

*Full Length Research Paper*

# **A model for a sustainable energy supply strategy for the social-economic development of Togo**

**Kossi Ayenagbo<sup>1</sup>, Josphert Ngui Kimatu<sup>2</sup> and Wang Rongcheng<sup>1\*</sup>**

<sup>1</sup>College of Urban and Environmental Sciences, Northeast Normal University, No.5268 Renmin Street, Changchun, Jilin Province, Post Code 130024. P. R. China.

<sup>2</sup>Department of Biological Sciences, South Eastern University College, (A Constituent College of the University of Nairobi). P.O. Box 170-90200- Kitui, Kenya.

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**Sustainable energy supply is necessary for the economic development of a country. Over 80% of the populations of African countries lack an access to sufficient and sustainable energy. Moreover, 3.5 billion people are without electricity, hence a significant number depends on biomass fuels such as charcoal, wood, dung and crop residues for lighting and cooking. This high dependency on fuelwood and lack of efficient delivery of clean energy indicate an infant stage of economic development condition. Togo is relatively rich in energy resources such as solar, biomass energy, hydroelectric and other renewable energy sources. However, it has experienced major political crises since the 1990s that have virtually paralyzed the growth of the economy. While the country is currently undertaking development and modernization reforms in all areas especially in economic modernization, it is important to address the links between energy and sustainable social-economic development. Modern economies are undoubtedly being driven by sustainable energy policies. This paper proposes a sustainable energy utilization model which can be used to cause a paradigm shift in the refocusing of the strategies used in planning future energy policies in Togo. We discuss how, properly harnessed energy resources could lay a strong foundation for sustainable social economic development.**

**Key words:** Togo, economic development, energy, hydro electric power.

## **INTRODUCTION**

Without the efficient sustainable planning and strategies for a constant supply of clean energy, the social economic long term development of a country might be hampered. Many countries have been laying down these strategies for the energy sector; however most of them have not been able to stand the test of time. The energy strategies in African countries have furthermore being complicated by erratic rains, political crises and undeveloped infrastructures. This is surprising, regarding that the African continent is rich in many energy resources. One of the ultimate goals for a sustainable development is making energy available and cheaper for all households and also for the economic sector (Chekete, 2007). There are three main sources of energy;

biomass, petroleum and electricity. However, the challenge with respect to electricity is to increase the capacity of production and reduce its cost. Developing countries are facing two related crucial problems in the energy sector. First is the insufficient production and inefficient use of traditional forms of biomass energy such as fire-wood and agro-residues, posing tremendous socio-economic, environmental and health hazards. Second is the highly uneven distribution and use of modern forms of energy such as electricity, petroleum and liquid gas, widening the disparity in income and quality of life (Barnes, 1990). Hence, an energy policy or strategy in this regard should be designed for these countries so that the country is able to maintain and promote a more sustainable form of production and efficient use of his traditional energy. Togo is one of those developing countries which are struggling to have a sustainable energy strategy. Hence, a comparative study

\*Corresponding author. E-mail: [wrc@nenu.edu.cn](mailto:wrc@nenu.edu.cn).

of other global strategies and the current projected energy strategies could be helpful in stabilizing the energy sector for the next decade and beyond. In this way the country will be able to meet all forms of socio-economic transition for efficient and clean use of modern energy. This will make the efficient production of goods and services to be possible and at a moderate cost. Furthermore, the accrued expenses due to energy costs in a product might make further research and exploitation of resources not viable. Moreover, with the environment being locally and globally threatened by air pollution from greenhouse gas emissions and inefficient energy production and usage, the welfare of especially women and children is endangered by long-term exposure to heavy plumes. These high health risks and common household lighting devices which are grossly inefficient as sources of light are compounding the hardships in these developing countries (Cecelski, 1996).

### **Energy as a core resource for modernization**

Energy which is one of the core resources for modernization and development has various implications in poverty alleviation, population growth, health and the environment sustainability while it invariably influences the pace of industrial, agricultural and socio-economic development of a nation. Efficient energy production processes can enhance rural/urban and large/small scale industrial development, causing a more affordable means of production of goods and services (Pearce and Webb, 1987). A nation which neglects its energy production and use is at serious risk of being economically landlocked.

Nationally and internationally, energy and environmental policies and strategies are being modeled at the level of the biomass, electricity and petroleum financing in response to a wide range of issues. These issues may lead to better energy efficiency such as in transportation, power generation, and in reducing pollution which are related to energy. Though lack of access to affordable energy, has serious implications on the development of a country, policies on issues of energy are more rhetorical than realistic in most least developed countries like Togo. These socio-economic consequences are often severe for developing countries in general and especially for the least developed countries. Biased focus on industry, transport and large-scale energy sectors has obscured the reality of developing countries where more than 90% of the population continues to rely on "traditional" biofuels like wood. The consumption of plants residue in developing countries exceeds one billion tons of oil equivalence, which is more than three folds the amount provided by coal consumption in Europe and twice in the United States or China (Barnes and Floor, 1996). In Togo, the annual ministerial budgets that always are statements of energy policies lack long-term strategies for energy

production, including socio-economic development. The country has instead relied on imported petroleum, which has virtually plunged the country into a chronic blackout condition.

The institutional structures have not experienced much change since the 1970s, posing formidable challenges to efficient supply of sustainable energy. Nevertheless a number of Ministries in Togo are involved in the formulation of strategies and energy policies which often lack the will to implement and coordinate. Despite the country being endowed with rich natural energy resources, Togo relies on importation of energy resources. It is important to note that the inadequate and poor quality electricity service provision has resulted in people depending heavily on fuel wood. For the entire rural population of Togo, energy needs are largely met by biofuels and agro-residues. Hence, the designing and implementation of holistic energy policies, which include the generation, conservation and harnessing potential energy resources in both rural and urban spaces, would have a profound positive change on socio-economic development. Stated in order words, poverty alleviation cannot take place without locating energy at the core of development paradigms. In addition, Togo could achieve the Millennium Development Goals (MDGs) through sufficient success to affordable energy resources such as electricity and solar power. On the larger scale, the overall MDG aims at reducing global poverty by one-half by 2015. However, to realize this goal, we feel there must be sufficient access to affordable energy. Given that energy constitutes a significant portion of Togo's gross domestic products (GDP) and even a greater fraction of household expenditure, energy efficiency measures including energy conservation should be adopted in energy policy planning and supply. The analysis of the energy sector starts with the identification of the demand and supply, which in Togo, encompasses energy requirements of the household, industry, commerce, mining, transport and agriculture.

Energy supply can come from electricity, oil and gas, petroleum products, energy based minerals and renewable energy resources. Energy policies should be carefully structured, inclusive and well coordinated, to minimize unpleasant side effects. For instance, the rural electrification project alone cannot solve rural energy poverty, (Tuntivate and Barnes, 1995). It should be augmented with ancillary policies and programs like forest preservation, education and job creation to a desired economic effect. Other aspects include affordability and broad accessibility of modern forms of energy. A successful transition to modern energy requires respectable income for the rural and urban sectors of the country. Such growth, in turn, requires economic development policies that support innovative electrification programs, expands oil and gas markets and increase the use of renewable energy; the other is sustainable use and rationalization of biofuel requires

afforestation policies, energy education and extension services, means of economic/efficient production and management and environmental friendly use of this source of energy. Use of biofuel should be expanded because it is relatively sustainable. However, studies have shown that even under the best transition scenario, biofuel will still be a reliable energy source for rural households in developing countries according to Leach and Mearns (1988).

The aforementioned important links are addressed and modeled in this paper (Figure 1) and analyses of sustainable energy strategies policies evaluated from the socio-economic development viewpoints. This will hopefully present a viable and comprehensive recommendation to attenuate the negative repercussions on the future energy situation in Togo.

### **A comparative energy situation analysis in Togo**

In almost all countries of West Africa, energy consumption is marked by a high use of biomass. It accounts for more than 80% in meeting people's needs in energy. Electricity consumption per capita is very low in Togo. It is only 125 kWh (Enda-TM, Sectoral Review of Togo-Goldenmarket), which is very low as compared to the average consumption in Europe, America or China whose current figures reach thousands of kWh. Although Togo has no proven reserves of fossil fuels, the fact remains that it has a significant but very poorly valued potential for renewable energy. Togo entirely dependent on not only imported oil but also electricity imported from Côte d'Ivoire, Ghana and Nigeria so as to satisfy its enormous energy needs. Despite multiple efforts, especially after the oil crisis of the 70s in oil exploration, the results were not satisfactory or encouraging. This led the company Unocal, which had even drilled offshore wells, to stop its activities in 1987. However, other surveys conducted in 1997 and 1999 have proved potentially favorable sites for reserves of oil and gas. As for renewable energy, qualified as energy flux versus energy inventory mentioned earlier, the potential exists in Togo. The development of solar, wind, biomass and small hydroelectric could contribute positively to energy security in Togo. Moreover, what is even better is that operation does not create greenhouse gas emissions. The solar potential is significant with power exceeding 700 W/m<sup>2</sup> (Enda-TM, Sectoral Review of Togo-Goldenmarket) in dry season with clear skies and low humidity. In the coastal zone wind, power is the largest with wind speeds up to 3 m/s on average. As for hydroelectricity, several interesting sites have been inventorised. However, lack of political will has led to the underutilization of potential sources of energy. The solar power, however, has emerged since the 1980s with the realization of solar water heaters. The development of sites listed as part of the technical feasibility study could

effectively contribute to reverse this trend.

In Togo and any other countries, staffing energy is a reliable indicator that may account for its level of development. It is in itself a powerful engine of economic and social progress. However, the sector still appears in Togo as a major constraint to business development in growth direction and employment. Energy security and people's access to services will constitute a major challenge, whose change has to inevitably need diversification of resources. More than two out of three households have no access to electricity. This lack of electricity supply slows industrialization and the attraction of investors. The final consumption of commercial energy per capita remains low. Besides wood and other biomass products, energy resources of Togo are made up by hydroelectric power whose productivity is estimated at 600 GWh per year (Jacques, 1994). Generally in every country the quality of life is measured by the level of energy consumption, which is associated with increased industrial and economic activities. As already mentioned energy services are crucial to provide adequate food, shelter, clothing, water, sanitation, medical care, education and access to information. The mentioned indices are – important tools aspects for addressing poverty reduction and economic growth in Togo. Energy use is closely linked to a range of socioeconomic issues, including poverty reduction, population growth, urbanization and opportunities for women and children according to Cecelski (1996).

Togo is reasonably endowed with energy resources, particularly biomass (wood), hydroelectric and even solar energy. These resources, if properly harnessed like we have already said, can play a predominant role in sustaining Togo's economic development. However, the country faces difficulties with commercial energy supplies, particularly electricity supply, as it imports all its petroleum (Table 1).

### **The links between energy strategies and poverty reduction**

The relationship between energy services and poverty reduction was explicitly identified by the World Summit on Sustainable Development (WSSD) in terms of implementation of Johannesburg (South Africa). The Summit called on the international community to conduct joint and consistent efforts to intensify cooperation at all levels in order to improve access to affordable and reliable energy services and achieve a sustainable development level high enough to facilitate the achievement of the MDG including the goal of halving the proportion of people living in poverty by 2015. This also serves to generate other important services that contribute to poverty alleviation. Keep in mind that access to energy facilitates the eradication of poverty (ESMAP, 2002a). Based on such recommendations, it is necessary

**Table 1.** The electricity situation overview in West Africa in billion kilowatt/hours, indicating how Togo is heavily dependent on petroleum imports for electricity supply in the sub region. (Source: Energy Information Administration).

Country	Consumption 2001	Generation 2001	Installed capacity, 1/1/2001 (gig watts)	Thermal capacity (total %)	Hydroelectric capacity (total %)
Benin	0.63	0.27	0.094	28.7	71.3
Burkina Faso	0.26	0.28	0.121	73.6	26.4
Cape Verde	0.04	0.04	0.007	100.0	0.0
Cote d'Ivoire	2.98	4.61	0.892	31.2	68.8
Gambia	0.08	0.09	0.029	100.0	0.0
Ghana	8.84	8.80	1.200	10.7	89.3
Guinea	0.74	0.79	0.195	73.3	26.7
Guinea-Bissau	0.05	0.06	0.011	100.0	0.0
Liberia	0.44	0.47	0.330	100.0	0.0
Mali	0.45	0.48	0.114	56.1	43.9
Mauritania	0.15	0.16	0.105	41.9	58.1
Niger	0.33	0.24	0.063	100.0	0.0
Nigeria	14.56	15.67	5.888	67.1	32.9
Senegal	1.41	1.52	0.235	100.0	0.0
Sierra Leone	0.23	0.25	0.128	96.9	3.1
Togo	0.61	0.10	0.034	88.2	11.8
Regional total	31.78	33.82	9.446	58.8	41.2

to improve energy services in Togo including for modern household fuels like; improved stoves, the increase in biomass production sustainable, and expanding access to electricity and mechanical energy. In Togo, energy services have a direct impact on poverty and other dimensions of poverty, such as gender inequality, poor health, inadequate education and poor access to services infrastructure. Electricity plays a vital role in providing basic social services, like education and in health, whereby energy scarcity is often a barrier to sterilization and purification of water and refrigeration of essential medicines. Electricity can also run machines that serve as support for income generating opportunities, such as pumping water in agriculture, food processing, apparel manufacturing and light industries.

In rural areas in Togo, lack of modern energy services may deter skilled workers such as teachers, doctors, nurses and extension agents to settle there, further limiting the services and opportunities available to local people.

### Energy purchase trends of the electricity sector

The available generation capacity for the energy sector was far less than the installed capacity due to poor maintenance, shortage of spare parts and inadequate and under-skilled technicians. The captive capacity in the mines and installed capacity in the towns virtually degenerated during the past years. In spite of substantial investment in the sector the situation continued to be desperate until recently, with the new government

desperate about providing electricity for at least the capital city. To date, rural electricity supply is largely ignored. The state of the power sector indicates a considerable imbalance between power demand and supply in Togo. Energy purchase followed a trend identical with that of the GWh quantities sold, averaging 50% of total charges from 1990 to 1992, before giving way to financial expenses and allocation to amortization and provisioning which account for 45 and 10% of expenditures, respectively. To meet the production losses from the Akossombo dam (Ghana) and the Nangbeto dam (Togo), the CEB set up two gas turbines (one in Lome, the other in Cotonou). Over the past five years, CEB energy production purchases stand as shown to Table 2. Hence, Togo is considerably sufficiently endowed with potential energy and should therefore adopt appropriate policies and strategies that should make it to meet the demand and supply for its population.

### The household biomass energy supply potential in Togo

The biomass energy source is the most form of energy used in Togo. It is used mainly in the form of wood and charcoal. These represent almost 80% in the total energy consumption in the country. These energy sources are used in the domestic sector in meeting not only the cooking needs but also in crafts like smoking fish, preparing local drink or peanut oil etc. The household consumption is estimated at about 1.63 million tons for fuelwood and 0.27 million tons of charcoal. As for crafts,

**Table 2.** The energy purchase trends as related to the production (Sources: CEB activity reports/ADB PPER mission).

Year/purchase	Purchase			CEB/Production				
	VRA	CIE	Total	Nangbeto	TAG	Total	Network total	Peak ( MW)
1997	422.54	262.44	684.98	88.36	0	88.36	773.34	133.7
1998	459.53	0	459.53	172.60	65.92	238.52	698.05	139
1999	325.63	201.65	527.28	198.84	159.79	358.63	885.91	139
2000	391.90	299.82	691.72	198.36	49.57	247.93	939.65	154.81
2001	302.05	577.23	879.28	91.78	62.75	154.53	1033.81	162.56

consumption is estimated at 27,600 tons for fuelwood and 9500 tons for charcoal (Enda-TM, Sectoral Review of Togo-Goldenmarket). However, irrational use of this form of energy is one of the main causes of deforestation and environmental degradation. In this perspective, the outcome of the project micro/mini hydroelectric will inevitably reverse that trend. Togo is richly endowed with a variety of renewable energy resources, including an abundant wood and non-wood biomass, solar, wind and water resources. With the exception of biomass, only a meager fraction of the country's present renewable energy potential is exploited. However, Togo has limited experience on renewable energy technologies (RETs). The biomass (firewood and charcoal) plays a predominant role in the electricity supply in Togo. 90% of household energy consumption is in cooking and fuelwood supplies. Fuelwood is free for the vast majority of rural households, with most families getting their wood requirements from local forests/bushes, especially during land clearing for farming that is largely shifting cultivation. Per capita fuelwood consumption in the rural areas is estimated at 700 kg per annum, accounting for virtually all household energy need and use. In urban areas (such as Lome) where there is a flourishing market prices and fuelwood consumption per capita can be much less. The approximate annual per capita consumption of other fuels in urban and rural are: charcoal 60 and 10 kg; kerosene 20 and 5 L; electricity 50 and 5 kWh, respectively.

According to Barnes (1998) these estimates are within the range experienced in other West African countries. The most notable exception is the low market penetration by charcoal in urban areas; for example, Lome consumption estimate is 60 per annum which are well below estimated urban use in Liberia (141 kg/year) and Senegal (230 kg/year). O'Keefe and Minslow (1989) argued that the level of dependence on fuelwood for household energy needs is disturbing, projected at 4.2 million m<sup>3</sup> for 2004. Fuelwood is obtained from cleared agricultural lands. The regrowth of trees during fallow periods plays an important role in the regeneration of soil fertility of soils and the support of the soil structure and moisture, which reduce runoff and many other functions of conservation of soil after harvest. Thus, with the worsening shortage of fuelwood, felling of trees prematurely became increasingly rampant; the shortening

of fallow periods, leading to their sharper degradation. The production of fuelwood is usually during the period of land clearing for agriculture, taking care of energy needs of rural agricultural. Fuelwood can also be a byproduct of forest management. The example illustrated by the silvicultural and wood waste from logging and sawmills. All varieties of mangrove trees or logs in Togo are used or exploited for fuelwood. Mangrove defined as fuelwood is widely and mainly used in most of all the coastal villages of common salt production and conservation of fish caught locally. Fuelwood is also in many cases, used in the cultivation and food processing and preservation. It is used for heating during the wet season, cooking, crafts, and possibly the night lighting activities of a social. Coal production for the urban market is concentrated in the reserve forest areas in Northern Togo in the forest villages in the mountainous forests. The essential and most important perhaps, is the culture of wood under the system of subsistence production. The production of fuelwood for the urban market and urban sprawl have led to deforestation, which if not controlled will lead to serious shortage of fuelwood for both the rural and urban poor. Biomass, primary source of household energy represents almost three quarters of consumption of Togo. It is almost entirely absorbed by the cooking needs of households and artisans.

According to Barnes (1990) the total energy production from various other biomass sources are in excess of 2700 GWh/year. Togo, like most developing countries, has enacted programs to improve the supply and use of biofuel though the programs are exceedingly small compared to allocated resources for electrification. Thus, such programs can increase supply through woodlot and forest management, farm forestry programs and end-use efficiency through improved woodstove programs. Several types of actors are distinguished in this sub-sector such as: farmers producing fuel wood and charcoal, the processing and timber service companies; wholesalers who run the rural production sites to buy from farmers their production and transport them to urban centers that result in the sector market for wood products and energy; wholesale traders settled in urban areas where they constitute a large stock of wood fire and charcoal, retailers selling the products of wood energy. Biomass energy plays a major role in energy supply in

Togo because of its contribution to the total final energy consumption. This is mainly fuelwood, charcoal and to some extent plant waste. Except for the use of waste for electricity production by some industries in place, these energies are mostly consumed by households for cooking and in the service industry for smoking fish, craft bread, cooking in restaurants and scrub. The biomass energy needs are met from levies on forest resources including the state of degradation which is becoming increasingly worrying. Togo prides itself in the strengths of the biomass potential, however there is need to lay strategies and policies that will oversee: the revision of laws and forest regulations for differential taxation which favors the planned use of natural resources coupled with reforestation; the support of the creation of controlled wood energy markets in rural areas and the organization of commodity trade of wood-based energy blueprint supply. However, several constraints of different orders hamper a good management of this sub-conventional energy like: a low level of organization of the biomass energy sub-sector; lack of planning of logging operations except in managed forests; insufficient knowledge of the evolution of forest cover which we do not really know the land by type of training, much less the volume of wood in place and sustainable levels of exploitation; taxation forest products remain low in comparison with those applied in other countries of the sub region; cooking habits contribute to limiting the alternative to modern energy; the problem of returns in consumption equipment most commonly used in Togo. Hence a candid, adequate and accurate assessment of energy potential of crop residues should be strategized to perform collaboratively.

### Forest resources

It is estimated that 85% of the area of Togo (56785 km<sup>2</sup>) is covered with natural forests. For natural forests, areas of closed forest (semi-deciduous forest, dense forests and dry mountain forests) increased from 350,300 ha in 1990 to 286,500 ha in 2000 is a regression rate of about 6400 ha/year. The areas of open forests (fallow agricultural and grazing excluded) that reached 1.2 million ha in 1990, did not exceed more than 800,000 ha in 2000 is a regression rate of about 40,000 ha/year. The reforested area (ha) from 1900 to 1999 is a total of 37,629 ha (Akakpo, 2000). Regarding the forest plantations, the evolution of areas planted from 1990 to 2000 is possible only from the cell data for development of National Forestry Action Plan (NFAP), which estimated 34,724 ha total area reforested in Togo until 1995 (National Report, 1998). Fuel wood in Togo is obtained directly from high dense forests and savannah woodland. Barnes (1990) estimated that the introduction of woodstove will gain widespread adoption, hence increase energy efficiency. Consequently, most early efforts focused only on the dissemination of the technology,

ignoring relevant crucial factors like the economic settings and the availability and prices of alternative local biofuels of targeted population. Designed for use by low-income households, simple and inexpensive, wood stoves mainly doubling the efficiency of wood energy, reducing air pollution inside and wooding costs. Different types of stoves are made, in particular 'mud stove' being the least expensive because it can be easily built and repaired in case of deterioration. The producers argue that mudstone and wonder stove have 50 and 55% efficiency over the other conventional stoves. On an independent inquiry into the efficiency, quality and simplicity of these stoves, which is to value their products, it is nevertheless a general consensus that they are more energy efficient. In Togo, the most common gadget for the kitchen is the "traditional open-fire", with a low 10 ~ 20% thermal efficiency. These gadgets are widely used in rural areas and about 65% of low-income households use in the capital Lome. However, the purchasing cost of the stove is higher than the lower energy-conserving stoves, which is limiting its adoption.

The use of improved stoves will not only reduce the cost of cooking but equally cut down on fuelwood consumption. Beyond these visible and apparent benefits, like Togo, there are many developing countries that have failed to adopt improved wood stoves. The broadcast program stove started in the 2000s and they are supported by the Government of Togo, NGOs and private donors with very impressive performance if adopted. Cost comparisons of different stoves show significant savings in switching to the more efficient stove gadgets that are currently tested. Strategies to plant mangrove trees will provide people with many benefits during the energy transition stage before the countries electricity demand and utilization efficiency becomes sustainable. Moreover the, mangrove tree has many uses, including drugs and drink, energy, fisheries, leather, construction, textile, food, household items, paper products and other natural products. High end charcoals are made from mangrove, which have reported good earnings to almost all the people of Togo. If favorable conditions are met, mangroves may create a very productive vast forest area.

### Household petroleum energy consumption

Petroleum products are mainly used in the transport sector and industrial production units. They are especially consumed in rural areas to meet the lighting needs (kerosene) and grain milling. Their share is just about 16% in the total energy consumption of Togo: It is all imported to the country. These imports weigh heavily in the balance of trade of Togo. Therefore, nearly 15% of export revenues can be spent on oil bill. Typically, kerosene and LPG are particularly used by medium and high-end income families. Kerosene and liquefied

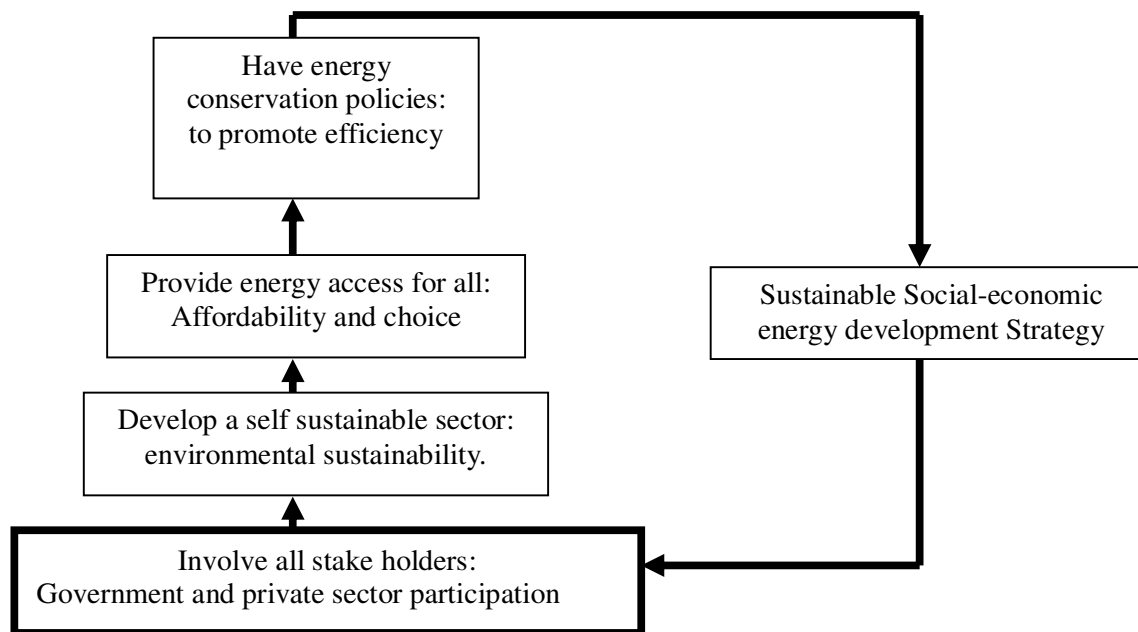
petroleum gas (LPG), commonly for cooking, are lot more convenient, efficient and cleaner-burning than wood, farm residues or dung (Floor and Van der Plas, 1991). Kerosene and LPG are 3 ~ 5 and 5 to 10 times more effective than wood respectively. The use of kerosene and LPG in cooking is also less harmful to health and the natural environment. However, both the rural and urban poor have limited financial muscle to access kerosene and LPG. The share of petroleum products in Togo is located at more than 90%. The energy demand in Togo is in constant growth to more than 90% by conventional high energy emitting CO<sub>2</sub>. Two categories of actors operate in the sub-sector. The Société Togolaise d'entreposage (STE) (Togolese Company of Storage) and private corporations licensed by the state since the initiation of activities of import and distribution in Togo, and importers and unauthorized distributors who have created parallel market to market petroleum products and acting illegally. In the sub-sector, Togo has several advantages such as relatively high hydrocarbon potential in the coastal sedimentary basin, large storage capacity of more than three months of consumption, and a storage capacity of approximately 80.000 m<sup>3</sup> crude oil. Petroleum products are predominantly used by the transport sector which is under the supervision the Ministry of Transport.

The modern economy of Togo anyway depends heavily on imported petroleum products for fuel and power (Table 1). For several years, the country's economy faced many problems, it was therefore unable to ensure regular, adequate and proper, supplies which impair performance is of the economy of the country. The plight of the country in foreign currency is the fundamental and the immediate reason why there is such an inadequate supply. Petroleum shortages as well as their consequences are exacerbated by deficiencies in procurement, price distortions and the government's inability to manage shortages. However, despite in the high cost of imports or the margin of excess payment for the supply of petroleum products or crude oil supply, delivery is the main problem. They also continue to experience delays. The involvement of Togo's Ministry of Finance and Economic in parallel market dealings has, from time to time, led to delays in petroleum products delivery, hence chronic shortages and escalated landed costs. In Togo, the lack of funds allocated for the budget on oil imports and the shortage of foreign currency have contributed to a rush of encouraging changes for each shipment. The equipment for the efficient distribution of petroleum products in rural areas of the country is quite inadequate. The high cost of delivery of petroleum products and the enormous difficulties of transport are that distribution companies are reluctant to extend or increase the facilities due to limited markets. Petroleum products marketing and sales are handled by the Ministry of Trade and Private Sector (MTPS). The Ministry of Finance and Economic (MFE) also plays a parallel role in the import and storage of petroleum products. The Ministry of Mines and Energy

(MME) deals with extraction of minerals, including energy related minerals. This Ministry develops also policies and programs for the systematic and economic exploitation of mineral resources. It also formulates appropriate regulations for mining and related industries to maximize benefits from the nation's mineral resources. The country is experiencing serious difficulties with the balance of payments because of the escalating costs of oil imports and fluctuating exchange rates. Currently the oil marketing and trading sector is dominated by five oil companies operating in the country.

Cap Esso, Sun Agip and Wando are by far the main players in comparison with Total and Texaco. However, much remains to be done in the fight against malpractices in the falsification of fraudulent products or illegal practices. The oil sector is a very sensitive area. The product concerned is delicate. The smallest mistake in its management can be very catastrophic. With this in mind, the actors in Togo's distribution of petroleum products have seen fit to streamline their field of action, to make it not only more professional, but also and above all secure (Redonko, 2009). To fight against these illegal practices in the oil sector, the Association of Distributors of Petroleum Products ("GD2P") was formed in Togo. The industry is facing many difficulties, including limited storage capacity. Fluctuations in exchange rates are only creating an already worse situation. Despite all this, the fact that the regions are composed mainly of the rural poor, these people are paying more for all categories of petroleum products because of high transportation costs. Supply difficulties are experienced from time to time. In addition to these problems there are also those of shipping and storage limits. Prices are also different in various regions of the country. The following comments explain the diversity of prices: a lump sum for the Petroleum Fund is now perceived by each gallon of gasoline, diesel and kerosene. Most of these funds go directly to the operation of petroleum services; a road user charge is levied on every liter of petrol and diesel. These funds are collected by the Service Road Maintenance Fund of Togo. Road funds are used for road maintenance; the oil prices are significantly higher in the most remote cities than in relation to the capital Lomé. However, we should not lose sight of other problems such as: Knowledge of certain formations and structures at Coastal Sedimentary Basin of Togo is insufficient and no drilling has been done on the onshore portion despite the structures that have been identified; despite the liberalization of import and marketing of petroleum products and their derivatives, Togo has not improved the coverage of national territory by the conventional distribution network.

Many localities with difficult access are sporadically supplied with petroleum products; it should be noted that informal sector activities interfere with approved companies and the administration currently has no opportunity to collect data on quantities of petroleum



**Figure 1.** The proposed hierarchical links of the four basic components involved in developing a sustainable energy development strategy in Togo.

products in the informal sector, which also are of issue in this sub-sector.

## DISCUSSION

### Conflicts in the key energy strategic formulation ministries

Energy is a key sector in Togo's economy. It is a major source of government revenue through fuel taxes, license fees and royalties. It is therefore an absolute necessity for the government to subsidize basic utilities like electricity. A number of ministries are involved in energy policy formulation which often conflict and therefore hinder energy coordination and harnessing. In Togo there are problems about management of energy resources among the ministries involved. Thus, there are overlapping responsibilities of the various ministries and coordination among the ministries is generally poor. There is no single central institution for assessing potential energy resources with regards to demand and supply and designing of energy development and investment plans in line with the needs of the nation. The Ministry of Mines and Energy (MME) is the custodian of mines and electricity services in Togo and therefore first responsible for charting out policies and coordination of these services. Hence, a proper coordination of the ministries as shown in the model (Figure 1) could make a sustainable energy strategy feasible in the long run.

### Electricity sub-sector situation in Togo

Studies have shown that electricity demand will surpass biomass and petroleum sources of energy in many developing countries. However, Togo's strategy for the electricity sector strategies needs to be polished to be sustainable. An evidence of this is the numerous power interruptions which resulted in a significant economic growth reduction in 2007. Furthermore, the electricity sector of Togo is governed by common rules between Togo and Benin which set out the tasks for key stakeholders. Although the sector has been liberalized, the supply of electricity is almost exclusively monopolized and is provided by the Compagnie d'Énergie du Bénin (CEB) (Energy Company in Benin). This company belongs to both Togo and Benin has a very limited production capacity and therefore imports electricity from Ghana, Cote d'Ivoire and Nigeria. Hence the electricity supply in Togo remains quite unreliable, with an average of 10 power outages a year. This is compounded by political crises which resulted in economic Togo sanctions. However, Togo has substantial assets that can promote the development of the electricity sub-sector among which include: the hydroelectric potential estimated at 624 MW through economic liberalization, administrative decentralization and sub-regional cooperation (WAEMU, ECOWAS and NEPAD). Currently there is construction in Togo of a power plant Contour Global by Americans in the capital Lomé. This plant is being built with the aim of strengthening the capacity of providing electricity in Lomé and indirectly ensuring the



works to supply other neighboring localities and other countries (Togo Economy, 2010). The General Director of Contour Global Togo, Yann Beuthler, stated that "With this plant, Togo will guarantee a production capacity of 100 MW which will significantly improve the reliability of distribution." The originality of the plant is to enable operation with three different fuels, diesel, heavy fuel oil, much cheaper and gas, relatively cheap. Contour Global should receive Nigerian gas through pipeline from West Africa. In this period, the plant would operate on diesel. Contour Global enable Togo to produce its own energy resource. Construction of Contour Global ended in August 2010. This is to give some autonomy to Togo in the matter of the provision and management of energy resource.

The completion of Nangbeto and Adjarala Hydroelectric Project would also represent the nation's first substantive move towards reliable and affordable power supply that is indigenous and renewable. It will enhance economic development and will provide opportunities for improving the living standards of the people in Togo. While households will finally enjoy reliable and low-cost electricity supply, national industries and businesses will also benefit from reduced production costs due to lower tariffs. Unemployment will drop as the economy expands leading to a reassuring and civilized social order. Moreover, greenhouse emission of greenhouse gases and other polluting gases will be reduced significantly. Finally, availability of environment friendly electricity will enhance the people's health and educational status, poverty alleviation and sustained economic growth. However, there are obstacles that confront the electricity sector in Togo. These include; Corruption and interference of government in the energy sector; the overall rate of loss recorded in the electrical system remains high. These losses include technical losses and non-technical losses. The technical losses are recorded due to the lack of standardization of the length of urban and rural networks, the low value of the distribution system, the transit of reactive power. Non-technical losses are due to illegal connections to the fraudulent use of electrical energy to defective meters; The inefficiency of the system for the performance of thermal generation is relatively low (below 40%); Problems of return on projects related to the weakness of the potential demand for electricity is essentially domestic and whose development is conditioned by the purchasing power of people. Hence, a proper modeled strategy can go along way in reducing these conflicts for the electricity sector to thrive in the 21st century.

### **The potential of renewable energy in Togo**

Despite the considerable wealth of Togo in different energy sources, the majority of Togolese heavily rely on fuelwood for domestic use. However, to meet the

challenges of energy security and energy access, other resources should be exploited; these include renewable energy sources that are insensitive to fluctuations in energy markets. Amongst the renewable energy used in Togo are; solar photovoltaic, hydroelectric, biogas and wind. The advantages of this sub-sector are for example, Togo and Benin, have a large solar field (700 KJ/cm<sup>2</sup> global solar radiation, an average of 5,000 W/m<sup>2</sup> per day) (UNDP, 2006); the rapid development of technologies for exploitation of wind energy. The identification of the coastal zone as an area with good wind potential is an asset in respect of project implementation capacity; the availability of energy resources for the development of biogas and the existence of the potentiality in the field of hydro-electric power. The development and use of renewable energy technologies (RETs) for growth and sustainable development in the face of different challenges is important, including the establishment of an institutional and strategic conditions for network and equal off-grid electrification, meetings of energy services, lack or absence of awareness and lack of technical support. In Togo, there are very few companies that deal with other forms of renewable energy. Solar energy is in extremely low proportions or if not lacking, while wind power is just used as an alternative energy system. Many traditional funding agencies or bodies dealing with problems of poor rural people have little or no knowledge of programs in renewable energy technologies. In Togo, the main renewable energy technologies, including micro-hydroelectric, biogas, wind, wind pumps, solar energy converters. However, these technologies and exceptional potential in renewable energy were remained virtually untapped in the country. Regarding solar as example, the sunny Togo offers significantly hopeful development. The potential estimated to an average between 6 and 7 kWh/m<sup>2</sup>/day for the region of West Africa remains available for operation as photovoltaic and thermal.

The micro hydro industry appears to be another potential of new and renewable energy that is relevant for rural electrification, as part of a decentralized operation to promote grassroots development and improvement of beneficiary population's life conditions. Compared to other alternatives, wind power could be limited to economically viable areas. The problems in this sub-sector are not exhaustive, however, the lack of a national energy policy as a basis for developing a strategy for renewable energy; the lack of operational structures responsible for promotion of renewable energies and finally the lack of a coherent policy for promoting equipment implementation of renewable energies especially in isolated communities remain on top of the list. Furthermore, the various forms of renewable energy also have specific problems for example; in the field of solar energy, there is the lack of upkeep and maintenance of equipment and the relatively high cost of initial investment; in the field of hydroelectric, there is the low minimum flow and the drying up of rivers; in the field

of biogas, there are non-mastery of biogas production techniques and the relatively high cost family facilities and finally the great variability in production of wind energy.

The Solar Energy Laboratory at the University of Lome is responsible for research in renewable energy and has developed and experimented water heaters and solar dryers as well as digesters.

### **The rural energy supply management strategies for Togo**

In Togo, biomass, particularly fuelwood, constitutes more than 90% of rural energy consumption, which exacerbates environmental degradation. Fuelwood is the main source of energy for most rural households, and access to sustainable and secure supply of fuelwood is important for the survival of rural households. The economic activities in rural areas including agriculture, business and social services are greatly influenced by energy (Bhatia and Desai, 1995). Hence an efficient provision of energy services might have a significant positive impact on rural welfare and sustainable economic growth. This is because majority of Togolese live in rural areas and it behooves any energy planning strategy to separately consider rural areas. The demand far exceeds the sustainable supply in several regions of the country and this, coupled with agricultural and settlement pressures, is resulting in the denudation of natural wood land.

The balance of energy needs is provided by other options, including kerosene, gasoline and candles. Interestingly, in Togo only less than 2% of the rural population has access to electricity. Economic growth and economic development are hampered by the low this low access to commercial energy. This is reflected by low levels of mechanization of agriculture and industrialization. There is hardly any investment in rural energy development. The growth or development of commercial activities in underdeveloped areas can be a stimulating factor or determinant for the economic empowerment of poor people. Any commercial activity usually starts with micro-enterprises and small businesses such as shops, kiosks and agro-industrial activities.

The modern energy services constitute an important and essential element for the development of business or generating income. Source of energy, electricity in particular, are a very important element for any business activity. Because of the impracticality of mains which is very costly or is accompanied with long delays, other supplies of electricity are urgently needed. It is important, if not indispensable, to establish in Togo, as in other developing countries, an institutional framework capable of mobilizing, coordinating and facilitating public and private initiatives in renewable energy in rural areas.

### **CONCLUSIONS AND RECOMMENDATIONS**

We have analyzed that biomass energy especially fuelwood is currently the main source of energy representing approximately 80% of energy consumption. The remaining 20% is supplied by petroleum energy sources which are virtually wholly imported. Hence, the traditional form of energy has been fuelwood which has not been significantly abandoned. It is almost exclusively used by households for cooking and lighting activities. However, in a modern economy, the largest sustainable and efficient source of energy is electricity followed by petroleum energy sources. Nevertheless, in recent years, exchange difficulties have caused some retention of oil imports, which has led to a limitation in energy consumption. In Togo, the implication is that the increase or the future growth of consumption of biomass fuelwood is expected to remain longer if strategic and policy measures are not urgently cooperatively made and implemented. Comparative studies have shown that in developed countries the energy trend has been moving from Biomass to petroleum energy and finally to electric energy. How ever the electricity sector in Togo is virtually remained untapped except in the last five years. On the other hand Togo is a country relatively well endowed with energy resources, particularly forestry and hydroelectric. Large hydroelectric power lines can be installed where appropriate and a rational exploitation of the vast network of rivers and their tributaries undertaken. Several sites of mini-hydroelectric plants have also been identified, but their feasibility has not yet been fully evaluated. Concerning oil, there is a potential offshore reserve, but limited exploration is still hindering a full evaluation.

Recent rises in oil price have unexpectedly taken place and Togo therefore struggles to cope with energy supply. The country was entirely dependent on imported oil needs for alternative energy and could not develop clean energy resources in order to reduce import costs high. In Togo, as in most developing countries, there is virtually no institutional structure, a lack of technical expertise and limited resources to manage this very complex problem. Rising oil prices came at a time when the country was already facing many difficulties due to the sharper decline in exports of mineral resources. The immediate consequence of these developments was a serious shortage of energy supply business with an auxiliary socio-economic disruption. Despite the severity of current problems in the energy sector in Togo and in many developing countries, basically there are reasons to be optimistic. Firstly, with the current government and strong political commitment to promote the latter's economic development project, the World Bank agreed to provide funds for the energy sector in Togo. Thus the World Bank approved a donation of \$ 26.82 million U.S. dollars to Togo for the rehabilitation of infrastructure and electrical services in the city of Lome, the capital of the country, (Report of the Bretton Woods Institution reached the

PANA). The donation is part of the Project for the emergency rehabilitation of infrastructure and electrical services Lome (PURISEL). It will enable Togo to rehabilitate, restore, improve and expand in Lome access to severely degraded urban infrastructure, stressed the Togolese Minister of Economic and Finance (Ministry of Economic and Finance, 2010). The government is devising ways to maximize economic benefits in the current price system of oil, while developing and implementing coherent and adequate politics for the energy sector to avoid repetition of the problems currently facing the sector.

We recommended that , the government should consider strategies or practices that may: (1) improve the sustainable collaborative strategy of the utilization of indigenous energy resources, or where national economic returns are important; (2) encourage the efficient and rational use of resources allocated to the various energy sectors by focusing on projects with high rates of profitability instead of those economies with low yields, (3) diversify the country's energy sources away from heavy dependence on oil, and (4) develop a framework of incentives or stimulation and an institutional structures able to adapt and benefit from the rapidly changing conditions in international energy markets.

### Further recommendation

The Togolese government should develop energy strategies and policies to be implemented by all energy sectors. These should include and emphasize; the provision of necessary environmental monitoring, predictive models for energy resources and the accompanying data storage and analysis technologies; establish a legal and institutional framework which is conducive to private investment; the MME should concentrate all its efforts on the adoption and formulation of policies for sound management of electricity resources and especially to ensure appropriate coordination of all the sectors. One task of the MS should be the description of the government's strategy for the sector in the short and long term by outlining a sustainable energy policy of development and lastly Increasing the access rate to electricity by the continued electrification of localities in the country with the objective of increasing the electrification rate to 60% if possible by 2015. These should also incooperate and expand the use of renewable energy from available energy resources to target applications in remote areas. This is also the global target of 2050 (UN New York, 2004) in the coming decades. This task is perhaps the most daunting facing the energy industry in its socio-economic and environmental development. All these discussed types of investments are able to generate satisfactory rate of return, especially if satisfactory or suitable pricing policies for commercialization of energy can be designed or

developed to be financially viable. Hence, future investment in energy resources is logically an inescapable economic venture for Togo.

In this view the improvement of the quality of life of the population, bilateral and multilateral donors should continue funding projects related to energy and especially to develop suitable and sustainable production and use of electricity and biofuels through agricultural development and natural resource management projects. Although energy is the main catalyst for the social-economic development of a country, however, the strategic sustainable energy planning should not be done in a sectorized basis and but should involve all stakeholders. Hence, the recent progresses achieved by the current government and the disappointments of the past years should favor options and smarter strategies for concrete policies for investment.

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