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A REVIEW OF THE ENERGY SITUATION IN UGANDA

K.O.Adeyemi* and A.A.Asere**

*Department of Mechanical Engineering, University of Abuja- Nigeria, kfadeyemi@yahoo.com
**Department of Mechanical Engineering, Obafemi Awolowo University Ile-Ife- Nigeria, aaasere77@yahoo.co.uk

Abstract: This paper reviews the energy sector of Uganda. As is typical of East Africa, it is characterized by excessive use of Biomass to provide over 90% of the energy needs. Uganda is one of the least developed countries in the region. Hydropower provides over 90% of the total electricity generated in the country while wind, solar and geothermal are under developed. Energy policies are geared towards the use of modern, clean and energy efficient technologies. This is stimulating public private partnerships, attracting multilateral and bilateral agencies to provide funding, grants and technical assistance in renewable energy projects. The Clean Development Mechanism (CDM) of the United Nations avail project developers the opportunity to obtain carbon finance. Several challenges hindering the development in the energy sector and utilization of renewable energy resources have been identified. Strategies for achieving the United Nations Sustainable Energy for All Initiative have been presented.

Index Terms: Renewable Energy; Energy consumption; Sustainable Energy

I. INTRODUCTION

Energy is the engine for economic growth and development for any society or country.With a projected population of 34.1 million in mid2012,Uganda is richly endowed with abundant energy resources that are fairly distributed throughout the country [1]. These include hydro, biomass, solar, geothermal, peat and fossil fuels. Uganda's energy matrix is dominated by biomass based energy sources contributing about 95% to the total primary energy consumption. Electricity and petroleum products contribute 4% and 1 % respectively [2]. With a per capita energy consumption of 0.3TOE or 12.72 GJ, Uganda's energy consumption is among the lowest in the world [3]. It is amongst the countries with lowest levels of electricity development as well as lowest per capita electricity consumption of 72 kWh [4]. Over 90% of the country's population is not connected to the national grid, much of the electricity network at present is poorly maintained and the country experiences frequent power cuts [5].The energy resource potential of the country includes an estimated 2000 MW of hydro power, 450 MW of geothermal, 460 million tonnes of biomass standing stock with a sustainable annual yield of 50 million tons, an average of 5.1 kWh/m^2/ day of solar energy, and about 250 million TOE of peat[6]. In addition, an unspecified amount of petroleum has been discovered in the western part of the country though all fossil fuels used in Uganda presently are importedwith a petroleum import bill of about US$ 120 million per year [3].This constitutes about 8% of total national imports and represents slightly above 20% of the country's total export earnings. Biomass constitutes 93% of energy consumption mainly in the traditional form.Wood fuel will continue to be the dominant source of energy in Uganda for the foreseeable future, even if the entire hydroelectric potential in Uganda was fully utilized, wood would supply more than 75% of the total energy consumption in year 2015 [7].Ugandan Power Sector Investment Plan estimates that a cumulative investment of close to USD 9 billion (7.2billion euros) in funding is needed between 2009 and 2030 to accommodate rising electricity demand and to achieve close to universal access to electricity [8].

II. ENERGY RESOURCES IN UGANDA

2.1*Hydro*

Despite Uganda's vast hydropower potential, estimated at over 2000 MW, less than 10% is currently exploited [9].Hydropower contributes only 1% to Uganda's energy supply [10]. Uganda has a hydropower-installed capacity of 683MWwith current peak demand of 400MW [5]. This has been growing at an annual rate of 8% [5]. To meet this growth in demand about, 20 MWof new generating capacity needs to be added each year. Given the large and growing gap between electricity supply and demand in Uganda, large-scale hydroelectric development is the most economical way forward for the country in the short and medium term. Due to drought, only 135 MW is generated from the hydropower facility. The generation output might reduce to 80-90MW depending on the weather situation. 50 MW is obtained from a thermal power plant installed in May 2005 as a partial solution to the electricity supply problem.

The demand for electricity is 260 MW during the day and rising to 350MW in the evening. The eveningpeak is mainly due to the domestic users who constitute the bulk of Uganda power distribution company customers (UMEME). Thecurrent power shortage has adversely impacted on the industrial and commercial sectors.Production has been disrupted. As a result, the GDP, which was expected to grow at 6 – 6.5% in 2012, has dropped to 4.5% [1].Uganda will require 2,000 Megawatts (MW) electricity by the year 2025 to run its industries and homes [3]. To provide access to electricity in the rural areas, the government with its development partners are constructing 10 mini hydro power plants with each power plant having 1-1.5MW generating capacity [11].

Table 1.0: Current State Of Power Generation In Uganda

Plant/Source	Capacity (MW)
Kiira hydro power station	200
Nalubaale hydro power station	180
Bujagali hydro power station	250
Mpanga small hydro power plant	18
Bugoye small hydro power plant	13
Mobuku III hydro power plant	10.5
Tronder Ishasha hydro power plant	6.5
Nyagak III hydro power plant	3.5
Kakira Cogeneration plant	22
Kinyara cogeneration plant	8
Namanve thermal power plant	50
Electro maxx	20

Source: [21]

Table 2.0: Hydro Power Projects In The Pipeline

Plant/Source	Capacity (MW)
Karuma hydro project	600
Anyagu hydro project	600
Oriang hydro project	400
Isimba hydro project	188
Muzizi hydro project	52
Kigati hydro project	18
Nyagak III hydro project	4.4

Source: [21]

2.2***Biomass***

Bioenergy, apart from hydropower, is considered to be the second significant pillar to secure energy supply, particularly in rural areas [7]. Biomass contributes over 90% of the total energy consumed in the country and providesalmost all the energy used to meet basic energy needs for cooking and water heating inrural areas, most urban households, institutions, and commercial buildings. Biomass isthe main source of energy for rural industries [12].Biomass alone can produce an estimated 1, 650 megawatts of electricity if exploited [13]. Biomass cogeneration from agricultural wastes is seen to hold particular promise as a technology for the country. The total biomass based cogeneration capacity potential for Uganda is estimated to be 190 MW [14].To date there are only three known cogeneration facilities, i.e in Kakira Sugar Works Ltd, Kinyara Sugar Works Ltd and Sugar Corporation of Uganda Ltd with total installed capacity of 30MW mainly for own consumption with about 5MW supplied to the grid.A significant peat resource also exists, of which approximately 25 million tonnes is feasibly available for power generation, equivalent to 800 MW of potential capacity for 50 years [9].Trading in biomass especially charcoal contributes to the rural economy, in terms of rural incomes, tax revenue and employment [15]. Charcoal production and transportation is not properly regulated and the disposal of biomass waste by burning, without extracting the energy content, is a common practice countrywide [16]. The government of Uganda through the Africa Biogas Partnership Programme is promoting the use of biogas as an alternative source of energy. It is a 4 year project with a target of 20,000 digesters installed in households by the end of 2013. The biogas digesters are subsidized at approximately 200 euros of the plant cost [17].

Table 3.0 Biomass Energy Projections

Year	2006	2011	2016
Population	28,750,903	33,817,496	39,778,010
Consumption (tons/yr)	27,525,903	32,699,196	38,893,119
Sustainable supply (tons/yr)	27,698,231	28,227,662	28,136,254
Crop residues	4,400,000	4,730,000	5,084,750
Balances (tons/yr)	162,328	4,471,535	10,756,866
Balances (when residues are included)	4,238,000	256,365	5,672,116
Deficit/Surplus (%)	3.2	-13.7	-27.7
Deficit/Surplus (tons/person)	0.031	-0.132	-0.270

Source:[18]

2.3 Geothermal

Geothermal resources were estimated at about 450 MW in the Ugandan Rift System and three areas Katwe-Kikorongo (Katwe), Buranga and Kibiro identified as promising areas for geothermal exploration [12]. To utilize the geothermal resources, the government and the federal Institute of Geosciences and natural resources Germany, has initiated a project on the rift system. A model has been developed which suggests a possible drilling location. A 10 MW_e binary power plant might be feasible, which could allocate a local electricity supply in Bundibugyo district for more than 200,000 people [19].

2.4 Solar

The mean solar radiation is 5.1 kWh/m^2 per day, on a horizontal surface. This level of insolation is quite favorable, for the application of a number of solar technologies. An estimated 200 MW of potential electrical capacity are available in Uganda [20].Solar energy is currently used primarily for off-grid electrification for rural communities, as well as for solar cooking, and providing water heating and power to public buildings [9].

III. Challenges Facing The Uganda Energy Sector

The major challenge in the energy sector revolves around lack of a mix of energy sources in power generation, low level of access to modern energy, inadequate infrastructure for generation, transmission and distribution and low level of energy efficiency. Other challenges include:

- Lack of strong legislative framework, practical policy, legal and regulatory environment for the private sector to be attracted to investing in renewable energy development.
- The high upfront costs of investment in renewable energy technologies make them uncompetitive in the market.
- High cost of thermal power generation

- Securing financing for small-scale energy projects

IV. Way Forward

- Aggressive reinforcement of the grid with the development of small hydro power plants.
- Constant review of Power Purchase Agreement (PPA) and Feed-in-Tariff. It mitigates financial risk through long-term income stream.
- Establish an appropriate financing and fiscal policy framework that will attract more investors to renewable energy and low carbon technologies.
- Women need to play a role in the provision and management of energy resources, since they are the most affected by inadequate energy supplies. The difference in interests, needs and priorities should be recognized in planning, implementation and monitoring of renewable energy projects.
- Campaign and launch the development, adoption and utilization of other modern fuels and technologies in order to achieve the objectives of emission reduction, protection of the environment and energy conservation.
- Uganda produces a lot of alcohol from sugar molasses, bananas etc containing 6-11% ethanol. This should be further processed using efficient technology to serve as a bio fuel rather than for drinking purposes.
- Promote research and development, technology transfer and international cooperation.
- Promote Renewable Energy and Energy Efficiency Programs (REEP) such as the distribution of improved cook stoves and compact fluorescent light bulbs to households.
- Develop the geothermal energy resource through donor assistance, bilateral funding etc.
- Cogeneration plants are under developed and generate below optimal capacity, plants need to be upgraded so as to sell power to the grid.
- Incorporate Clean Development Mechanism as a component of renewable energy projects for the purpose of getting carbon finance.

V. Conclusion

Ugandahas long way to go if it has to key into the sustainable Energy for all Initiative of the United Nations (SE4ALL) and to also achieve the millennium development goals (MDG) by 2030.. Developing and harnessing of the country's renewable energy potential is still demanding if the country's energy needs are to be met. It has set its objectives in the Energy and Renewable energy policiesas "to meet the energy needs of Uganda's population for socio and economic development in an environmentally sustainable manner and to increase the use of modern renewable energy sources from the current 4% to 61%" respectively. This is an ambitious target that should be backed up with capacity building activities inmodern energy technologies and adequate financing.

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AUTHORS

First Author Adeyemi Kafayat, PhD Mechanical Engineering, University of Abuja, kfadeyemi@yahoo.com

Second Author Asere Abraham, Professor of Mechanical Engineering, Obafemi Awolowo University Ile-Ife, aaasere77@yahoo.co.uk

Correspondence Author Adeyemi Kafayat, PhD Mechanical Engineering, University of Abuja, kfadeyemi@yahoo.com +256781678994