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Energy and Sustainable Development in East-Africa: Case Study of Eritrea

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A paper presented by KIFLOM MICHAEL KAHSAY
State of Eritrea

Alternative Energy in Eritrea

Introduction

The East African region is endowed with a diversity of energy resources unevenly located across the continent. They include relatively important reserves of oil, gas and coal. The hydropower potential of this region accounts more than 3/5 of the continent.¹ However, energy is still produced largely from biomass.

The region has large hydro dams, enjoys abundant solar radiation ranging from all year round, strong wind power potential and a considerable geothermal power as it lies in the Rift Valley of the continent.

Yet, in spite of all its energy potential the region is unable to establish sustainable economic growth. Its energy consumption is largely dominated on biomass, animal wastes, municipal and industrial waste. All this energy is consumed by households for cooking, drying and space heating.

Like most developing countries of the region, Eritrea heavily depends on biomass sources of energy. According to a national energy survey the energy balance showed that 77.3 % was from biomass and the rest covered by oil products and electricity, accounting for 21.3 % and 1.4 % respectively.²

¹ Siddiqi Moin. African Business Review of Business & Technology “The challenges of lighting Africa” (Nairobi: Kenya, October 2008).

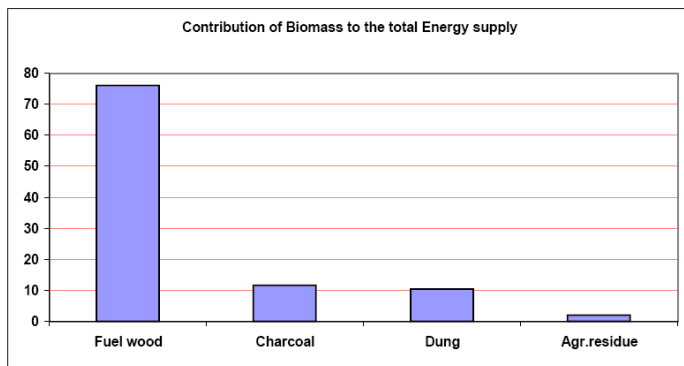
² The State of Eritrea Ministry of Land, Water and Environment. “Eritrea’s initial National Communication under the United Nations Framework Convention on Climate Change (UNFCCC)” (Eritrea: Asmara, December 2001).

Energy is central to achieving the interrelated economic, social and environmental aims of sustainable development, and energy services play a crucial role at realizing developmental programs. In this regard, Eritrea is facing a number of challenges, such as achieving more reliable and efficient access to energy for domestic consumption and production to attain sustainable economic growth.

The main objective of this study is to look at what dominates the current Eritrean sources of energy, explain the link between energy, poverty and economic development, highlight possible mitigation options in the energy sector.

Source of Energy

Eritrea heavily depends on biomass sources of energy. A large number of the Eritrean population depends on biomass for cooking and other household energy needs. On the basis of the survey conducted in 1996 by the Ministry of Land, Water and Environment out of the total primary energy consumed, 75.5% came from wood.³



Source: THE STATE OF ERITREA MINISTRY OF LAND, WATER

As a consequence, a large forest cover of the country had been cleared for fuel. The land became vulnerable for water and wind erosion and lost its organic nutrients. Crop productivity was reduced and the emission of smoke of women and children. This is highly revealed in the highlands where there is high population density per km².

³ The State of Eritrea Ministry of Land, Water and Environment. "Eritrea's initial National Communication under the United Nations Framework Convention on Climate Change (UNFCCC)" (Eritrea: Asmara, December 2001).

Today, the vegetation which once covered some 30% of the total land area of the country has been drastically reduced in less than a century. By 1952, that figure had declined to 11%, and in 1960 the forest cover was estimated 5%.⁴ In the year of 2000's the country is listed among one of the poorest countries hit by drought and desertification, with little, unreliable and erratic rainfall.

Nonetheless, efforts are being made by the Government to change this situation. For instance the share of biomass energy consumption fell by 30 % between 1994 and 1998.⁵ This decrease could be attributed to the introduction of regulations that banned the cutting of live trees for fuel, the prohibition of charcoal making and selling of wood without licensing and the growing area coverage of declared closures, which has restrained access to fuel wood.

In the world of scarcity humans are compelled to find alternatives to satisfy their needs. Similarly, these conditions have pushed the Eritrean people to shift to other sources of energy, such as kerosene and to increase the efficiency of traditional stoves, whenever biomass is used as a source of energy.

Petroleum products hold the second major source of energy in the country. The consumption of oil products increased by about 11% from 1994-2000. However, the share of electricity in the energy sector is just around 2%. Its supply is concentrated in the urban areas and only 2% of the rural population is estimated to have access to electricity.⁶

According to the Eritrean Project Concept Paper, 80% of the population is estimated to live in rural areas, practicing a range of agricultural and pastoral activities. Those

⁴ Pagini, 1952. (Cited in) Bein and others. Useful Trees and Shrubs in Eritrea. *"Identification, Propagation and Management for Agricultural and Pastoral Communities"*, Technical Handbook No 12. Regional Soil Conservation Unit (Nairobi: 1996).

⁵ The State of Eritrea Ministry of Land, Water and Environment. "Eritrea's initial National Communication under the United Nations Framework Convention on Climate Change (UNFCCC)" (Eritrea: Asmara, December 2001).

⁶ The State of Eritrea Ministry of Land, Water and Environment. "Eritrea's initial National Communication under the United Nations Framework Convention on Climate Change (UNFCCC)" (Eritrea: Asmara, December 2001).

people have the right to energy access to develop and meet their economic growth. The urban people too depend much on the rural people's crop production for the food that they require. The government's food security policy by itself could never be realized without ensuring adequate energy for its producers.

This obliged the government to undertake a formidable task to supply modern energy to the rural areas. For instance, electricity consumption grew in the rural areas from 16 kWh in 1991 to about 50 kWh in 2000.⁷ Considerable efforts are been made also to promote alternative sources of energy such as photovoltaic systems in rural areas of remote schools, health centers and village water pumps.

However, the potentials of other renewable energy resources like modern bio-fuels, geothermal and hydropower are not conclusively studied and developed.

Link between energy, poverty and economic development

Energy is indispensable for continued human development and economic growth. Providing adequate, affordable energy is essential for eradicating poverty, improving human welfare, and raising living standards world-wide. And without energy it will be difficult to address poverty or achieve economic growth.

Energy has a paramount importance in industries and productive activities that require it in various forms to fuel machines conserve perishable goods ensure transport, etc. Its limited availability critically impairs development but much more the socioeconomic development of the poor people.

There is high correspondence between energy and poverty. According to World Bank indicators database, there is a strong correlation between modern energy

⁷ The State of Eritrea Ministry of Land, Water and Environment. "Eritrea's initial National Communication under the United Nations Framework Convention on Climate Change (UNFCCC)" (Eritrea: Asmara, December 2001).

consumption and GNP per capita. The GNP of countries tends to rapidly increase as commercial energy use per capita increases, mainly for low-income countries.⁸

That is why most countries are now integrating energy needs as requirement to achieve the Millennium Development Goals. Developing countries came to understand that without access to adequate energy services they would continue to suffer from deep poverty, since energy is required for most basic household needs, such as cooking and heating.

Mitigation Options in the Energy Sector

Some specific challenges of the energy sector can be identified as low energy production due to largely untapped energy resource potential, uneven regional distribution of energy resources, weak share of renewable energy in the energy mix, underdeveloped transport, transmission and distribution infrastructure, low private sector participation and investment in the energy sector and very low access to energy in rural areas. Add to this, the inappropriate supply of energy needs to the majority of people and economically unaffordable by most of those who have access to it.

Mitigation options in the energy sector for the Eritrean context could be viewed in terms of short and long strategies. Over the short term period energy efficiency improvements such as improvement of traditional stove “*mogogo*” and the use of small-scale renewable energy alternatives such as photovoltaic system “solar” could be pursued. In the long-term efforts could be made to introduce new power supply sources such as *Hirgigo* power plant or pioneer advanced renewable technologies for geothermal and other potential alternative energy sources.

⁸ UNITED NATIONS ECONOMIC COMMISSION FOR AFRICA (UNECA). *On behalf of the Joint Secretariat* UNECA, UNEP, UNIDO, UNDP, ADB and NEPAD Secretariat. *Report on “Energy for Sustainable Development”*: African Regional Implementation review for the 14th Session of the Commission on Sustainable Development (CSD-14).

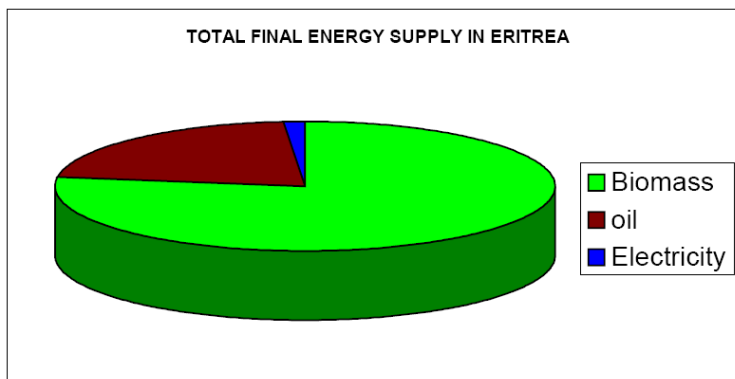
In this respect the mitigation options that may be pursued are meant to increase energy efficiency and commence sustainable energy supply for the country to achieve economic growth and reduce poverty.

Hence, it is worth mentioning here some of the activities and achievements, which in practice Eritrea is making in its mitigation efforts.

1. Changing consumption/production patterns of energy

Comparatively, Eritrea has one of the world’s lowest energy consumption rates. Its per capita energy consumption is about 8.12 Giga Joules per year. The commercial energy products (electricity plus oil products) constitute one third of the total energy consumption. However, 97 percent of all biomass fuels in 1998 were utilized by the household sector for cooking and heating purposes. Liquefied petroleum gas (LPG) and kerosene are also mainly used in the household sector.

While LPG is exclusively utilized in the urban centers (mostly the capital city) for cooking purposes, kerosene is used both in the urban and rural areas of the country.



The transport sector on its side utilizes more than 87 percent of gasoline and about 44 percent of diesel consumed in the country.⁹

⁹ Poverty and Natural Resource Management. *Chapter 3 Agriculture, Energy and Land Degradation in Eritrea*. Available at <http://dissertations.ub.rug.nl/FILES/faculties/eco/2005/b.araya.tesfamicael/c3.pdf>. Accessed in 3, December 2008.

Source: THE STATE OF ERITREA MINISTRY OF LAND, WATER AND ENVIRONMENT December 2001 Asmara, Eritrea

Yet, the current energy consumption pattern is not sustainable. Energy and forestry sectors in Eritrea, as in many developing countries, are highly correlated. The forest of the country is destroyed on the past centuries for different purposes. One cause could be due to the high dependence of the majority of the population on biomass for their daily energy uses. This over-reliance on biomass as a source of energy is also one of the major factors behind the high level of land degradation in the country.

According to an article prepared by Semereab, biomass fuels accounted for 64% of the total energy production in Eritrea in 2003.¹⁰ Rural households which account 80% of the total population have only a 2% access to electricity and derive their energy from traditional fuels, mainly fuel wood, charcoal, dung and agricultural residues.

Although, large-scale tree planting activities are being undertaken by mobilizing community labor and students summer programs, which are expected to increase the supply of fuel wood, which is presently the most important source of household energy and the only source of energy for almost all rural households in Eritrea, this is unlikely to continue considering the survival rate of the seedlings and the carrying capacity of the forest to the demanded energy.

For instance, the records of the Ministry of Agriculture indicate that over 50,000 hectares of land have been planted in 1996. However, the FAO field survey revealed that less than 15,000 hectares of these plantations survived in 1997.¹¹ Moreover, this could only serve as a short-term energy solution strategy since it could not have a larger impact on sustainable development or economic growth of the poor.

¹⁰ Semereab Habtetsion. "Energy Needs for Achieving MDGs in Eritrea" *Paper prepared for presentation at the EUEI Facilitation and Policy Dialogue Workshop* (Maputo: 12-15, 2005).

¹¹ Poverty and Natural Resource Management. *Chapter 3 Agriculture, Energy and Land Degradation in Eritrea*. Available at <http://dissertations.ub.rug.nl/FILES/faculties/eco/2005/b.araya.tesfamicael/c3.pdf>. Accessed in 3, December 2008.

For this reason, taking biomass as a main source of energy is unsustainable. As Semereab pointed out, the forest off take is estimated at 2.4%-2.8% compared to the threshold for sustainability of 1.25%.¹² This implies that the country's vegetation is heading beyond reversible if massive intervention is not undertaken soon.

Putting into this account, Ministry of Energy and Mines is undertaking different activities to diversify sources of energy, increase efficiency and expand access to electricity in the country. To diversify energy sources; wind, solar and alternative uses of biomass energy is being actively investigated. Major investments are also being made to change the national electricity supply system and to install higher voltage lines to enhance efficiency. The Ministry is also undertaking a research to arrive at affordable and more efficient cooking stoves to reduce the amount of fuel-wood required for cooking.

However, yet more emphasis is required on improving the energy production resource mix, through increased use of renewable sources such as geothermal, bio-fuel, inter-regional hydro-electric power, wind and photovoltaic potential energies.

2. Financial Issues

Energy is central to achieving sustainable development. However, Eritrea still faces with a number of challenges in this regard, such as achieving more reliable and efficient access to energy for domestic consumption and production.

It had poor infrastructure and outdated electrical grids that were installed during the Italian time. Considering its negative impact in development, the government undertook huge investment to provide adequate and affordable energy to eradicate poverty, improve human welfare, and raise the living standards of the society. For instance, the project of **Hirgigo Power Plant** is the first in its kind which had been

¹² Semereab Habetstion. "Energy Needs for Achieving MDGs in Eritrea" *Paper prepared for presentation at the EUEI Facilitation and Policy Dialogue Workshop* (Maputo: 12-15, 2005).

constructed with huge investment in cooperation with bilateral and multilateral organizations to mitigate the problem.

However, making this energy supply reliable and accessible to the poor, specifically to the 80% rural people who had no access to electricity is very important to cope with poverty reduction and economic growth. Since, energy services are the result of a combination of technology, infrastructure (capital), labor (know-how) and materials; the government is cognizant of this huge capital investment. But, it is not sufficient to consider only how energy is supplied but also for what purposes energy is used to ensure its investment worth.

Financing energy is expensive and could not be met with the sole internal resource. Deregulating and privatizing energy will not only reduce the burden of the government but could deliver efficient service to the people. The government could control the services through regulatory framework. However, it is obvious that private investors might not be much encouraged to invest in poor countries like Eritrea which have low return rate considering their energy consumption rate. Therefore, raising funds through loan or grants from multilateral organizations for that purpose could be a solution.

The Eritrean energy sector yet lacks appropriate finance for the development of key energy generation, transport and distribution infrastructure. Overall, financial flows in this sector are far below the needs. Though, the investments made are enormous, yet not enough to meet the goals of poverty reduction. Therefore, mobilizing finance for the energy sector is a priority issue for the country.

3. Promote energy regional integration as a catalyst for development

Today, expanding regional cooperation in the energy sector to further regional economic integration has been a concern of most regional economic communities. In West Africa, a regional electricity market is established through the West African Power

Pool (WAPP), and the provision of natural gas to Benin, Togo and Ghana from Nigeria for electricity generation. In Southern African countries a regional energy planning database; facilitating the creation of an information exchange system is running.¹³

In the IGAD (Intergovernmental Authority for Development) countries similar projects could be carried out. It is very fortunate for these countries as they are situated on the Rift Valley which has a potential of geothermal power. Ethiopia alone is endowed with 20% of the total 3/5th of the hydropower generating potential it shares with Democratic Republic of Congo.¹⁴

All countries of this region are in dire need of energy. They seek to promote energy pooling and cross-border energy flows to minimize the cost of supply through economies of scale and to enhance the security and reliability of supply. Putting the power of influence into consideration in this region, Eritrea could play a substantial role if it uses its leverage power and political stability at integrating the region for the economic advancement.

The countries of this region are in war for centuries. One cause of this chaos could be attributed to the scarcity of energy. Hence, Eritrea needs to work to ensure IGAD governments put their differences and animosity and work for development. It should strive to put in place coherent regulatory and policy frameworks of energy for all those countries to live in peace and harmony. It needs to endorse inter regional energy extraction scheme such as hydropower and geothermal energies.

¹³ UNITED NATIONS ECONOMIC COMMISSION FOR AFRICA (UNECA). *On behalf of the Joint Secretariat* UNECA, UNEP, UNIDO, UNDP, ADB and NEPAD Secretariat. *Report on "Energy for Sustainable Development": African Regional Implementation review for the 14th Session of the Commission on Sustainable Development (CSD-14)*.

¹⁴ Siddiqi Moin. *African Business Review of Business & Technology "The challenges of lighting Africa"* (Nairobi: Kenya, October 2008).

Hence, Eritrea has the obligation to help others recognize the importance of expanding regional cooperation in the energy sector to further their regional economic integration, to maintain not only sustainable development but also sustainable peace.

4. Link rural energy development programs to poverty reduction strategies

As had been noted, a large percentage of the Eritrean population still resides in the rural area and not getting adequate electricity. Those people largely use biomass for energy. Depending on biomass will have a negative effect on women and children's health. Moreover, forests will be destroyed, lands eroded and crop production will be affected too. This will have a disastrous effect on overall influence on the economic aspect of the poor people.

Although, no particular explicit target related to modern energy provision to the poor or the energy requirements is available, yet affordable energy is an essential parameter for poverty reduction. As indicated in the Interim National Poverty Reduction Strategy Paper (I-PRSP), the Government of Eritrea (GoE) emphasizes that access to sustainable source of energy by the poor is a prerequisite for poverty alleviation and sustainable human development.¹⁵

In accordance to this, the Ministry of Energy and Mines has outlined energy development programs proper to poverty alleviation, education, water and environmental sustainability, with particular attention to the development of alternative energy resources and proper utilization of the available energy resources.

Access to energy problem is inseparable from poverty reduction efforts and economic growth strategies. Therefore the government must be willing to drastically increase its financial investment in the rural energy sector and assist in the development

¹⁵ Semereab Habetzion. "Energy Needs for Achieving MDGs in Eritrea" *Paper prepared for presentation at the EUEI Facilitation and Policy Dialogue Workshop* (Maputo: 12-15, 2005).

of key infrastructure that can sustain the minimum economic growth required to break the cycle of poverty.

5. Strengthen local research capacity

Energy is essential to sustainable development and poverty reduction endeavors. It affects all aspects of development social, economic, and environment. On this basis, the Eritrean government recognizes that energy issues must be given high priority to achieve sustainable development on the country.

Ministry of mines and energy, through its research department, took a number of programs to solve the critical energy needs that the country is facing. The prime example is the achievement it made at improving the efficiency of traditional stove “*Mogogo*” by around 50% which it renamed it later “*Adhanet*” meaning saver.

Other initiatives such as setting up of solar panels in a number of rural areas, clinics and schools on one hand and the establishment of wind energy in Assab are typical schemes undertaken by the ministry but need much research and investment for their full exploitation. Moreover, a substantial research is required on geothermal energy considering the geographical location of the country on the Rift Valley.

In addition, the potential sources of bio-fuel are yet untapped. The country is blessed with castor beans which naturally grow in all the highland areas. Other seeds which have similar function could be put in to use if an adequate investment research is undertaken.

However, if the energy researches are not based on indigenous material and appropriately integrated into the socio-economic programs, planning, operation and maintenance of long-lived energy consuming infrastructures of this country, its sustainability is beyond reach.

7. Alternative energy

In this twenty-first century, a large number of the Eritrean population live in rural areas and rely heavily on traditional and unprocessed biomass (wood, animal dung, agricultural waste, etc.) for their daily domestic energy needs.

Traditional fuel such as biomass that constitutes the dominant energy source for the country is mostly used in an unsustainable manner that poses much threat to human health and the environment. Therefore, improving the electricity generation resource mix is the predominant challenge for sustainable development.

However, lack of investments, inadequate level of research and low technical capacity of the country are among responsible causes for its under development.

Moreover, providing sustainable modern energy to rural areas of country is hindered by major barriers including: i) dispersed settlements and the country's mountainous landscape that increase investment and transactions costs of rural electrification projects; ii) low population density; iii) inadequate technology context for the rapid expansion of new appliances and technical services; iv) high illiteracy prevalence of the people that limits their ability to act efficiently as agents of change in their environment.

Hereby, a review of the available energy potential in the country will present a striking diversity of resources, which offers a unique opportunity for an optimal energy resource mix for power generation that could meet the diverse need and mode of life of the Eritrean society.

a. Solar energy

Long years of drought, desertification, war, and increasing population have exposed the forest cover to destruction. The country has no forest resources it had at the end of the 19th century.

The dominant cause for the destruction of the forest is the excessive dependence of energy on fuel wood. The majority of the population use wood as a fuel for cooking, despite its environmental repercussion.

Hence, making use of solar energy instead of burning wood could reduce the pressure on the few remaining woodlands, and may help to improve the situation with regard to soil erosion, desertification and carbon emission. Moreover, it may also relieve women from their daily time consuming work because they spend long hours per day on collecting wood to prepare food for their families, as had been documented by the Ministry of Mines and Energy.

Eritrea enjoys an average annual solar radiation which amounts to 6 kWh/m² per day, which is 2190 kWh/m² per year.¹⁶ This will have a significant impact at solving the critical energy demand of the poor society residing in the rural areas. Therefore, energy savings could be made through increased use of solar energy and would have an important contribution at targeting poverty reduction policies.

In most rural areas there is no electrification at all. Solar Photovoltaic (PV) electricity systems could provide a high-value energy supply to isolated rural villages for specific purposes such as delivering light in Health Centers, for information and communication systems in the administration of schools and irrigation to power water pumps.

However, the required investment budget on the equipment for all those off-grid generation of solar energy, with its all operation and maintenance cost in comparison to its out put and use (mainly, to the traditional cooking and baking '*injera*'), might be unparalleled and non cost-effective.

¹⁶ Vision Eritrea. "Baseline Study of Renewable Energy in Eritrea" Novartis Foundation for Sustainable Development, *Centre for Development and Environment* (CDE), Institute of Geography, University of Bern.Basel: Switzerland. Available at http://www.oekozentrum.ch/downloads/publikationen/baseline_study_sun21.pdf. Accessed in 11, November 2008.

Therefore, the country needs to intensify its research to come up with the best solar energy optimization option suitable to the existing know how and traditional cooking aspects of the society to solve its hungry energy need.

b. Wind energy

Wind is the fastest-growing power source in the world today. As a number of researches indicate, there is high potential of wind energy on the South-Eastern coastal area of Eritrea. Accordingly, the government had put in test some wind powered turbines in Assab. These wind turbines are now used to provide electricity for pump irrigation water, everyday use such as lighting, sea water pumping to salt fields along the coasts and ice making for fishers, as most residents of this area are fishers.

However, the high wind that is produced near Assab, which flows from the Gulf of Aden, weakens its intensity as one proceeds towards the north.¹⁷ Assab is almost more than 600kms far from Massawa, where the energy power plant of the country is established. Therefore, adding this potential for the creation of a national grid-based electricity generation will make it costly.

Furthermore, the large coastal area is desert but habited by dispersed few fishermen and nomads. Investing in this large, unpopulated desert area is uneconomical for poor countries like Eritrea if the residents of that area remain scattered and reluctant to meet the government's resettlement policy.

However, it should be recognized that providing stand-alone wind energy systems will definitely have an important benefit for these fishermen and nomads.

¹⁷ Mengsteab Habtegiorgis. Development of a National Climate and Resources Information System for Eritrea. Metreorological Services/San Jose State University and Robert Van Buskirk, Eritrea Technical Exchange Project/ICSEE. Available at <http://www.punchdown.org/rvb/papers/EriPaper6C.html>.

c. Hydro-power Energy

Hydropower energy could be seen as one of the best alternative energies in Eritrea. According to previous studies, three potential sites for hydropower projects were identified, namely, Tekeze river, which is an Ethiopian river but borders Eritrea, with a possible energy yield of 23 000 GWh per year - Anseba river and Setit River with a possible energy yields of 120 GWh and 240 GWh per year respectively. Those potentials are significant for the country in comparison to the present generation which is almost about 150 GWh per year.¹⁸

However, generating hydropower energy is not easy. For its efficient and reliable service, adequate rain is a prerequisite. But Eritrea is known for its little and unreliable rainfall. The scarcity of rainfall in most parts of Eritrea is evident with one third of the country receiving less than 200 mm average annual rainfall and 90 percent receiving less than 600 mm.¹⁹ With such capacity, generating power might be possible, but will deplete the national reserve putting in to account the infrastructure and technology that it likely to cost.

Therefore, it would be more cost effective if the government could leave the two options of its hydropower potential (Anseba and Setit Rivers) but concentrate on bilateral hydropower project with Ethiopia on Tekeze River.

As a matter of fact this project had been supported by both governments and was in program in 1996. However, the Ethiopian government foiled it unilaterally and started the project with Chinese government.

¹⁸ Vision Eritrea. "Baseline Study of Renewable Energy in Eritrea" Novartis Foundation for Sustainable Development, Centre for Development and Environment (CDE), Institute of Geography, University of Bern. Basel: Switzerland. Available at http://www.oekozentrum.ch/downloads/publikationen/baseline_study_sun21.pdf. Accessed in 11, November 2008.

¹⁹ Poverty and Natural Resource Management. *Chapter 3 Agriculture, Energy and Land Degradation in Eritrea*. Available at <http://dissertations.ub.rug.nl/FILES/faculties/eco/2005/b.araya.tesfamicael/c3.pdf>. Accessed in 3, December 2008.

The project did not consider the socio-economic, environmental and political repercussions. Eritrea was not asked its opinion while it has a share to this river. Later, war ignited between the two friendly countries. This had happened while the two countries were in the middle of trading words at each other due to disagreements on trade and other economic issues. This does not mean that it was the reason for their going to war; however, its negative contribution to the whole situation could not be denied.

Warring countries could never achieve development. Peace and security have a paramount importance at sustaining development. The Intergovernmental Authority for Development (IGAD) was formed in the east African region to promote this goal. Eritrea is a member of this group. It is a newly country and got its independence in 1991. But yet, it had strong government and unified society in the region. This is an asset for the country to make the best of it to unify the region at solving the energy crisis.

d. Geothermal Energy

The Great East African Rift Valley extends for about 6,500 km from the Middle East (Dead Sea-Jordan Valley) in the North to Mozambique in the south. This system consists of three main categories, namely, the Red Sea Rift; the Gulf of Aden Rift; and the East African Rift which develops through Eritrea, Ethiopia, Kenya, Tanzania, Zambia, Malawi and then Mozambique.

The East African Rift, including Eritrea is one of the potential zones of the world where the heat energy of the interior of the Earth comes out to the surface in the form of volcanic eruptions, earthquakes and hot springs. The Eastern lowlands of Eritrea such as Alid are believed to be of high potential of geothermal prospect area.

Current researches indicate that this area had an average reservoir temperature in the range of 250°C-350°C. According, to studies sponsored by USAID, the water to rock

ratio in the reservoir is high enough for the development of hydro-thermal electricity generation system.²⁰

It is possible, then, that there could be other sites suitable for the discovery of high temperature reservoirs in that area. If this potential energy is exploited, it would be cheap, very short in distance from the national grid (Based in Massawa) which is less than 90km and moreover, friendly to the environment.

Therefore, the government should look ways to invest in a number of researches for exploiting this asset.

e. Other Sources of Energy

Ministry of Energy and Mines is trying to its best to solve the energy crisis in the country. As one of its efforts, it improved the efficiency of the traditional stove “*mogogo*”. This improvement contributed at lessening CO₂ emissions, saving forest cover and moreover, it protected the health of women and children.

However, the ministry needs to go further, to discover other available energy options, such as castor beans which grow in abundance in large area of the highland. The Eritrean highlands were cultivated for hundredth of years and have lost their fertility capacity. They are still used for the same purpose of cultivating wheat, barely and other crops which mainly support the subsistence food of the highlanders’ immediate needs.

The land is fragmented in to small unproductive plots and the pressure will be high as the settlers of this area increases in density per km². As an alternative solution, for bringing out the society out of the vicious circle of poverty and cope up with economic growth, this barren land could be used to grow castor beans.

²⁰ Semereab Habtetsion. “Energy Needs for Achieving MDGs in Eritrea” *Paper prepared for presentation at the EUEI Facilitation and Policy Dialogue Workshop* (Maputo: 12-15, 2005).

According to African Business Review 4kgs of croton seed could be squeezed to give 1litre of bio-diesel. Crotons seeds are produced for bio-diesel in a number of countries such as Kenya and contributing a significant wealth to the nation.²¹ Therefore, the poor households of the rural area of the highlands of Eritrea who live on subsistence food could be made to produce castor beans under the guidance of ministry of agriculture and ministry of energy. Fund could be solicited from multilateral or environmental organizations to support the program.

With the exception of this, Eritrea is known for its magnificent Italian built infrastructure and better sewage and disposal systems. Its drainage, specifically in the capital, is unique in East Africa but yet unexploited for its bio-gas energy potential.

Concluding remarks

The issue of ensuring sustainable energy development in Eritrea is not going to go away overnight. This will remain a major challenge for the coming years. However, finding a solution to the crisis of energy for this country is the crux for poverty reduction and maintaining sustainable development.

The Eritrean economy, particularly the rural economy, still heavily depends on traditional fuels. Insignificant percentage of the rural population has access to electricity in Eritrea. Heavy dependence on biomass sources is likely to have an adverse impact on the welfare of the society unless alternative energy sources are discovered.

The East African region is blessed with hydropower and geothermal potential energy which could contribute significantly to the economic growth of its habitants (including Eritrea) if peace and security is guaranteed. However, since the region had been in turmoil of war for decades, the countries remained poor and are yet suffering from energy crisis.

²¹ Siddiqi Moin. African Business Review of Business & Technology “The challenges of lighting Africa” (Nairobi: Kenya, October 2008).

Eritrea is one of these countries but different in its socio-economic and political structures. All except Ethiopia had been under European colonization and yet not free economically and politically from their former colonizers. It is obvious that if a country is not independent economically it would be hard for it to be politically. However, even Ethiopia which was not under any colonial rule, with the exception of the five years reign of the Italians, it is not only far beyond economic growth but listed as one of the highly indebted countries of the world.

Eritrea had unique position in its history. It got its freedom with an arm struggle while the others were granted by their colonizers. As a result, Eritrea was fortunate to own unified society, disciplined and strong army added with its self-reliant economic strategy. Those values are important for a country to emerge out of poverty and take precedence towards the road of poverty reduction and optimally to economic growth.

However, energy has remained as critical as war and drought on this region. Unless regional energy integration is pursued, poverty reduction, economic growth and peace will stay beyond realization. But, Eritrea could play a considerable role at unifying the region on energy, to tackle this problem if it utilizes its strong values mentioned above.

Eritrea has the duty to call IGAD countries to bury their differences and challenge one enemy that is “poverty”. It should show its commitment and take initiative to trade its sovereignty for geothermal energy for the purpose convincing others to do the same. Similarly, persuade others such as Ethiopia to make their hydro-power sources accessible to others not only for economic development but also for peace and security of this region.

In addition, Eritrea should seek out and invest in researches to solve its energy crisis from other alternative energy sources such solar energy, wind energy and other bio-energy possibilities considering their cost effectiveness to maintain sustainable development.

Bibliography

1. Siddiqi Moin. African Business Review of Business & Technology “The challenges of lighting Africa”. Nairobi: Kenya, October 2008.
2. The State of Eritrea Ministry of Land, Water and Environment. “Eritrea’s initial National Communication under the United Nations Framework Convention on Climate Change (UNFCCC)”. Eritrea: Asmara, December 2001.
3. The State of Eritrea Ministry of Land, Water and Environment. “Eritrea’s initial National Communication under the United Nations Framework Convention on Climate Change (UNFCCC)”. Eritrea: Asmara, December 2001.
4. Pagini, 1952. (Cited in) Bein and others. Useful Trees and Shrubs in Eritrea. “*Identification, Propagation and Management for Agricultural and Pastoral Communities*”, Technical Handbook No 12. Regional Soil Conservation Unit. Nairobi: 1996.
5. The State of Eritrea Ministry of Land, Water and Environment. “Eritrea’s initial National Communication under the United Nations Framework Convention on Climate Change (UNFCCC)”. Eritrea: Asmara, December 2001.
6. The State of Eritrea Ministry of Land, Water and Environment. “Eritrea’s initial National Communication under the United Nations Framework Convention on Climate Change (UNFCCC)”. Eritrea: Asmara, December 2001.
7. The State of Eritrea Ministry of Land, Water and Environment. “Eritrea’s initial National Communication under the United Nations Framework Convention on Climate Change (UNFCCC)”. Eritrea: Asmara, December 2001.
8. UNITED NATIONS ECONOMIC COMMISSION FOR AFRICA (UNECA). *On behalf of the Joint Secretariat* UNECA, UNEP, UNIDO, UNDP, ADB and NEPAD Secretariat. *Report on “Energy for Sustainable Development”*: African Regional Implementation review for the 14th Session of the Commission on Sustainable Development (CSD-14).
9. Poverty and Natural Resource Management. *Chapter 3 Agriculture, Energy and Land Degradation in Eritrea*. Available at <http://dissertations.ub.rug.nl/FILES/faculties/eco/2005/b.araya.tesfamicael/c3.pdf>. Accessed in 3, December 2008.
10. Semereab Habtetsion. “Energy Needs for Achieving MDGs in Eritrea” *Paper prepared for presentation at the EUEI Facilitation and Policy Dialogue Workshop*. Maputo: 12-15, 2005.

11. Poverty and Natural Resource Management. *Chapter 3 Agriculture, Energy and Land Degradation in Eritrea*. Available at <http://dissertations.ub.rug.nl/FILES/faculties/eco/2005/b.araya.tesfamicael/c3.pdf>. Accessed in 3, December 2008.
12. Semereab Habtetsion. “Energy Needs for Achieving MDGs in Eritrea” *Paper prepared for presentation at the EUEI Facilitation and Policy Dialogue Workshop*. Maputo: 12-15, 2005.
13. UNITED NATIONS ECONOMIC COMMISSION FOR AFRICA (UNECA). *On behalf of the Joint Secretariat* UNECA, UNEP, UNIDO, UNDP, ADB and NEPAD Secretariat. *Report on “Energy for Sustainable Development”*: African Regional Implementation review for the 14th Session of the Commission on Sustainable Development (CSD-14).
14. Siddiqi Moin. African Business Review of Business & Technology “The challenges of lighting Africa”. Nairobi: Kenya, October 2008.
15. Semereab Habtetsion. “Energy Needs for Achieving MDGs in Eritrea” *Paper prepared for presentation at the EUEI Facilitation and Policy Dialogue Workshop*. Maputo: 12-15, 2005.
16. Vision Eritrea. “Baseline Study of Renewable Energy in Eritrea” Novartis Foundation for Sustainable Development, *Centre for Development and Environment* (CDE), Institute of Geography, University of Bern. Basel: Switzerland. Available at http://www.oekozentrum.ch/downloads/publikationen/baseline_study_sun21.pdf. Accessed in 11, November 2008.
17. Mengsteab Habtegiorgis. Development of a National Climate and Resources Information System for Eritrea. Meteorological Services/San Jose State University and Robert Van Buskirk, Eritrea Technical Exchange Project/ICSEE. Available at <http://www.punchdown.org/rvb/papers/EriPaper6C.html>. Accessed in
18. Vision Eritrea. “Baseline Study of Renewable Energy in Eritrea” Novartis Foundation for Sustainable Development, *Centre for Development and Environment* (CDE), Institute of Geography, University of Bern. Basel: Switzerland. Available at http://www.oekozentrum.ch/downloads/publikationen/baseline_study_sun21.pdf. Accessed in 11, November 2008.
19. Poverty and Natural Resource Management. *Chapter 3 Agriculture, Energy and Land Degradation in Eritrea*. Available at <http://dissertations.ub.rug.nl/FILES/faculties/eco/2005/b.araya.tesfamicael/c3.pdf>. Accessed in 3, December 2008.
20. Semereab Habtetsion. “Energy Needs for Achieving MDGs in Eritrea” *Paper prepared for presentation at the EUEI Facilitation and Policy Dialogue Workshop*. Maputo: 12-15, 2005.
21. Siddiqi Moin. African Business Review of Business & Technology “The challenges of lighting Africa”. Nairobi: Kenya, October 2008.