Technology Fact Sheet for Mitigation

H. Combined Cycle Gas Turbine (Kivu Methane – Combustion Turbine Power Technology), CCGT[1] [i]

1. Introduction	
1.1. Historical	- Kivu methane Gas: extraction of small amount since 1950[s] for heat purposes of the brewery BRALIRWA in North-West at Gisenyi City in Rubavu District - Annual supply: about 1.5 million cubic meters - Properties of the gas: mix of CO_2 and CH_4 - CCGT is not yet applied in Rwanda - CCGT is a combined use of sets of components: combustor of gas, gas turbine, heat recovery boiler, steam turbine and is a reliable technology and is commercial
1.2. Location of Resources	- Lake Kivu
1.3. Variability of Resources	- Where the depth of water in lake Kivu is greater than 300m, the concentration of dissolved gases is high enough - The speed of renewing methane resources is relatively limited - The planned speed of extraction can be adjusted to such a process of transformation resulting in renewability of methane(CH_4

[1] CCGT technology is hereby recommended for replacing the current conventional internal combustion option in use by the actual pilot project generating electricity; to fulfill the conditions of mitigation scenario, al types of GHG emissions have to be treated accordingly: CO2 neutral scenario is possible(reinjection into the lake; storage), H_2S can be transformed into sulfuric acid

	associated to CO_2 and H_2S
2. Brief Description	
2.1. Conditions	- Extraction of mixture of gas from the lake - Separation and collect the CH_4 combustible, re-injection of CO_2 into the lake or use it for industrial purposes - Opportunity of liquefaction for the transfer to the end-users far from the Lake Kivu
2.2. Characteristics	- CT and CCGT can be taken together so that the CT branch can cover the demand linked to the peak load periods while the CCGT cover the base load demand - Modular units of CT: 1 MW to 10 MW - New option: Gas-fired Micro Turbine technology with electric capacity ranging between 25 kW and 250 kW - How CCGT is working with both CT and ST? ✓ The methane gas is injected into a combustion chamber ✓ Then burned gases drive a gas turbine (CT) combined to a generator for producing electric energy ✓ The waste heat is extracted from this gas turbine and sent to a boiler in charge of producing steam (Heat Recovery Steam – Gas Turbine) ✓ Such a steam, in turn, rotate a steam turbine (ST) combined to a

	generator - Specific parameters for a CCGT system: ✓ Thermal efficiency: 34% for a CT system and 51% in case of a CCGT ✓ ST inlet temperature: 538 °C ✓ CT inlet temperature: 1 300 °C ✓ Capacity factor: 80% (i.e. 19 hours) ✓ Life span: 25 years
3. Applicability and Potentialities in Rwanda	
3.1. Applicability	- Already: 1st steps of exploitation - Heat for domestic and industrial - Electrical option is set us s priority at national scale
3.2. Potentialities	- Potential extractions of 10^9 Nm^3/year - Potential electric power generation of 700 MW during about 50 years (MININFRA, 2009)
3.3. Limitations	- Refer to paragraph 3.1
4. Status of the Technology in Rwanda	
4.1. Local Production	- Referring to above paragraph. 1.1. the Kivu methane gas is exploited at very small scale
4.2. Shared Power Plants	- Probably shared option is expected between Rep. Dem. Congo and Rwanda, lake Kivu basin is covering parts of two countries
4.3. Projects	- The generation of electric energy and heat for industrial and domestic purposes is one of the high priority of Rwanda in energy sector (MININFRA,

	2003)
5. Benefits to Development	
5.1. Social	Potentially high
5.2. Economic	Potential important at industrial sector and energy supply levels
5.3. Environmental	- The CCGT system produces GHG emissions relatively significant for NO_x (about 110 mg/Nm^3 while the emission standard is 125 mg/Nm^3 and for CO_2 (400 mg/kWh against 600 mg in case of a CT system taken alone
6. Climate Change Mitigation Benefits	
6.1. Reduction GHG Emissions	Requirements: application of appropriate techniques[regarding carbon sinks, capture, sequestration, storage /underwater]; Associated with the CCS, the CCGT can contribute to GHG mitigation at rate of about 79% with comparison to the oil thermal power plants characterized by an emission of 750kg/MWh
6.2. Low Carbon Credits	Given that both CCGT option and carbon capture systems are expected to result in a low carbon technology of Kivu methane, this technology (highly prioritized at national level) is eligible to carbon credits
7. Financing Requirements and Costs	
7.1. Private Sector Involvement	Financial support to private investors is required especially for those who are intending to be involved both in electric power production and in liquefaction (-168°C)of methane gas towards long - distance –distribution for use by

	households and industries(progressive replacement of fossil fuels and wood/charcoal fuels by methane gas associated with measures for low carbon emissions)
7.2. Capital Cost	- Costs for CCGT (up to 300 MW) - Capital cost: 650 USD/kW and 560 USD/kW respectively for the years 2005 and 2015 [Equipment: 74%] - Gene ration costs: 5.6 and 5.2 US Cents/kWh respectively for the years 2005 and 2015
7.3. Generating Costs	- O & M Cost: 9%; Fuel cost: 74% - Comparison to a simple CT system: ✓ Given that, and among others, the heat associated to the rotation of gas turbine is regularly extracted, CCGT gas a high efficiency (51% against 34% for a CT system) and higher capacity factor (19 hours); in addition, the generating cost is 2 times more important for a CT system
7.4. GHG Emissions	CCGT, if associated with techniques for carbon sequestration and for use of H_2S, is considered as a low carbon technology; it can therefore become the case for development of the Kivu methane projects Taken alone, conventional Gas Turbine technology can result in an emission factor of about 630 kg/MWh against 750 kg/MWh by the oil thermal power plants

7.5. Capability Building	Training and expertise regarding both the combustion/gas/steam turbines, thermoelectric processes , distribution of liquid methane, techniques for carbon sequestration are recommended for any sustainable diffusion of such a CCGT new technology in Rwanda

[i] **This fact sheet has been extracted from TNA Report – Technology Needs Assessment and Technology Action Plans For Climate Change Mitigation– Rwanda. You can access the complete report from the TNA project website http://tech-action.org/**