National Round Table Forum

"Energy accessibility & efficiency in Rwanda"

– Report –

Reported by Prof. Bonfils Safari

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SUCCEED Network consortium:

European Union:

- University of Alicante, Spain (Coordinator)

East Africa:

- Université du Burundi, Burundi
- Moi University, Kenya
- University of Rwanda, Rwanda
- Mzumbe University, Tanzania
- Makerere University, Uganda
- Inter-University Council of East Africa, Uganda

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FOREWORD

Energy deficit and energy poverty have become a major obstacle to growth and development in Eastern Africa. One of the major energy issues is price volatility and energy security. Eastern Africa suffers from high prices in the energy market and shrinking natural energy resources. Restricted access to energy resources is hampering the East African region from sustainable development.

Despite the energy emergency in the region, support from research institutes and academia is inadequate to address this situation. However, at the policy level, various countries have stressed the importance of energy access and quality research and innovations. Unfortunately, there is a mismatch between policies, political decisions and societal needs.

The strategic framework for Rwanda's energy sector is established in the Energy Sector Strategic Plan (ESSP) 2013–17, the Rural Electrification Strategy (2016) and the National Energy Policy (NEP) 2015, which set targets up to 2017/18. These documents recognize the essential role of electricity access in accelerating economic development, as well as improving health outcomes and standards of living for people in Rwanda. The target for electricity access is for 70% of households to have access by 2017/18, to be met through a combination of on-grid and off-grid supply. 100% access to electricity is targeted by 2020. This requires advancing technology which requires an ever-expanding range of ways for households to access electricity: a solar lantern that can also charge a phone or radio; a larger solar home system that can light an entire house and power appliances such as a television; and a grid connection that can power large-scale commercial and industrial use. As reflected in the Medium Term Economic Development and Poverty Reduction Strategy for 2013-2018 (EDPRS-II), the Government of Rwanda has undertaken partnership with the private sector for the socio-economic transformation in easing doing business and reducing barriers to private investment in renewable energy such solar systems and mini-grids, in promoting competition which will help drive down costs and improve customer choice.

SUCCEED Network

Launched in October 2013, the three-year project SUCCEED Network is an ACP/Edulink project (contract number FED/2013/320-274) funded by the European Commission, which aims to promote East African university campuses as "living laboratories" for sustainability and energy efficiency, in particular by establishing a sustainable campus development platform to foster collaborative learning and action for energy access and efficiency, with the idea of contributing to solve the problems described above. The project will do this via a set of activities with the objective of improving institutional, academic and cooperation building which should result in a stronger institutional background, an enriched academic offer in renewable energy and energy efficiency, and an increased attractiveness for relevant stakeholders in order to establish new cooperation schemes in the field of energy.

OBJECTIVES OF THE NATIONAL ROUND TABLE

The National Round Table Forum *"Energy Access and Energy Efficiency"* was held on November 16, 2016 and November 23, 2016 at the School of Science, College of Science and

Technology, University of Rwanda. It was organised in the framework of the SUCCEED Network ACP/Edulink project.

One of the University of Rwanda's strategies is to strengthen its relations with Private Sector through research, consultancy, internships, seminars and lectures. In the framework of partnership between the University of Rwanda and the industry, the University of Rwanda has initiated a dialogue with industry through a series of conferences and discussions between managers and scientists, administrative staff, students and members of the UR Energy Efficient Unit. The aim of the event was to bring together the main stakeholders in the field of energy in Rwanda to exchange ideas and discuss energy issues at a national level in Rwanda.

The specific objectives of the National Round Table were to:

- Discuss problems and issues in the field of Energy affecting National Stakeholders, with the idea of identifying where the Higher Education System could contribute with specific services/input.
- Encourage dialogue and strengthen co-operation links in the energy sector at national level among academia, researchers, industries and policy makers.
- Present the Succeed Network projects and their developments.

PARTICIPANTS

The National Round Table brought together several relevant stakeholders in the field of Energy in Rwanda, including:

S/N	Institution	Name	Role
1	CST	Prof. Bonfils SAFARI	SUCCEED Project-UR
2		Dr. Céléstin TWIZERE	Academic staff EEU member
3		Fabien MUKUNDUFITE	Academic staff EEU member
4		Isaac NTIHINYUZWA	Academic staff EEU member
5		Adrien UWAMAHORO	Academic staff EEU member
6		Dr. Anastase RWIGEMA	Physics academic staff
7		Dr. Emmanuel NSHINGABIGWI	Physics academic staff
8		Dr. Christian KWISANGA	Physics academic staff
9		Dr. Sylvestre BULIKUNZIRA	Physics academic staff
10		Mr. MAGEZA Céléstin	Physics academic staff
11		Mr. HAKIZIMANA Anastase	Physics academic staff
12		Mr. MUSHINZIMANA Xavier	Physics academic staff
13		Mr. SINARUGURIYE Jean de la Croix	Physics academic staff
14		Mr. NKURIKITIMFURA Innocent	Physics academic staff
15		Mr. HABYARIMANA Fabien	Physics academic staff

16		Mr. SHYIKIRA De Padoue	Physics academic staff
17		Mr. BAHARANE Valerien	Physics academic staff
18		Mr. MAKUTAZA Joseph	Physics academic staff
19		Mr. SAFARI Abdou	Physics academic staff
20		Egide MUNDERERE	Coordinator Nyagatare Campus
21	CST & CMHS	Olivier KALIBOLI	DEMF
22	CASS	Ernest BARAKAGWIRA	DEMF
23	CAVEM	Christian HATEGEKIMANA	DEMF Musanze Campus
24		Cassien NSANZIMANA	DEMF Nyagatare Campus
25	CE	Damascene NIYONZIMA	DEMF

CST: College of Science and Technology
CAVEM: College of Agriculture & Vetarinary Medicine
CMHS: College of Medicine and Health Sciences
CE: College of Education
DEMF: Director of Estate Management and Facilities

ROUND TABLE

DISCUSSION POINTS: 'TITLE RT1' "Recent Developments and challenges on Energy Access and Energy Efficiency in Rwanda"

Presenter: Eng. Jean-Bosco Mugiraneza, CEO of Rwanda Energy Group Ltd
Moderator: Professor Bonfils Safari

PRESENTATION

In Rwanda, the installed capacity for electricity generation has increased from 45 Mega Watt (MW) in 2006 to 97.4 MW in 2010/11 exceeding the target of 90 MW for 2010/11 while the target for 2012/2013 is 130 MW. The number of electricity connections increased from 91,332 in 2006 to 215,000 in 2010/11 compared to the EDPRS I (2006/2011) target of 200,000 connections. EDPRS II (2012/2018) has set targets for electricity generation of 349 MW in 2015/2016 and 563 MW in 2017/18 with a baseline of 2012 of 110 MW. For households with access to electricity the targets are 57% in 2015/2016 and 70% in 2017/18 with a baseline of 2012 of 45%.
Rwanda Energy Group (REG) was established out of Energy Water and Sanitation Authority "EWSA" and its predecessor companies and has two Subsidiary Companies namely Energy Development Corporation Limited (EDCL) which is a development wing of the Group and Energy Utility Corporation Limited (EUCL) which is a commercial entity of the group.

With the aim of streamlining and decentralizing its business functions, REG/EUCL established branches in each district.

Photo 1:

The CEO of REG Ltd Eng. Jean-Bosco Mugiraneza delivering a lecture on Recent Developments and challenges on Energy Access and Energy Efficiency in Rwanda.

The group with its subsidiary companies owns and operates:

- Generation;
- Transmission, 220 and 110kV;
- Distribution Lines, 30/15/6.6/0.4kV;
- Retail of electricity;

And is also the single buyer for power produced by Independent Power producers.

Table 1: Percentage of Energy Generation

Source	2015/16	2014/15	Growth
Hydro	42%	50%	-8%
Diesel	27%	47%	-20%
Methane	18%	2%	16%
Solar	2%	6%	-4%
Import	11%	10%	1%

Importance of Energy efficiency

Improvements in energy efficiency are both a smart business investment and an imperative for the global community. Like investment in renewable energy sources (solar, wind, and biomass), investment in energy efficiency presents great opportunities:

- More competitive industries through energy cost savings;
- Greater outreach of energy services to the rural poor, among others, through more efficient generation and supply; and most importantly.
- Technology and employment gains through international best practices.

Improved energy efficiency is a vital component of the global strategy to reduce the use of fossil fuels (oil, gas, and coal) and thereby help to reduce greenhouse gas emissions and the threat of climate change.

Achievements in areas of Energy Efficiency-REG

The ultimate objective for a Utility to invest in energy efficiency programs is the efficient use of available resources but also would be considered a postponed generation investment if amount of energy required to provide products and services is reduced. The predecessor companies with the help of World Bank championed the campaign to phase-out incandescent lamps and introduced CFL which led to 65GWH energy saving, reducing pressure on peak demand by around 44MW and a target to reduce close to 40,000 tons of carbon emissions. The above achievements highlight the efficient use of resources and a challenge to researchers to invest time and resources to save future generations.

In addition to the above achievement, REG is also undertaking below initiatives:

- Investments to reduce loading of transmission/distribution infrastructure (reinforcement of Kigali electricity network, improving quality of supply etc...);
- Initiatives to rollout Light Emitting Diodes due the benefits over CFLs,
- Derisking solar water heaters distribution project (through provision of soft loans and subsidies);
- Encouraging private sector participation especially in renewable energy business,
- Awareness campaign on energy efficiency and saving.

Gaps and challenges in the energy sector in Rwanda

- Management of energy efficiency investments and electricity scale-up investments (financial challenges to manage both at the same time);
- Capacity gaps (not enough skills to meet specific needs of the energy sector and specialized training are done abroad);
- Infrastructure challenges (old infrastructure);
- No home grown solutions to fit local needs especially the poor,
- Dependence on imports for both electrical materials and equipment but also specialized services,
- Cost of getting electricity is still considerably high and requires government subsidies;
- Expertise required in areas of indigenous resources like geothermal exploration, peat to power, methane gas,

- Mechanisms for loss reduction,
- Energy saving and efficiency: improved stoves, biomass, solar systems
- Rural electrification for sustainable development.

Energy Sector Strategic Plan strategies to address challenges

- To enhance energy security and to better align demand and supply balances;
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- To ensure that tariffs and prices for energy services are cost-reflective;
- To reduce coordination failures and the cost of financing infrastructure;
- To meet ambitious energy access targets without raising the average cost of electricity services, increasing subsidies, compromising service quality, or compromising environmental sustainability;
- To develop the requisite institutional, organizational, and human capacity to increase accountability, transparency, national ownership and decentralized implementation of energy service delivery;
- To dramatically scale-up energy investments through more effective private sector engagement.

Energy Sector Strategic Plan high-level target objectives

- To increase the electric power system equivalent installed capacity (domestic generation + imports) to 563 MW;
- To increase household access to grid electricity to 48% and access to off-grid electricity to 22%;
- To achieve savings from energy efficiency measures of 10% through demand-side management measures and grid-loss reductions (from a 2013 baseline);
- To reduce the carbon intensity of the grid by 10% by 2018, and 25% by 2025 (from a 2013 baseline);
- To ensure 80% of all households employ clean cooking energy technologies;
- To realize all EAC Regional Integration Policy priorities for energy sector;
- To ensure the necessary infrastructure is in place to meet current petroleum strategic reserve requirements (currently 150 m3 storage).

Research Opportunities

- Renewable energy sources: Solar, Peat, Methane Gas, Geothermal
- Climate change vs Hydro resources
- Future energy mix might include:
- Nuclear technology
- More imported power (Power trade among countries)

DISCUSSIONS

Discussions were focussed essentially on how the University can collaborate with the main supplier of electricity in Rwanda in order to support students in supervision of internship and final year projects; and staff in providing data for research.

CONCLUSION

The CEO REG highlighted, during his presentation, recent developments and challenges on Energy Access and Energy Efficiency in Rwanda. The gaps and challenges presented, demonstrated opportunities for academia for collaboration, especially areas of partnership in research and development in energy sector. Staff of the Research Development Unit which recently approved by the REG Board of Directors will work closely with university researchers on various topics related to energy sector in Rwanda. This will help students and scientists of UR engage more with REG through Technology Transfer systems in order to develop renewable energy technologies.

DISCUSSION POINTS: 'TITLE RT2' "Strategies on Energy Access and Energy Efficiency in Rwanda, Opportunities from Kivu Methane Gas Power Plant"

Presenter: Eng. Alex Kabuto, General Manager of Symbion Power Lake Kivu Ltd

Moderator: Professor Bonfils Safari

PRESENTATION

Lake Kivu is one of the most beautiful lakes in the World. It is located at an altitude of 1,460 meters above the sea level in the East African Rift Zone between Rwanda and the DRC. The total volume of water is 560 billion m^3 with a total volume of dissolved carbon dioxide (CO_2) of 255 billion m^3 and a total volume of dissolved methane gas (CH_4) of 65 billion m^3. The methane in Lake Kivu is estimated to be sufficient to generate 700 MW of electricity over a period of 55 years. The main risks associated with the methane gas extraction are: (i) the alteration of the lake stability, (ii) the deterioration of the lake ecosystem due to an increase of the nutrients inputs, (ii) to waste the resources due to an inefficient technology.

During his presentation, Eng. Alex Kabuto said that Symbion Power Lake Kivu Ltd is a key partner of Rwanda's plan to increase generation capacity. An agreement between the Minister of Infrastructure and the CEO and founder of Symbion Power LLC was signed in December last year to produce 50 MW electricity from Lake Kivu methane gas which represents 30% of Rwanda's total current installed capacity of 185MW countywide. Base load power generated from the lake resource methane gas by Symbion Power Lake Kivu Ltd will help boost Rwanda's electricity supply and lower the overall cost of electricity.

The company will build a power station by constructing gas extraction facilities to lift, separate and process methane gas, which is dissolved in the deep waters of Lake Kivu, and then deliver it to an on-shore generating facility located at Cape of Busororo in the Nyamyumba area of Rwanda.

The process of extracting methane from the waters of Lake Kivu will be done in a safe and controlled manner, said Eng. Alex Kabuto. It starts with inlet water at a depth of –321 meters, water with dissolved gases comes through the vertical deep pipe to first Vessel Separator separation gases from water is proceeded. The rejecting water from Vessel Separator send back to Lake at a depth of 90 meters some gases such as hydrogen sulfide (H_2S) and CO_2. At this depth, it is good enough to keep the layers of lake stable due to

hydrostatic pressure of water column. After the first Vessel Separator, the mixture of gases continue to the next vessel called Scrubber where cleaning of CH_4 is processed from remaining mixture gases such as $CO_2$and H_2S.

Photo 1:

The General Manager of Symbion Power Lake Kivu Ltd, Eng. Alex Kabuto delivering a lecture on "Strategies on Energy Access and Energy Efficiency in Rwanda, Opportunities from Kivu Methane Gas Power Plant".

The Process of scrubbing is done by pumping fresh water at -6meters to the top of scrubber which meets with the mixture of gases coming from the separator. During the process of scrubbing, big amount of mixture of gases CO_2 and H_2S is solved in the fresh water, by the principle of solubility, and then the waste water is sent back to depth of -90 meters in the same way as the rejecting water of separator. CH_4 which has low solubility in water continue through outlet of Scrubber to a Dryer for removal of additional humidity. The methane gas then goes through the gas pipe line to onshore Power Station. In case of startup process of gas extraction or in case of additional amount of gas in system, the gas is flared or burned to avoid penetration of gases into the ozone layer. Air-lift (compressed air) is used to increase flow of water from depth and therefore to increase the total amount of methane gas flowing through the process. The air-lift is connected to inlet pipe at a depth of 60 meters. This technology is the same as for Air Lift of Oilers.

By removing the methane, this power project will contribute to reduce the potential risk of gases trapped in the deep layers of the lake rising to the surface and endangering the surrounding communities, and will help to replace expensive, imported and polluting fuel with indigenous fuel sources to produce electricity, said Eng. Alex Kabuto. He highlighted that the first barge of Symbion Power Lake Kivu Ltd will provide 14 MW of electricity 15

months after the project reaches financial close and the full 50 MW will be commissioned within 36 months after the agreement completion.

DISCUSSIONS

Discussions were focussed essentially on sustainability and on how to secure the population living in the surrounding of the plant by preventing them against a disaster caused by an uncontrolled realising of carbon dioxide as it happened in Lake Nyos in Cameroun. Eng. Alex Kabuto assured that all security measured were taken and that the technology used in extracting methane gas sustainable.

CONCLUSION

The General Manager of Symbion Power Lake Kivu Ltd highlighted, during his presentation, recent the technology used in producing power from extraction of methane gas of Lake Kivu. This is an opportunity for Rwanda to increase its capacity of production of electricity.

He took the opportunity to thank the University of Rwanda for having given him an opportunity to come and interact with students and invited them to apply for internship as this will increase their chance to get job in his company.

ANNEX

Power Point Presentations:

- "Recent Developments and challenges on Energy Access and Energy Efficiency in Rwanda"
- "Strategies on Energy Access and Energy Efficiency in Rwanda, Opportunities from Kivu Methane Gas Power Plant"

Summary Presentations posted on the University of Rwanda Website:

http://cst.ur.ac.rw/index.php/news/142-ceo-of-reg-delivers

http://cst.ur.ac.rw/index.php/news/145-ur-drives-to-strengthen-relations-with-industry