PROVISION OF AFFORDABLE AND RELIABLE ENERGY DATA BANK

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ABSTRACT
This paper focuses on the preparation of a data bank for alternative reliable and affordable source of energy. It has examined the energy needs of Tanzania and the alternative energy available from conventional sources ranging from Biomass, Solar, Nuclear and Wind respectively, which need to be exploited for the provision of affordable and reliable energy for national growth and poverty reduction in Tanzania. A typical Nigeria case was examined; data from different geographical zones were collected and critically analyzed to recommend a model for creating reliable and affordable data bank for the provision of reliable and affordable energy in Tanzania. The management of existing capacity from energy sources was examined, ways of improving the management was suggested and conservation of energy using energy saving devices was recommended.

Key words: Energy data bank, Biomass, Solar, Photovoltaic Systems (PV), Biogas Digester and Wind Mill.

1.0 INTRODUCTION

The world Bank Global Issues Seminar Series (2005): Report on "Towards a Sustainable Energy Future", reveals that about 1.6 billion people lack access to network electricity and if good policies as to how affordable and reliable energy can be created are not put in place, 1.4 billion people will still lack electricity and energy access by 2030, thereby conflicting the global vision of eradicating poverty by 2030 since energy is a vital tool to eradicating poverty (1). Energy issues in the developing countries is a pathetic one, the issue becomes even more pathetic when the energy trend in developing countries is traced. The rural dwellers suffer a high degree of deprivation when it comes to issue of energy supply and utilization. 4 out of 5 people without electricity live in the rural areas of the developing world, mainly in South Asia and sub – Sahara Africa. (World Bank Series 2005). Energy has a major impact on every of our socio – economic life (2). It plays a vital role in the economic, social and political development of our nation. Inadequate supply of energy restricts socio – economic activities, limits, economic growth and adversely affects the quality of life. Improvements in standard of living are manifested in increased food production, increased industrial output, the provision of efficient transportation, adequate shelter, healthcare and other human services. These will increase energy consumption. Thus our future energy requirements will continue to grow with increase in living standards, industrialization and a host of other socio – economic factors (3). It is pertinent to note that the impact of energy goes beyond national boundaries. Energy supply can be used as an instrument of foreign policy in the promotion of international operation and development. Energy service matters more than ever in the global fight against poverty, because these services underpin economic growth that provides jobs in developing countries where they are solely needed. Most economic activity would possibly be impossible without energy, even the small village and household enterprise in developing countries that are the main source of income for the poor in those countries. The services that hydrocarbons and electricity provide – motive power for industry and agriculture: transportation of people and goods; heating and cooling of workplaces, power for appliances – increase productivity and economic output (4). Thus economic growth that creates jobs and raise income depends on greater access and more efficient use of energy services and their constituent energy resources.

The importance of energy services for social development is reflected in the association between energy consumption and human development (Fig 1). A very strong correlation between commercial energy consumption and UNDP's Human Development Index is shown in (Fig 2). This index is composed of human development indicators that reflect achievements in the most basic human capacities – leaving a long life (life expectancy), being knowledgeable (educational achievement), and enjoying a decent standard of living (income measured in purchasing power parity terms). Far from being affordable and reliable, the reality today in many of the world's poorest countries is that energy services are expensive and often only intermittently available. As at 2004, the richest 20% of the world's population consume 58% of total energy, whereas the poorest 20% consume less than 4% (World Bank Series 2005). Lack of reliable energy services in these countries imposes a huge cost on industry and commercial firms undermining their competitiveness and therefore their ability to expand and provide employment (5). This situation

entrenches poverty, constrains the delivery of social services, limits opportunities for women and erodes environmental sustainability.

2.0 ENERGY SITUATION IN TANZANIA. "AN OVERVIEW"

Tanzania, a low income country with an area 945,000X10^{3}M^2 , per capital GDP - USD 280 (2003), in which 75% of the population (22 million) live in the rural area, about 80% (27 million) engage in Agriculture. The issue of energy is a pathetic one. Though Tanzania is blessed with abundant energy resources in different forms, biomass, solar, wind, hydro etc. but with the exception of biomass and hydro, most of the other energy resources remain unexploited. Biomass fuels (firewood, charcoal and farm residues) are dominant energy sources in Tanzania, accounting for more than 90 percent of total energy consumed in the country and for about 98percent of the total energy used in the rural household sector [2]. Per capital commercial energy (electricity and petroleum) consumption is low relative to per capital biomass energy consumption. The overwhelming dependence on wood fuels for energy, clearing of land for agriculture and commercial logging are greatly contributing to environmental degradation, such as high deforestation and soil erosion (Sawe 2005). More than 90 per cent of the populations (35million) in the country do not have access to electricity. About 80 per cent of the population (28million) lives in the rural areas. Only one percent of this (0.28 million) is connected to the electricity grid, leaving a large population (27.723million.) of Tanzania without electricity and depending on wood fuels as their main sources of energy. Other sources of energy available to the people are wind contributing about 8.0% of the total available energy and hydro which contributes just 2% of the total energy, solar (suppressed). It was found that biomass and human were the overwhelmingly dominating sources of energy in rural areas. Major use of biomass (firewood, bio – waste) energy is for cooking (three stone stove in households and rural industries, while human energy is used in agriculture. An X – ray of the energy consumption reveals that [2]:

1. Light is provided by kerosene (wicked lamp), few places candle and wood sticks.
2. Dry cell batteries are used for torches and radios. This normally imposes huge financial burden on the rural people. Global report reveals that the poor spends more than 35% of their house hold income on energy (Sawe 2005)
3. In very few places lead/acid (car) batteries are used for radio and video shows.

In many villages were there was no grid, it was found that only few households (1 – 5 percent) of the households were connected even more than 15 years after electricity was introduced in the village, almost all the rural households had never used electricity for cooking. Use of modern energy technology i.e. improved stoves; solar PV, solar driers, wind mill and turbines were very limited in rural areas. In the few places where the technologies were found, most of them were not working. In some places where the technologies were found working, there was a supportive institution. The problems of rural energy are complex and have been long recognized, some of them among others include [6].

1. Inadequate rural energy infrastructure.
2. Inadequate data on rural energy.
3. Absence of clear energy strategy.
4. Inadequate rural energy issues and policies; knowledgeable human resources.
5. Low existing local capacity to implement rural energy projects and programmes.

Inspite of the above and on the basis of the available information, the rural energy sector is undoubtedly the largest energy – consuming sector in Tanzania. It accounts for about 85 percent of the total final energy consumed in the country. To facilitate improved and sustainable energy services for the majority of the population, concerted efforts in formulating and implementing effective rural energy policies and strategies is required. It is anticipated that, if affordable and reliable energy alternatives are not provided, this trend is unlikely to change positively in the foreseeable future unless there are serious efforts taken both at the national and local level [7].

3.0 ENERGY DATA BANK: A MODEL FOR ADDRESSING NATION'S ENERGY NEEDS

Energy data bank is a resort center were information concerning the climate and geography of a nation are adequately analyzed in other to recommend an alternative energy source to meet the energy needs of the people. Such climatic data on the nature of vegetation, the temperature conditions the natural resource

base; the intensity of rainfall and the wind intensity are normally treated in other to proffer solution to the energy needs of such areas [8].

* CASE 1: A TYPICAL NIGERIA SITUATION

A survey carried out in Nigeria gave the following data:

1. The nation had a proven crude oil reserve of about 32 billion. Nigeria has four refineries with a total installed capacity of 445,000 barrels per day.
2. Nigerian proven natural gas reserves are estimated at about 163 trillion.
3. Available data shows that coal of sub – bituminous grade occurs in about 22 coal fields spread in over 13 states of the federation. The proven coal reserves so far in the country are about 639 million tones while the inferred reserves are about 2.75 billion tones.
4. Nuclear minerals such as uranium and thorium were found in appreciable quantities on the Jos plateau and it's environ.
5. The biomass resources are; wood, forage grasses and shrubs, annual waste arising from agricultural, municipal and industrial activities.
6. The annual average wind speed at 10 m height varies from about 2m/s in the coastal area to about 4m/s in the far North.
7. Solar radiation is fairly well distributed. The annual average of total solar radiation varies from about 12.6MJ / M^2-day in the coastal latitude to about 25.2 MJ / M^2-day in the far north.
8. Nigeria is well endowed with large rivers and some few natural falls. River Niger and river Benue and their tributaries constitute the core of Nigeria river system which offers a renewable source of energy for large scale [8].

An energy data bank was created from this information as shown in Table 1. Such data bank can also be applied to Tanzania, to recommend a reliable and affordable energy source. For Tanzania energy potentials and development status, refer to Table 11.

CASE 11: A TYPICAL TANZANIA SITUATION

Statistic from Table 11 reveals that Tanzania has a serious energy problem which requires immediate attention to ensure that the people are provided with alternative energy sources which are reliable and highly affordable. This alternative, reliable and affordable energy source will not only meet the energy needs of Tanzania but it will also reduce the overwhelming dependant on the biomass (forest and vegetation) which is the dominant energy sources available to the people. This will save the people from the calamity associated with overdependence on forest such as environmental hazards and other disasters. Provision of alternative, reliable and affordable energy source will also help Tanzania in actualizing the global vision for eradicating poverty by 2015, since in the fight against poverty eradication;, energy is a vital issue [9].

4.0 ADDRESSING THE ENERGY NEEDS OF TANZANIA: PROVISION OF RELIABLE AND AFFORDABLE ENERGY

1. The use of Biogas Digester/Saw dust Stove should be popularized, by the government. Foreign investor should be invited to help in the design of effective biogas digesters as this will help utilize the energy stored in cow dungs.
2. Wind Mill. Since Tanzania is blessed with abundant wind, the use of wind mill in which the energy stored in wind can be tapped and use for application such as pumping water and electricity generation should be encouraged. The government must work in collaboration with experts in this field to built sufficient wind mill to alleviate the energy problems of the people [8].
3. Coal Oven. Tanzania has a coal deposit of about 1200million tonnes. The use of coal oven should be highly encouraged as this will solve the energy needs of the rural dwellers in the areas of finding affordable energy for cooking [6].
4. Most importantly, the Authors of this paper wish to strongly advice the government of Tanzania on the need to invest massively on solar energy as this is the best energy alternative that will put smile on the faces of all Tanzania's. I.e. solar energy (Photovoltaic system) is highly recommended as the most reliable, affordable alternative energy source.

SOLAR POWER AND ITS POTENTIAL

How practical is solar for home and mobile home/marine use? These days it is practical especially for remote homes. Until solar power came along, people who want to live in remote areas, frequently had to pay large fees to have a power cable run to their house. Now a remote home can be virtually self – sufficient with solar power. Even in areas where power lines are nearby, solar may be a reliable, affordable and viable alternative to being connected to a power company. An average home has more than enough roof area to produce enough solar electricity to supply all of its power needs. With an inverter, which converts direct current (DC) power from the solar cells to alternating current (AC) which is what most homes appliances run on, a solar home can look and operate very much like a home that is connected to a power line. For recreational vehicles (RVs), solar power provides the freedom to go to more remote locations, without relying on a plug – in power source or a noisy generator. Similarly, boats can use solar power for many of their power needs, rather than a generator or engine. Solar power is used for many lighted highways signs, eliminating the need for diesel generators (10).

Note:
* *For overview of the potentials of PV systems, refer to Table111.*
* *For households' improvement due to PV systems, refer to Table IV.*

4.1 TOWARDS A SUSTAINABLE ENERGY SOURCE IN TANZANIA; VIS A VIS ENERGY SECURITY, POLICIES, OBJECTIVE AND STRATEGIES

Alternative energy sources other than biomass, hydro power must be fully exploited such as wind, nuclear, solar, and coal. Sustainable energy policies must be formulated and appropriate strategies aimed at good energy security must be devised. For solar energy utilization as example, policies such as;

1. Aggressive pursuance of the integration of solar energy into Tanzania energy mix,
2. Keeping abreast with worldwide development in solar energy technology are good policies that can be formulated by the Tanzanian government? The objective might be to;

1. Develop the nation's capability in the effective utilization of solar energy.
2. To use solar energy as a complementary energy resource in the rural and urban areas.
3. To develop the market for solar energy technologies.
4. To develop solar energy conversion technologies locally.

And the following strategies can be applied to meet the set objectives;

1. Intensifying research and development in solar energy technology.
2. Promoting training and manpower development.
3. Providing adequate incentives to local manufacturers for the production of solar energy systems.
4. Introducing measures to support the local solar energy industry.
5. Providing adequate incentives to suppliers of solar energy products and services.
6. Setting up an extension programs to introduce solar technology into the energy mix.
7. Providing fiscal incentives for the installation of solar energy systems.

Such policies, objectives and strategies can be done regarding every other alternative energy sources to ensure sustainable energy in Tanzania. Energy securities according to World Bank, means ensuring that nations can sustainably produce and use energy at reasonable cost. To achieve this, Tanzania must turn to renewable energy sources such as wind, (use of wind mill), solar (use of PV cells), and hydropower (1).

5.0 AFFORDABLE ENERGY: A STRATEGY FOR POVERTY REDUCTION

Human development aimed at meeting the Millennium Development Goals (MDGs) cannot be achieved if the energy sector is neglected. Energy consumption is a key in the fight against poverty and promotion of socio – economic development. Therefore it becomes very imperative for good policies and strategies to be formulated if Tanzania must meet these vision 2010 agenda vis a vis provision of reliable and affordable energy. Modern energy services that provide lighting, cooking, heating, refrigeration, transportation, motive power and electronic communications are indispensable to increasing productivity, creating enterprises, employment and incomes. Energy must play a prominent role in strategies to achieve the eight MDGs. Some glaring statistics (fig 1) illustrate the scale of energy deprivation faced by the poor. Without

access to modern energy services, the poor are deprived of opportunities for economic development and improved living standards. There are many options for improving the poverty reduction focus of current energy policies. These policies would span not only the provision of electricity but all the basic energy services in urban and rural areas. Among the important pro – poor policy options to consider are the following (3);

1. Establish effective frame works and policies for rural and off grid areas for various types of providers of energy services. These regulatory frameworks would stimulate local community participation; remove barriers and develop the roles of local entrepreneurs in providing energy services under new business models.
2. Formulate policies to provide energy services to the poor in close co – operation with electricity services providers, such as establishing power distribution entities that have viable mixes of urban and rural power markets (2).
3. Design and implement grid and off – grid renewable energy programs; programs for sustainable use of biomass resources; and new efficient technological standards aimed at promoting the use of cleaner cooking fuels for the poor and cleaner energy for heating, industrial processes and power generation.
4. A strengthened focus on household energy, particularly the sustainable production and use of biomass requires special attention since this is the only fuel available to the extreme poor (4).

6.0 MANAGEMENT OF EXISTING CAPACITY

For the existing energy capacity in Tanzania, there is the need to design a front page for maintenance principle and practice. Such front page should contain among other things,

1. Establishment of National Board for Energy and Energy Data Bank Management (NBEEDBM) in Tanzania charged with the responsibility of collecting data on energy issues, analyzing them and rendering advice on the way forward.
2. Man power capacity training. The government of Tanzania should establish a Center for Energy Studies and Training (CEST), where young talented individuals will be trained on energy issues Vis a Vis design and construction of energy storing devices and maintenance of already existing energy saving devices (5).
3. The need for government to encourage private sector participation and also create awareness on rural energy development.
4. Good rural energy financing mechanism, good commitment and good resource allocation, coupled with the provision of reliable facilities for rural energy skill capacity building (5).

7.0 CONCLUSIONS

Formulation and implementation of a sustainable energy development strategy could result into a positive contribution to the overall socio – economic development and energy sector needs of Tanzania. The need for energy data bank cannot be over emphasized as it will also help to recommend alternative energy source. Government, non governmental organization and international organization must recognize the importance of energy in poverty reduction, hence help formulate good policies, and strategy aimed at meeting the energy needs of the people. Finally, the government of Tanzania must note that:

1. It is a great challenge to provide modern energy in rural areas.
2. Integrated rural development should be the overall priority in meeting the energy challenge. Multi – sectoral cooperation is essential.
3. More efforts are required to promote local energy institution and entrepreneurs.
4. All efforts should be made to fully involve the local people in all stages of designing and implementing of rural energy initiatives.

Government are responsible for removing institutional and regulatory barriers that prevent energy companies from delivery of modern fuels and electricity, to regulate environmental performance of energy supply and consumption and to mobilize financial resources for investment in energy infrastructure and services. Legislators and policy makers in national and local government should take the lead in linking energy planning to meeting economic and social development goals and in sustaining political commitment to sound energy sector management and governance.

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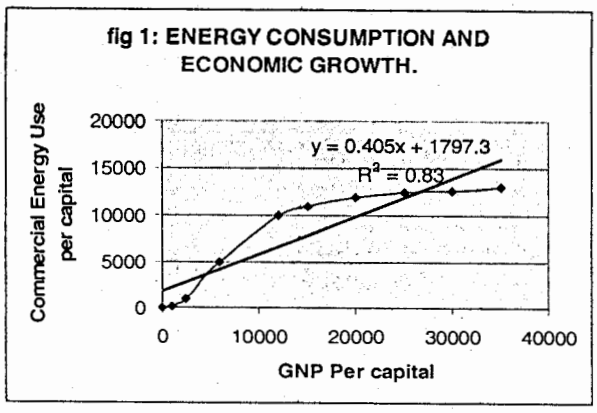

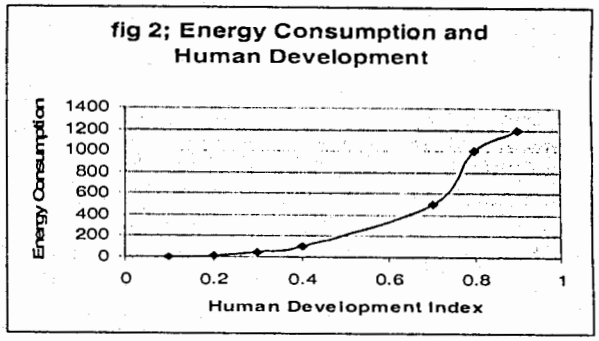

TABLE 1

ENERGY DATA BANK; A TYPICAL NIGERIA SITUATION

S/N	NATURAL RESOURCE INFORMATION	RECCOMMENDED ENERGY TYPE
1	Very high sunshine in the Northern region (25.2 MJ / M^2-day)	Solar energy (Pv system)
2	High wind intensity in the Northern region 4m /s @ 10m.	Wind energy (Wind mill)
3	Abundant biomass resource in the west and middle belt region	Biogas digester, Saw dust stove.
4	Large rivers in the East and Niger delta	Hydro power (Grid system)
5	Deposits of Nuclear materials in the plateau	Nuclear energy.
6	Large deposits of coal in the East	Coal energy (Coal oven)
7	High crude oil Reserve.	Natural gas (Gas oven, Gas cooker)

TABLE 11: TANZANIAN ENERGY POTENTIAL AND DEVELOPMENT STATUS:

S/n	Energy Sources	Demand	Percentage Contribution	End Use Equipment	Services
1.0	Hydro – 470MW	500MW	2%	Machines	Mechanical
2.0	Small Hydro – 240MW			Bulbs	Power
3.0	Natural Gas – 45M^3			Stoves	Refrigeration
4.0	Coal – 1,200M tonnes				
5.0	Solar – 187MW	Suppressed.			
6.0	Biomass * Crop Residues est. 15Million tonnes.				
7.0	Biomass • 34 million hectares of forest • 14 million cattle.	36 million M^3	90%	Stoves	Cooking, pumping water.
8.0	Wind: Between 1 to 6M/s				
9.0	Petroleum Fuel: **None**	1.45 million tonnes (Imported)	8.0%	Pumps, machines, vehicles, tractors and stoves	Transportation, Cooking, Lighting.

(Source: Sawe 2005)

TABLE 111: OVERVIEW OF THE POTENTIALS OF PV SYSEMS

AREA	POTENTIAL	RESULT
Equipment and Investment	Flexible, easy scaling from a few Wp upward	Pv mainly competitive in low energy use range in remote unelectrified areas. Need for financial mechanism, also due to low capital availability in rural areas.
Operation and maintenance	Reliable, low maintenance and supervision needs and cost	Pv systems often competitive on life circle cost basis
Organization.	Easy integration in user package, highly adapted to user's needs	Need for institutional change in the energy sector for PV Telecommunication projects
Environmental Implications	Environmental friendly, low emission of carbon dioxide, compared to fossil based fuel	Possible financing

TABLE IV: HOUSEHOLD IMPROVEMENT DUE TO PV SYSTEMS

Work / Education / Homework in the evening	77%
Better recreational possibilities (TV / Radio, Telecommunication etc)	78%
Better health conditions (Refrigeration, No smoke, No danger to life)	42%
Time liberations, especially for women.	44%
Improvement in housing coinciding with installation	40%
Self – esteem.	56%
Others.	5%