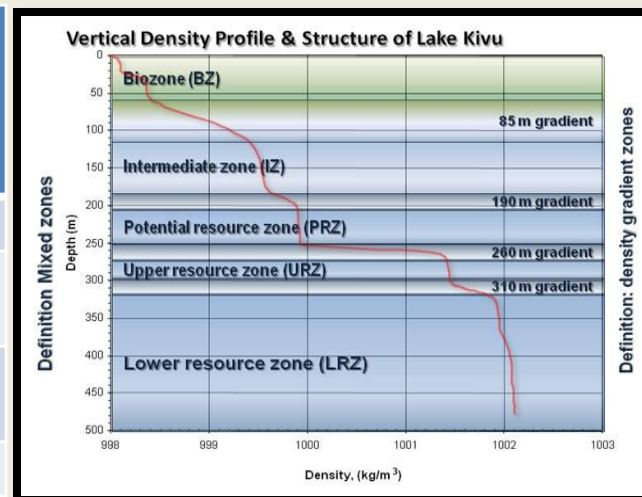
Potential for Methane-to-Power Generation

- Lake Kivu contains about 300 billion m^3 of CO_2 and 60 billion m^3 of CH_4 gas. An estimated 120 to 250 million m^3 of CH_4 is generated annually in the lake
- Rwanda wishes to utilize this resource to develop methane-to-power projects and other uses such as fertilizer and gas-to-liquids projects
- The methane in Lake Kivu is estimated to be sufficient to generate 700 MW of electricity over a period of 55 years; Rwanda's share of the total generation potential is about 350 MW, with the rest being DRC's share



Methane in Rwanda

Characteristics of Methane in Lake Kivu		Characteristics of Scrubbed Gas After Extraction	
Methane	24.9% vol	Methane	80%
Carbon Dioxide	73.5% vol	Carbon Dioxide	18%
Hydrogen Sulphide	0.05% vol	Nitrogen	2%
Other gases	1.5% vol		

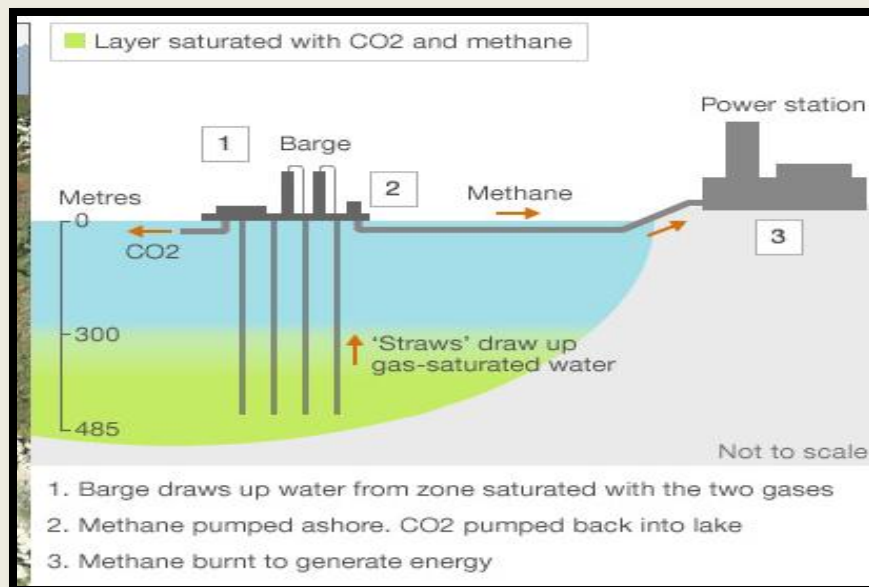


Historic Use of Lake Kivu Methane in Rwanda

- Lake Kivu methane was first tapped by Union Chimique de Belge with a gas pilot plant at Cape Rubona in 1963 to supply the Bralirwa brewery
- Bralirwa brewery converted one of its boilers to use gas in place of fuel oil, and was supplied with 5,000 m³/day of methane gas purified to 80%



Methane Use in Rwanda



- Gas extraction requires an innovative technology due to the unique nature of the gas accumulation in water layers
- Gas extraction concept is flexible and can be adapted to different technology designs and processes

Existing Methane-to-Power Projects in Rwanda

- KP1, a 4.5 MW pilot plant developed by GoR, is operating at about 1.5 MW since late 2007. GoR is in negotiations with a strategic partner to scale-up capacity to 50 MW in phases
- KivuWatt, a subsidiary of Contour Global (USA), is developing a 100 MW plant: 25 MW 1st Phase by end 2012, and 75 MW 2nd Phase by 2015. Phase I is currently under construction
- REC, a subsidiary of RIG (Rwanda), is a 3.6 MW plant.



Investment Opportunities in Methane Projects

Opportunities in Existing Concessions

- **KivuWatt's** 25 MW Phase I (est. cost \$140m), is under construction with GOR Sovereign Guarantee and MIGA guarantee. Phase I financed by a lending syndicate - Emerging Africa Infrastructure Fund, FMO, AfDB, etc. The 75 MW 2nd Phase will need financing. Estimated cost: \$320m-\$360m. Completion: 2014
- **REC** is seeking partners and financing to revive the plant and scale it up to 50 MW. Estimated cost: \$106m. Completion: 2015

Other possible opportunities

- KP 1 need only adjustments on process to reach optimum production of 4.5 Mw. This can be achieved in 4- 6 months. Project may be restructured depending on the new partners and investors
 - Ongoing negotiations with private partners for 100 MW may be an opportunity if discussions are not concluded
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- KP1 and KivuWatt use a modular design which allows quick replication and scaling-up of gas extraction platforms



Development of Methane Resources in Rwanda

Policy, Law & Regulation

- Draft Gas Law and Regulations for methane projects is under review by Parliament, and is to be gazetted
- A draft Concession Agreement and draft PPA is under development for new projects (existing projects have PPAs with the utility)
- Management Prescriptions for the safe extraction of Lake Kivu gas resources are to be adopted

Available Documents

- Numerous reports on Lake Kivu going back to 1937 are available. Recent studies by LAHMEYER-OSAE and K. Tietze, and Lake Management Prescriptions are also available
- Project specific documents may be available subject to confidentiality agreements

Why invest in methane gas to power?

- Methane demonstration plants prove that the gas extraction technology is feasible.
- Rwanda is keen to develop its methane resources as part of its strategy to substantially increase the power capacity



Peat-to-Power Projects in Rwanda

Opportunities for Investment in Rwanda



Peat Reserves in Rwanda

Background

- A Peat Master Plan prepared by EKONO indicated that Rwanda has an estimated reserves of 155 million tons of dry peat spread over an area of about 50,000 hectares
- About 77% of peat reserves are near Akanyaru and Nyabarongo rivers and the Rwabusoro plains

Potential for Peat-to-Power Generation

- The theoretical potential (assuming all peat bogs are exploited) for electricity energy generation from peat is estimated to be about 1,200 MW
- Peat in the Rwabusoro marshland and around the Akanyaru river can fuel 450MW of electricity generation for 25 years
- The Rwabusoro marshland and Rucahabi in the districts of Nyanza and Bugesera present significant opportunity for large-scale peat harvesting for power generation
- Rwanda plans to develop its peat resources to generate about 200 MW of power by 2017



Peat Reserves in Rwanda

SITE	AREA (ha)	THICK- NESS (m)	ASH CONTENT %	RESERVES (Mm3)	RESERVES DRY MATTER (1000 t)
NYABARONGO -AKAGERA	26740	2-4	9-20	800	40000
RUCAHABI (AKANYARU NORTH)	460	2-4/6	7-13.6	20	994
AKANYARU NORTH (OTHERS)	5120	2-6	10-20	200	10000
BUSORO (AKANYARU SOUTH)	800	1-5	6-15	32	1000
RWAMIKO (AKANYARU SOUTH)	130	1->20	6-8	13.5	675
AKANYARU SOUTH (OTHERS)	7070	2->20	6-15/20	920	69000
CYABARALIKA	23	1-5	5.3-17.8	0.35	150
KIGUHU	49	1-4	8.5-14.4	1.8	240
RUGEZI	6500	1->11	2-15	650	32000
GISHOMA	410	1-5	6.3-13.6	7.85	463
GIHITASI	80	1-2	14.4	0.62	40
MASHYA	30	1-5	2.7	0.79	60
KAMIRANZOVU	820	1	6	8.2	500
TOTAL	48200			2650	155000

Main Peat Bogs in Rwanda

Source: Rwanda Peat Master Plan



Investment Opportunities in Peat Projects





Peat Characteristics in Rwanda

Characteristics of Peat in Rwanda	
Heating Value	18.7 - 20.7 MJ/kg
Ash content	2.7% -14.4%
Sulphur	0.2%-0.4%
Water content	92.1-95.1%
Density of Dry Peat	40 kg/cu.m - 76 kg/cu.m
pH of water	4.9 - 6.3(3.1 in some areas)
Melting point of ash	1300 - 1450 ^o C
Carbon, Hydrogen and Nitrogen content	50-59% C 1.3-1.9% H ₂ 5.5% N ₂
Light Sphagnum Peat with Low Degree of decomposition(H1-H3)	Not encountered



Peat Use in Rwanda

Present use of peat in Rwanda

- Two firms are mechanically harvesting peat in Rwanda
 - PEC (Peat Energy Company) supplies 2,000 tons per month to a cement plant
 - RAS (Rwanda Auto Service) supplies peat to prisons for cooking purpose.

Prospective Peat-to-Power Projects in Rwanda

- GoR is developing a 15 MW peat-to-power project in Bugarama /Rusizi district.
- GoR is negotiating with a strategic partner to develop a 100 MW peat fired power plant in South Akanyaru prospect. Project to be developed as an PPP.
- GoR has advertised tenders for EPC contractor and an Owner's engineer for 100 MW peat-to-power project in Rwabusoro prospect. Project to be structured either as public or private.



Development of Peat Resources in Rwanda

Policy, Law & Regulation

- The GOR is preparing a Peat Policy to sustainably and safely harvest peat resources for power generation
- EIA are required for all power projects.

Available Documents

- The Peat Master Plan (1992/93) study prepared by EKONO energy
- An updated Peat Master Plan is under review
- Peat to power Pre-feasibility studies on 8 sites are under preparation

Why invest in peat to power?

- Peat-to-power technology is a proven commercial technology and the risks are low and peat mining projects are in operation
- Rwanda is keen to develop its peat resources as part of its short-term strategy to substantially increase power capacity



Waste-to-Power Projects in Rwanda

Opportunities for Investment in Rwanda

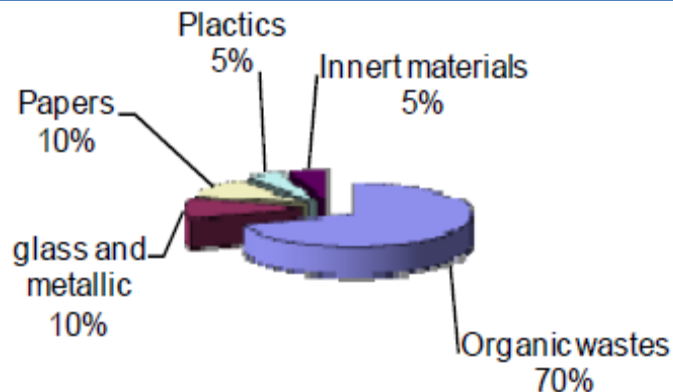


Municipal Solid Waste in Kigali City

Background

- Kigali City produces around 450 tons per day of solid waste of which between 300 and 350 tons/day is centrally collected.
- The fraction of organic waste comes from households, restaurants, hotels and markets.
- Other types of waste solid waste available in the country include agricultural waste, livestock waste, water hyacinth.
- The waste is transported to Nyanza landfill where it is dumped and covered with soil by using bulldozers.
- Kigali City Council and MININFRA are in charge of waste to power projects.

Composition of solid waste at Nyanza landfill



Source: Kigali City

Investment Opportunities in Waste to Power Projects



Opportunities in Waste to Power Projects

- It is estimated that 100 tons per day of raw municipal solid can produce 1MW, using traditional thermal technologies.
- The population in Kigali is expected to reach about 1.5 million by 2020. It is believed that the waste collected will reach about 1000 t per day.
- This represents about opportunity of 10 MW plant.





Investment Opportunities in Waste to Power Projects

Key parameters for a biogas to power project (5 MW)

Amount of Gas Extractable	6 million m³/yr
Electricity Generation	4,000,000 kWh/yr
Capital Expenditure	2.5 million Euros
Operation Period	10 years





Development of Waste to Power Projects in Rwanda

Policy, Law & Regulation

- Regulations regarding solid waste management (collection and disposal waste) have been developed by RURA and REMA.
- Kigali City has developed also the rules and directives on sanitation and hygiene promotion.
- GoR is developing the strategic plans of integrated solid waste management.

Strategies and Solutions developed

- Renovation and eventual closure of Nyanza landfill
- Construction of a new engineered landfill
- Recovery of all recoverable material from the waste stream
- Proper and sustainable waste management through 3R (Reduce, Reuse and Recycle) principles.

Available Documents

- Numerous reports on Waste to Power Projects are available
- Recent guidelines developed by RURA are available and can be checked on:
www.rura.gov.rw/board_decision/18_GUI_DELINES_Landfill.pdf



Benefits/Incentives

Why invest in waste to power

- Waste to power projects are eligible for climate change funds (eg. CDM), this means that additional revenues for emission reduction can be generated by the project.
- An integrated waste to power project will not only generate the much needed power for the grid, but also contribute to addressing issues related to sanitation, health and environment.



THANK YOU FOR YOUR KIND ATTENTION