

Review

The challenges of energy supply for Sierra Leone's economic development

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Accepted 24 November, 2009

Energy problems in developing and under developed countries are serious and widespread. Lack of access to sufficient and sustainable supply of energy affects over 85% of the population in these countries. Over 3 billion people are without electricity and a similar number remains dependent on fuels such as animal dung, plant residue, kerosene, wood and charcoal as a source of fuel for lighting and cooking. Without efficient supply of clean energy, peoples' efforts to effectively engage in economic activities or improve living standard will be fruitless. Sierra Leone has just emerged from a decade-long civil war which virtually paralyzed the economy. As the country currently embarks on post-conflict development and economic modernization, there is need to thoroughly address energy issues for sustainable economic growth. Modern economies are energy dependent; meaning that economic prosperity and sustainable living standards could only be achieved through paradigm shift in energy policy and planning. Sierra Leone is fairly endowed with energy resources, like biomass energy, hydropower, solar energy and other renewable energy resources. If properly harnessed, these rich resources of energy can lay the basis for sustainable economic development in Sierra Leone.

Key words: Economic development, energy, hydro electric power, living standard, Sierra-Leone.

INTRODUCTION

Energy plays a crucial role in sustainable socio-economic development. Energy has various implications for poverty alleviation, population, health and the environment and invariably influencing 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, hence more affordable means of production of goods and services (Pearce and Webb, 1987).

Ideally energy and environmental policies are modeled at national and international levels in response to a wide range of issues including improved energy efficiency as in transport and power generation; financing oil and gas industries financing global warming and reducing energy related pollution. An equally important but often neglected aspect of energy production and use is the lack of access to affordable energy sources such as electricity, liquid fuel and biomass. This often has serious socioeconomic repercussions for developing 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).

Developing countries are facing two related crucial problems in the energy sector. The first is the insufficient production and inefficient use of traditional forms of energy such as fire-wood and agro-residues, posing tremendous socio-economic, environmental and health hazards. The second is the highly uneven distribution and use of modern forms of energy such as electricity, petroleum and liquid gas, widening disparity in income and quality of life (Barnes, 1990). Hence an energy strategy for developing countries must be designed to sustain efficient production and use of traditional energy while addressing socio-economic transition to the efficient use of clean modern energy. It is hard to farm efficiently or produce goods and services if people must use most of their unproportional time and energy searching farther a field for wood fuels or

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use two thirds of their income to pay for energy that is inefficient. Moreover, with the environment locally and globally threatened by air pollutions from greenhouse gas emissions and inefficient energy production and use, the welfare of especially women and children is endangered by long-term exposure to heavy plumes. In addition to high health risks, common household lighting devices are grossly inefficient as sources of light (Cecelski, 1996).

In Sierra Leone, annual ministerial budgets constitute energy policy statements that lack long-term strategies for energy, hence socio-economic development. Sierra Leone is endowed with energy resources, particularly biomass, water for hydroelectric power generation and solar energy which, if well harnessed can enhance and accelerate sustainable socio-economic development (CEMMTS GROUP, 2004).

The country instead relies on imported petroleum, which has virtually plunged the country into chronic blackout. In Sierra Leone the institutional structures have not changed significantly since the 1980s, posing formidable obstacle to efficient and sustainable energy supply.

A number of Ministries are involved in energy policy formulation which often conflict and therefore hinder energy coordination and harnessing. In fact the country is experiencing energy deprivation despite its rich natural energy resources. This is evident in the low level of consumption of modern forms of energy (electricity and petroleum products), inadequate and poor-quality electricity service and over reliance on fire-wood. Energy planning (Largely petroleum and electricity) has often focused on urban needs (Freetown, Bo, Kenema and Makeni) as the main users of commercial fuel and electricity. The energy needs of the larger rural population are largely met by biofuels and agro-residues. Hence improved energy supply to the rural areas could have a profound socio-economic impact, thereby alleviating poverty in Sierra Leone.

The overall Millennium Development Goals (MDG) aims at reducing global poverty by one-half by 2015. To realize this goal, there must be sufficient access to affordable energy. As one of its economic objectives, the Sierra Leone constitution (1991) states as follows: "the state shall harness all natural resources of the nation to promote national prosperity and efficient, dynamic and self reliant economy". A constructive energy policy that exploits the vast energy potential of biomass, water resources and other renewable energy resources must be directed towards meeting the above economic objective. As the country embarks on energy and economic transition, it is both appropriate and prudent that the centrality of energy for economic development realization is sufficiently emphasized. Vulnerability of the economy due to insecure energy supply calls for a sober look at the energy situation with the view of accomplishing two interrelated goals. i) The adoption of policies for short-, medium- and long-term perspectives for addressing the energy needs of the country. ii) Creating the enabling environment for a sus-

tainable supply of affordable energy. A critical factor in this direction calls for a significant improvement in the governance of the people, efficient management of the energy sector and affordable or broad access to energy service to stimulate production.

As Energy constitutes a significant portion of Sierra Leone'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. Energy sector analysis starts with the identification of demand and supply, which in Sierra Leone, 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 must be carefully structured, inclusive and coordinated to minimize unpleasant side effects. For instance, rural electrification 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.

This paper analyzes energy from the perspective of socio-economic development and recommends strategies for mitigating adverse consequences of current energy status in Sierra Leone. Two parallel goals are addressed: i) broad accessibility and affordability 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 increased use of renewable energy. ii) Use of biofuel should be expanded because it is relatively sustainable. Even under the best transition scenario, biofuel will be a reliable energy source for rural households in developing countries according to (Leach and Mearns, 1988). Rationalization and sustainable use 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.

ENERGY SITUATION IN SIERRA LEONE

Energy services are a crucial to adequate food, shelter, clothing, water, sanitation, medical care, education and access to information - important aspects for addressing poverty reduction and economic growth in Sierra Leone. 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). Generally the quality of life is measured by the level of energy consumption, which is associated with increased industrial and economic activities. Sierra Leone is reasonably endowed with energy

Table 1. Electricity overview in West Africa, billion kilowatt/hours.

Country	Consumption, 2001	Generation, 2001	Installed capacity, 1/1/2001 (gig watts)	Thermal Capacity (% of total)	Hydroelectric Capacity (% of 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

Sources: Energy Information Administration, the table above indicates how Sierra Leone is heavily dependent on petroleum imports for electricity supply in the subregion.

energy resources, particularly biomass (wood), hydro-power and even solar energy. These resources, if properly harnessed, can play a catalytic role in sustaining Sierra Leone's economic development. The country, however, faces difficulties with commercial energy supplies, particularly electricity supply as it imports all its petroleum, Table 1.

Energy is a key sector in Sierra Leone's economy. It is a major source of government revenue through fuel taxes, license fees and royalties. On the other hand it accounts for about 26% of the country's total import (MTI, 2002). It is therefore an absolute necessity for the government to subsidize basic utilities like electricity. The Ministry of Energy and Water Resources (MEWR) is the custodian of electricity and water services in Sierra Leone and therefore responsible for charting out policies and coordination of these services. However, the wider energy sector is, within the purview of a number of ministries. MEWR handles matters related to electric power supply, including hydroelectric power and renewable energies like solar energy and biofuels. The Ministry of Agriculture, Forestry and Food Security (MAFFS) is primarily responsible for food production, including plants and animals and even fuel wood. Petroleum marketing and sales are handled by the Ministry of Trade and Industry (MTI). The Ministry of Finance and Economic Development (MFED) plays a supportive role in fiscal transactions. Yet the Ministry of Mineral Resources (MMR) deals with minerals, including energy related minerals. There are therefore overlapping responsibilities of the various ministries and coordination

between the ministries is generally poor. There is no single central institution for assessing potential energy resources with regards demand and supply and designing energy development and investment plans in line with the needs of the nation.

Electricity sub-sector

The Ministry of Energy and Water Resources which oversees electricity supply, is the policy making organ for the electricity sector. Its responsibilities also cover harnessing the country's immense potential hydropower sector, most important of which is the Bumbuna Hydroelectric Project (BHEP) and matters relating to alternative energy resources. National Power Authority (NPA) is a vertically integrated monopoly supplier of electricity in the country. The Bo-Kenema Power Services (BKPS) is a semiautonomous body of NPA responsible for the supply of electricity to the townships and districts of Bo and Kenema. Power supply is still grossly inadequate and is persistently interrupted, even in the capital city of Freetown.

Recently, NPA revenue collection from electricity supply has increased from Le100 billion to Le2.5 billion per month (according to current press conference report in Freetown by, the minister of energy and power). According to the minister, NPA has added over 2000 customers because of reliable supply of electricity following maintenance of transmission and distribution facilities. The minister promised conducting tariff analysis to redress policy issues on

energy. Such analysis would include advice on the strategies of tariff through socioeconomic survey where the customers and NPA can equally contribute. The National Power Authority Act of 1982 established NPA with the sole responsibility for power (including hydropower) generation, transmission, distribution and supply in the country. NPA therefore forms part of the Technical Committee that oversees the Bumbuna project implementation unit (PIU).

Sector performance

Less than 10% of Sierra Leone's population has access to electricity and those who do live in the Western Area around the capital-Freetown and in the provincial head quarter towns of Bo and Kenema (Statistics Sierra Leone April 2003 - May 2004). The country's generating capacity prior to the 1991 civil war was about 120MW, 116MW of which came from thermal plants and the other 4MW from the Dodo hydroelectric plant in Kenema district (MEWR, 2004). Of the total installed capacity, NPA operated 33.4 MW in the Western area and 14.5 MW in isolated provincial towns. There were some 28 MW captive capacity in the mining sector and 40 MW estimated capacity of auto-generators. The available generation capacity for the Western Area 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 provincial towns virtually degenerated during the 10-year conflict. In spite of substantial investment in the sector since 1991 in the Western area, 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. Over the last three decades, the Bumbuna Hydroelectric Project has undergone various implementation phases, all of which have been fraught with difficulties ranging from finance and civil war to technical problems. However, with renewed political will, the Bumbuna Hydroelectric Project has been pre-commissioned on the 18th September 2009 at the Kingtom Bumbuna substation in Freetown it is now slated for completion not later than 2009.

About 80% of the power generated by NPA is consumed in the Western Area, with a consumption pattern of roughly 70% industrial/commercial and 30% residential. Previous studies have projected annual growth rates of 4.5 and 7.4% for the Western Area and the provinces respectively (MEWR, 2004). The state of the power sector indicates a considerable imbalance between power demand and supply in the country.

NPA OPERATION IN WESTERN AREA

Electricity supply and service in the Western Area is poor; installed capacity is grossly inadequate and breakdowns

frequent. Consequently, there has been frequent load shedding and the situation is unlikely to improve in the immediate future. The state of electricity network is also highly inadequate. Current improvements, funded by the European Union (EU), will only increase the capacity of network to about 31 MW and there will still be a low efficiency network.

Electricity tariff is one of the highest in the sub-region, despite the fact that it excludes capital cost recovery. High technical and commercial losses combined with poor revenue collection scheme are the major contributors to the liquidity problems of the utility (CEMMATS GROUP, 2004). The customer-base is small and literally ranges from 35,000 to 40,000. The government of Sierra Leone has signed a number of memoranda of understandings (MOUs) relating to power supply by Independent Power Producers (IPPs), but without concerted plan or implementation.

BUMBUNA HYDROELECTRIC PROJECT

The Bumbuna hydroelectric dam in Sierra Leone, under Bumbuna Hydroelectric Project (BHP), is in the Sula Mountains valleys on River Seli in the Northern Province of Sierra Leone. BHP (initiated in 1970s), aims at providing affordable and sustainable electricity supply in the country of Sierra Leone, especially in the Western Area which includes the nation's capital. This objective is in resonance with that of New Partnership for Africa's Development (NEPAD) aimed at Africa integration into a global energy economy and poverty reduction. However, for the past thirty-eight years, BHP is still to achieve such a lofty objective since the dam remains to be operational. The delay in the project completion has mainly been due to inadequate financing, environmental constraints and the civil war.

The Bumbuna Hydroelectric Project is now hydroelectric project which was started in April 1975 has been pre-commissioned on the 18th September 2009 at the Kingtom Bumbuna substation in Freetown over 85% complete, the project is estimated to be completed by the end of 2009. The project has tremendous potential for a substantial augmentation of electricity supply in the country. The associated transmission infrastructure links priority areas in the provinces, eventually forming the cornerstone of the national power grid. Bumbuna will provide some 50 MW at peak seasons and 25 MW during low flow seasons. Subsequent phases of the project will generate some 300 MW of electricity (CEMMATS GROUP, 2004). Sufficient funds have been contributed by international donors for the completion of the project.

The completion of Bumbuna Hydroelectric Project would represent the nation's first substantive move towards reliable and affordable power supply that is indigenous and renewable. It will enhance economic development and provide opportunities for improving the living standards of the people in Sierra Leone. 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 reduce significantly. Finally, availability of clean electricity will enhance the people's health and educational status, poverty alleviation and sustained economic growth.

BO-KENEMA POWER SERVICES

Bo-Kenema Power Services (BKPS) is entrusted with the zonal responsibility for the generation, transmission, distribution and sale of electricity to the cities of Bo and Kenema and the environs. BKPS has a mixed hydro-thermal operation and operates a 33 kV sub-transmission line in addition to an 11 kV and local, low voltage distribution. There is need to expand and upgrade the distribution network because of growing demand. In 1999, BKPS served about 8000 consumers, most of whom are domestic. The generators in Bo deteriorated sharply but were overhauled recently by the Chinese Government.

The 4 MW Goma hydroelectric facility operated by BKPS, an autonomous subsidiary of NPA, is expected to be upgraded to 12 MW in a two-phase augmentation work: the first phase is expected to be an upgrade of the turbines from 4 to 6 MW and the second is the construction of a new dam upstream the current one, followed by an additional installation of turbines to bring the total installed capacity to 12 MW. This upgrading is undertaken by China National Electric Equipment Corporation (CNEEC).

HOUSEHOLD ENERGY SUPPLY

Sierra Leone 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. Biomass (firewood and charcoal) plays a very significant role in energy supply in Sierra Leone. It constitutes over 90% total energy consumption in the country and provides almost all energy needs for cooking in the rural and most urban households and is also the main source of energy for rural, small-scale industries (CEMMATS GROUP, 2004). However, Sierra Leone has limited experience on other Renewable Energy Technologies (RETs).

In Sierra Leone, 98% of household energy consumption is in cooking and fuelwood supplies. Fuelwood is free for the vast majority of rural households in Sierra Leone, 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 600 kg per

annum, accounting for virtually all household energy need and use. In the urban areas (such as Freetown) where there is a price and flourishing market for fuelwood, per capita consumption can be much less. The estimated annual, per capita consumption of other fuels in the urban and rural areas are as follows: charcoal 50 and 10 kg; kerosene 18 and 5 L; electricity 55 and 5 kWh respectively. According to (Barnes, 1998) these estimates are within the range experienced in other West Africa countries. The most notable exception is the low market penetration by charcoal in urban areas; for example, Freetown consumption estimate is 50 kg per annum which is well below estimated urban use in Liberia (141 kg/yr) and Senegal (230 kg/yr).

ECONOMIC IMPORTANCE OF FUELWOOD AND CHARCOAL

The organization of this sector is officially under the Ministry of Agriculture, Forestry and Food Security which is responsible for issues relating to fuelwood. Forest depletion and re-forestation are within the purview of this ministry. However the downstream operations are within the purview of various other ministries and agencies and many of these operations are very poorly regulated. A large percentage of the urban population are engaged in wood selling and associations like the wood-seller association, charcoal-sellers association and other organizations for stove manufacture and sales have even emerged in this industry. There is a considerable level of confusion down the organizational line in this sector.

The Forestry Division of the Ministry of Agriculture Forestry and Food Security (MAFFS) is officially responsible for wood fuel and the related matters. It is also responsible for the protection and management of all state and some chiefdom forests, overseeing sustained yield management and development planning of other chiefdoms and private forest lands in the country. According to the (MAFFS, 2004) there is a close link between food production and energy procurement. Fuelwood is obtained from cleared agricultural lands. Tree regrowth during fallow periods plays an essential role in regenerating soil fertility - sustaining soil structure and moisture, limiting runoff and many other soil preservation functions after cropping. With worsening fuelwood shortages, premature tree felling is becoming rampant, shortening fallow periods and leading to further soil degradation.

O'Keefe and Minslow (1989) argued that the level of dependence on fuelwood for household energy needs is disturbing, projected at 4.2 million m³ for 2004. Fuelwood is normally harvested along land clearing for farming, which takes care of the energy needs of rural farm families. Fuelwood can also be a by product of forest management, e.g. thinning from silvicultural treatment and wood wastes from logging and sawmilling. All varieties of mangrove trees in Sierra Leone are used as firewood. Mangrove as fuelwood is extensively used in virtually all

coastal villages manufacturing common salt and preserving locally caught fish. Fuelwood is equally used in crop and food processing and preservation, heating purposes in the wet season, cooking, artisanal activities lighting in night time social activities. Most important, perhaps, is the culture of wood as part of the subsistence production system. Over 95% of fuelwood used in Sierra Leone is for household purposes and the per capita consumption of fuelwood is 0.58 m³ (FAO, 1990). Fuelwood production for the urban market is in farmlands along motorable roads or waterways. Such areas have been severely exploited over the years. Charcoal production for the urban market is concentrated in the forest reserves of Freetown Peninsular, village forests in the mountains and sections of the mangrove forests.

FOREST RESOURCE

It is estimated that 86% of Sierra Leone's land area (7.3 million ha) is covered with natural forest. Out of this, 5% is closed high forest (365 000 ha), located largely in the Eastern and Northeastern parts of the country. About 52% of the total land area (or 60% of the natural forest) is forest regrowth derived from closed high forests (IDA Guarantee, 2005.) This represents the fallow phase of the bush fallow system and amounts to 3.7 million hectares. Secondary forest amounts to 261 000 ha, Savannah woodland 1.6 million ha and mangrove and swamp forests 286 000 ha. Out of the 365 000 ha of closed high forest, 219 000 ha are productive closed forests of which 100 000 ha remain unlogged. Fuelwood supplies in Sierra Leone are obtained directly from the closed high forests and Savannah woodlands.

Mangrove forests

Where conditions are favorable, mangrove may form a very extensive and productive forest. The total area of mangrove vegetation in Sierra Leone is 171 600 hectares. Mangrove, however, has many uses, including energy, construction, fishing, textile, leather, food, drug and beverage, household items, paper products and other natural products. High end charcoals are also made from mangrove, bringing good income to the people.

HOUSEHOLD ENERGY CONSUMPTION

Kerosene/gas

Kerosene and liquefied petroleum gas (LPG), commonly for cooking, are lot more convenient, efficient and clean-burning than wood, farm residues or dung (Floor and Van der Plas, 1991). Kerosene and LPG is 3 ~ 5 and 5 ~ 10 times more efficient than wood respectively. Cooking with kerosene and LPG is also less damaging to the natural environment and health. However, because these forms of

fuel are more expensive than wood, the poor hardly affords them. Typically, kerosene and LPG are used by medium and high-end income families. At the same time, substitution of kerosene and LPG for wood is more influenced by increasing income than by relative market prices in developing countries. In Indonesia, Ecuador, Sierra Leone and several African countries, governments have tried to encourage substitution through subsidies, which efforts have failed to produce desired results.

In Sierra Leone, charcoal and wood make up 90% of total energy consumption. It is the preferred energy source in cooking and ironing for both low- and middle-income earners. Sales from firewood and charcoal virtually provide income to about 400 000 rural dwellers with quick investment and return (CEMMATS GROUP, 2004).

Woodstove in Sierra Leone

Simple and inexpensive woodstoves (designed for use by low-income households) can double energy efficiency of wood, reduce indoor air pollution and cost of wood. Despite these apparent benefits, many developing countries have failed to adopt improved woodstoves. Initial woodstove programs in the late 1980s to early 1990s, supported by the government of Sierra Leone, NGOs and private donors, projected remarkable benefit if adopted. (Barnes, 1990) estimated that the introduction of woodstove will gain widespread adoption, hence increased 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.

Various types of stoves are being manufactured of which mud stove remains the cheapest as it can be made and repaired very easily. The respective producers claim that mudstone and wonder stove have 48 and 50% efficiency over the other conventional stoves. While an independent investigation on the efficiency of these stoves remains to be done, there is, however, a general consensus that they are energy efficient. The most common gadget for cooking is the "traditional open-fire" (or 3-stone stove), with a poor thermal efficiency ranging from 8 ~ 15%. Such gadget is widely used in rural areas and by about 60% of low-income households in the capital city of Freetown.

Cost comparisons of different stoves show significant savings in switching to the more efficient stove gadgets that are currently being tested. The Louga-stove, introduced by Plan International pilot project, has the lowest cooking cost. The 3-stone stove is the most expensive to use with long-term costs of twice that of Louga. The caussanel metal stove, designed by the French, is also more economical than the 3-stone stove and is now being produced on a small scale. 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.

WOODSTOVE MARKET IN FREETOWN

Freetown, with about 1.800 000 inhabitants (Statistics Sierra Leone, 2004) and an average of six persons per family, has approximately 180 000 households has a market of roughly 53 000 improved stoves per year. An improved stove program in Freetown relies primarily on the private sector which produces metallic stoves. Cost of materials (6 ~ 8 stoves are produced from a used oil barrel), production time and profit margins determine the final sales of improved stoves. Government or donor inputs are needed for design and market research, artisanal training, publicity and above all, appropriate pricing policy. The goal of the programs is to produce and market, on a large scale, affordable improved metal stoves that reduce household consumption of fuelwood while concomitantly satisfying family cooking needs and budgets. No government investment is required in producing the stoves. Since they are produced from locally available materials and scrap metals, foreign exchange should not influence the pricing system.

RENEWABLE ENERGY IN SIERRA LEONE

There are very few companies that deal with other forms of renewable energy. Solar energy forms an extremely small fraction, while hardly wind energy is utilized as an alternative energy system. There are very few dealings with renewable energy in Sierra Leone (CEMMATS GROUP, 2004). Employment of renewable energy technologies (RETs) for sustainable development faces various challenges, including establishment of institutional framework, level playing field for grid and off-grid electrification, meeting energy services, lack of awareness and poor technical support. Many of the traditional financing bodies dealing with the rural poor have very little or no knowledge of RET program. The main renewable energy technologies includes micro-hydro, biogas, wind generators, wind pumps, solar converters. All these technologies had remained untapped until recently when photovoltaic (PV) systems have been developed to provide electricity supplies for small-scale applications.

Solar and wind energy

Not much research has been done in this area. The power sector master plan studies in 1996 considered in the main power plants, considerable contribution from solar and wind to overall power generation in the country. This implies an output of at least 100 kWh. Renewable with an output power below that, like photovoltaic home systems, were not investigated. The study concludes that large photovoltaic systems are not economical. Average solar

radiation was estimated at 1460 ~ 1800 kWh per meter square per year. According to the study, solar generation is not economically viable, costing between US\$0.20 ~ 0.25 per kWh. In Freetown, it varies between 308 ~ 465 calories per meter square per day for about five months in each year. With the possible exceptions like hotels, this implies that solar hot water heaters are more costly than charcoal boilers.

Studies also estimate photovoltaic electricity generation costs at 1800 kWh per meter square per year at US\$0.65 ~ 0.85 per kWh. The contribution of photovoltaic power plants in Sierra Leone's mainstream power supply will, under any best scenario, would be insignificant. Thus the study suggests that the future of PV systems lies in PV home systems, which typically consist of 40 ~ 60 Wp module and batteries that are highly competitive in many rural areas in Africa. Experience in other African countries with PV projects strongly indicates that such programs must be closely tailored to national and local conditions for any successful commercialization. Where productive use of energy is high and significant load growth is imminent, PV system may not be an appropriate choice.

Wind velocities are reportedly low (1 ~ 5 m/s) with short-lived peaks during storms and as such not an attractive source of energy. Electricity generation cost from wind is estimated at US\$0.8 ~ 0.10 per kWh (without grid connection). Compared with other alternatives, wind energy could be limited to economically viable areas.

Biomass (non-wood)

Most developing countries have enacted programs to improve the supply and use of biofuel though the programs are exceedingly small compared to allocated resources for electrification. Such programs can increase supply through woodlot and forest management, farm forestry programs and end-use efficiency through improved woodstove programs. According to (Barnes, 1990) the total energy production from various other biomass sources is in excess of 2700G Wh/yr. A more accurate assessment of the energy potential of crop wastes needs to be carried out in Sierra Leone.

Lignite resource

According to the Ministry of Mineral Resources (MRR), lignite has been sported in Sierra Leone for sometime now with alluvial deposits in the coastal regions. Major deposit areas are around Yema, some six miles Northeast of Waterloo, which is within economic distance of potential demand centers - Freetown. There are also deposits of lignite (at 35 ~ 45ft below the land surface) in the environs of Kenema, the eastern provincial headquarter town. There is an extremely high quantity lignite with a heating value of + 8000 BTU/lb, which is at the upper end of UN international lignite grading system (4000 ~ 8000 BTU/lb). The department of Geological survey in Sierra Leone

carried out a survey in Koya chiefdom, 25 miles from Freetown, where 200 000 tons of lignite was discovered and there are indications of another 300 000 tons deposit in the area. Earlier geological surveys show deposits of sufficient amount of lignite to sustain a 20 MW power plant for two years. There are also possibilities of exploiting the lignite for household level uses.

PETROLEUM PRODUCTS IN SIERRA LEONE

Modern Sierra Leone economy is highly dependent on imported petroleum products for fuel and power (Table 1). In recent years the economy has struggled to secure adequate and regular supplies, adversely affecting performance of the country's economy. The immediate reason for the inadequate supplies is the country's difficult foreign exchange situation. Petroleum shortages as well as their consequences are exacerbated by deficiencies in procurement, price distortions and the government's inability to manage shortages. Despite excessive margin of payment for crude supply, deliveries have never been on time. Shortages of foreign exchange, together with the absence of budgeted allocated funds for petroleum imports have encouraged scramble for foreign exchange for each cargo. The parent involvement of the ministry of finance in parallel market dealings has, from time to time, led to delays in petroleum products delivery, hence chronic shortages and escalated landed costs.

Facilities for distributing petroleum products in rural areas are grossly inadequate. Distribution companies are reluctant to extend such facilities due to limited market, higher delivery cost and transportation difficulties. Petroleum marketing and sales are handled by the Ministry of Trade and Industry (MTI). The Ministry of Finance and Economic Development (MFED) also plays a parallel role in the import and storage of petroleum products. The Ministry of Mineral Resources (MMR) deals with extraction of minerals, including energy related minerals. Petroleum products are predominantly used by the Transport sector which is under the supervision of the Ministry of Transport and Aviation. Petroleum exploration and production is regulated by the Petroleum Exploration and Protection Act, 2001. This act makes provision for the establishment of Petroleum Resources Unit. The Ministry of Mineral Resources develops 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 mineral sector is governed by the Mines and Minerals Act, 1996. There are several other regulations dealing with the industry and a core minerals policy has recently been formulated. The main objective of the new policy is to promote the country's mineral sector as social and economic engine of growth.

Sierra Leone revived petroleum exploration by announcing its first bid in April 2002. Before then, the government had contracted TGS NOPEC, a geophysical company, to

carry out seismic survey over approximately 5700 km stretch of land off the southern coast of the country. The data, as well as those of old Mobil and Amoco, have been reprocessed and packaged for licensing by viable oil companies. The area covered for surveying has been divided into seven blocks, each between 3500 ~ 5500 Km², including both the continental shelf and deep waters. The country is experiencing severe difficulties with the balance of payment due to escalating oil imports costs and fluctuating foreign exchange rate. The petroleum marketing and sales sector is dominated by five petroleum companies operating in the country. Mobil, Safecon and NP are, by far, the major players in comparison with Unipetrol and Leon oil. Close to 200 000 tons of petroleum products are imported annually, representing (in monetary terms) some 26% of all imports into the country (MTI, 2002). The Sierra Leone Oil Refinery was sold in 1994 to West African Refinery Company, a company with strong Nigerian shares including the Government of Nigeria. The Petroleum Unit (PU) was set up in June 1992 under the Government of Sierra Leone (GOSL) for comprehensive Structural Adjustment Program for macroeconomic stabilization.

Energy industry has been growing steadily since initial realignment in 1993 and import levels are almost back to pre-war levels of 200 000 metric tons per annum. The industry contributes as much as Le 46 billion annually to government revenue from Excise and Road Tax. Downstream petroleum sector in Sierra Leone has a relatively satisfactory product supply and distribution programs. There, however, remains a lot to be done in terms of combating malpractices in product adulteration and fraudulent or illegal practices. The industry is faced with a number of problems including Limited storage capacity. Exchange rate fluctuations only serve to make an already bad situation worse. MTI has mooted the idea of a strategic reserve for petroleum products program consisting the following: Petrol-5500, diesel-6600, kerosene-6000 and fueloil-6000. Unscrupulous dealers are involved in various malpractices from adulteration of fuel to charging higher than stipulated prices for products, especially in the provinces. Despite the fact that the provinces consist mainly of the rural poor, they pay more for all classes of petroleum products because of added transportation cost. Supply difficulties are experienced from time to time. There are also shipping and storage limitations. Since the refinery was bought out, it has only been used for storage purposes and sales of limited quantity of refined products brought in by Unipetrol (SL). The Refinery still remains non-operational fourteen years after it was sold out. Prices also differ in various parts of the country. The following comments explain this point:

1. A standard charge for Petroleum Fund is now levied per each gallon of petrol, diesel and kerosene. Most of this goes to PU operation.
2. A Road Users' charge is levied on each gallon of petrol and diesel. This goes to Sierra Leone Roads Authority's

(SLRA) Road Fund used for road maintenance.

3. Prices of products are much higher in most provincial areas. There is ample evidence that the prices set are not necessarily adhered to. In many instances prices are considerably higher in rural areas than stipulated.

RURAL ENERGY

Economic activities in rural areas including agriculture, business and social services are greatly influenced by energy (Bhatia and Desai, 1995). Good energy services positively impact rural welfare and sustainable economic growth. Majority of Sierra Leoneans live in rural areas and behooves any energy planning to separately consider rural areas. Biomass, particularly fuelwood, constitutes 95% 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. Demand exceeds sustainable supply in many areas of the country and this, coupled with agricultural and settlement pressures, is resulting in the denudation of natural woodland. The balance of the energy requirement is met by other options, mainly kerosene, petrol, diesel and candles. Less than 1% of the rural population has access to electricity. The low consumption of commercial energy has retarded economic growth, which is manifested in low levels of agricultural mechanization and industrialization. There is hardly any investment in rural energy development. There is a need to establish an institutional framework that can mobilize, co-ordinate and facilitate private and public initiatives in rural renewable energy. The development of commercial activities in underdeveloped areas can be a crucial factor for economic empowerment of the poor. Commercial activity usually begins with small businesses and micro-enterprises, such as kiosk shops, entertainment facilities and agro-industrial activities. Modern energy services are an essential input for the development of commercial activities. Electricity, in particular, is a key element for commercial activities. Where the supply of grid electricity is impracticable, costly or delayed, alternative electricity supplies are required.

SUMMARY

Fuelwood is the dominant source of energy in Sierra Leone, accounting for about 80% of the energy consumption (CEMMATS GROUP, 2004). The other 20% is supplied by imported oil. Fuelwood is the traditional form of energy and is used almost exclusively by households for cooking and traditional activities. Petroleum, on the other hand is the most important source of energy in the modern economy. In recent years, difficulties with foreign exchange have restrained petroleum imports, limiting energy

consumption. Future growth in consumption of fuelwood is expected to return in the longer term, to historical trend as the country shifting towards modern fuels, primary oil but eventually hydroelectric power, a resource that is still virtually untapped.

Sierra Leone, with a population of 5.9 million (Statistics Sierra Leone, 2004) is reasonably well endowed with energy resources, particularly forestry and hydropower. Annual supply of wood fuel from forest is estimated at 5 million m³, about 20% of which is consumed in Freetown. Annual sustainable yield of wood is estimated at 9 ~ 15 million m³, but large part of this supply is not economically accessible and there are shortages near urban areas. There is an extensive network of rivers and tributaries which, when harnessed, can provide a large hydroelectric power. Technically and economically, the most promising site is the Bumbuna, at the Seli River with a total potential of 305 MW (Mansaray and Khare, 2007). Around 20 mini-hydro sites have also been identified, but their feasibility are yet to be fully evaluated. The only development so far has been a mini-hydro plant of 4 MW, built with the help of China. As far as petroleum is concerned, there is a potential for off-shore reserves but limited exploration yet hampers full evaluation.

Recent rises in oil price have caught Sierra Leone totally unprepared and therefore struggles to cope with energy supply. The country has been entirely dependent on petroleum imports for non-traditional energy needs and has not developed indigenous energy resources to mitigate high import costs. As in many other developing countries, there is practically no institutional structure, little or no technical expertise and modest resources to manage this complex problem. The oil price hikes came at a time when the country was already facing difficulties with forex because of declining mineral exports. The net result of these developments has been a severe shortage of commercial energy supply with attendant disruption of economic activities. While the current problems in the energy sector are severe, there are grounds for optimism. Firstly, with the new government and the strong political will, the World Bank has agreed to provide funds for the energy sector in Sierra Leone. The government should devise means to maximize economic benefits in the current oil pricing system while developing a coherent policy for the energy sector to avoid recurrence of the problems currently facing the sector. In particular, the government should consider options which can: (a) Encourage efficient utilization of available resources to the energy sector (focusing on projects with high rates of economic returns instead of those with low forex savings); (b) Enhance the use of domestic energy resources where economic returns are high; (c) Diversify the country's fuel mix away from high dependence on oil and (d) Develop incentive framework and institutional structure capable of adapting to and benefiting from rapidly changing conditions of international energy markets. Within the above settings, the rest of this paper will now focus on

short-term and long-term issues in the energy sector of Sierra Leone.

Short-term issues

The most urgent short-term needs are improving supply of electricity and petroleum products and strengthening management institutions. A major priority can be arrangements for overhauling and repairing generating plants with importation of spare parts for timely and proper maintenance. Enhancing reliability of power supply can save the country millions of dollars annually which can discourage importation by small and less efficient private generating sets. These savings would help to pay for major part of the estimated amount for rehabilitation expenditures. At the same time, an independent review can be carried out to determine details of rehabilitation programs, including technical and economic viability of repairing the MAN generator units which are nearing the end of their normal working lives. Contingency plans should also be made for new generating capacities to complement these units in case repairs become economically unwise.

Institutional deficiencies are a major obstacle to efficient and reliable supply of energy in Sierra Leone, these deficiencies include: (a) The absence of a single ministry for formulating and coordinating energy policy and (b) The absence of incentives, on the part of institutions, to supply energy at low cost. There is no single ministry or autonomous body with the political mandate and status to coordinate the activities of the various ministries, or develop energy policy. At the moment, there are five ministries dealing with special energy issues in a much uncoordinated manner. This lack of coordination has, in turn contributed to chaos during fuel shortages. The Ministry of Energy and Water Resources (MEWR) is, in theory, responsible for coordinating all energy activities. In practice though, MEWR is mainly preoccupied with electrical power and water distribution, in effect, lacking the stature or political mandate to carry out a coordinative role. To strengthen sectoral management, it is recommended that MEWR be given the stature and support necessary for coordinating activities in the energy sector. There is lack of management autonomy among the energy agencies (NPA) and National Petroleum (NP). This problem applies particularly to NPA, which operates as a department under MEWR. NPA act is intended to provide NPA with a high degree of autonomy through an independent board. In practice, this is not the case as the board itself is highly susceptible to MEWR interference. The lack of autonomy undermines the effectiveness of NPA management. To increase the effectiveness of NPA, the NPA act should be reviewed and modified to give it a greater autonomy of management and unless such is done, physical and fiscal rehabilitations cannot bring about sustainable improvement in public power supply - which should be the objec-

tive of the reform. More recently though, there have been improvements in electricity supply in the capital city and in the relationship between NPA and MEWR with the appointment of a new General Manager and board. While these changes are in the right direction, the basic issue of autonomy and lack of representation of the business community remains.

Other components of action programs should include: a) A feasible mechanism to ensure that: i) NPA can regularly set tariffs at levels that allow it to recover costs and ii) NPA has access to sufficient forex for importing spare parts and carrying out routine maintenance; b) Requirement for greater legal and financial autonomy where NPA can run on commercial basis to achieve target return rates and fully account for power supply; c) Focusing MEWR's efforts on power sector policy formulation and coordination, development of policy statements outlining the government's short- and long-term strategies for the sector; d) Increasing remuneration for skilled NPA staff to be competitive with the private sector - this will require payment of premiums above the scale for the public service sector.

NPA has national electricity supply monopoly for the entire country. NPA should therefore consider increasing cost effectiveness by decentralization of operations and management on local basis. This can include selling provincial systems to the private sector or local community groups, when such needs arise and establishing joint ventures with mining companies for generation facilities to supply mines and local communities. The government lacks any cohesive demand management policy. Both the level and structure of prices badly need review to eliminate price distortions and reduce subsidies that only magnify financial woes of the government. Beyond price review, the government should reconsider the objectives of policies underlying the establishment of ex-refinery and retail pricing, particularly at this time of great uncertainty in international oil market. In addition to the issue of tariffs, there are various distortions and anomalies in the current NPA tariff structure. Given recent measures by the new government, this paper recommends that NPA completes tariff study to design a logical tariff structure that reflects the body's financial objectives, reduces existing anomalies and distortions and develop tariff adjustment plans for transition to a hydropower-based system - that is, the Bumbuna Hydroelectric Project.

Long-term issues

In the long-run, the focus should be on the development of efficient energy resources that can meet growing demands (for different energy sources) of the economy beyond the turn of the 21st century. Long-term options for meeting future power requirements should include: The viability of Bumbuna Hydroelectric Project, now close to completion, to meet future demands in the Western Area and deve-

lopment options for isolated provincial centers. There are a number of options open to Sierra Leone in this regard. These include alternative hydroelectric projects as well as the possibility for thermal systems in Freetown based either on coal or oil. The rehabilitation of Kingtom and Falconbridge plants can provide sufficient capacity to meet demand in the Western Area. Since the new government has commissioned new generating facilities, it is hoped that the situation will improve

While the reduced Bumbuna Hydroelectric Project will not add significantly to debt servicing compared to thermal alternatives, lumpy initial financing could create problem, given the constraints on forex, resulting in borrowing years in advance. However, financing constraints in themselves are a sufficient rationale for accelerating projects that are economically and technically viable. The financial aspects can be evaluated in the following ways: i) Economic rate of returns relative to other investments given forex constraints; ii) Magnitude of available supply credit, representing additional resources and iii) options available to government for better management of financial issues from investment in Bumbuna hydroelectric Project.

There are a number of mini-hydro projects identified in recent surveys which could largely meet demand in the mining sector with huge savings on fuel imports. If all the mini-hydros in the country are operational, they can yield high economic returns. NPA should resolve a number of issues before taking a final decision on the Bumbuna Project and develop plans for the provincial systems. Among others, NPA should: a) Review sequencing and financing of the reduced Bumbuna Project; b) Investigate the prospects of exporting surplus energy from Bumbuna to Guinea; c) Evaluate the viability and optimum sequence of development of more promising mini-hydro projects and d) Define technical standards for interconnecting isolated provincial systems.

Rising fuelwood costs are absorbing a significant proportion of the income of urban households (as much as 40% of their monthly expenditures). In addition rising prices are a symptom of growing regional shortages and deforestation near urban areas. Without some measures for increasing supplies or reducing demand especially in the peninsula area and around provincial towns like Bo, Makeni, Koidu and Kenema, where cost of fuelwood is expected to increase. The most promising strategy for controlling wood fuel costs is increased use of improved stoves, whose efficiencies are about twice conventional woodstoves currently available on market. These stoves, which are locally manufactured, would cut down on wood demand by 40 ~ 60% while reducing investment cost on the part of the consumer. A demand management program centered on the utilization of improved stoves is required on the part of the government through coordination, testing and promotion private production and marketing of improved stoves. As the stoves are made from locally available scrap metals, forex should have no influence on the pricing system.

RECOMMENDATION

Oil exploration

The government should draw up promotion strategy to be implemented more oil companies for exploration. This should include: a) Give equipment and assistance for improving storage of technical data; b) Interpret existing data including those generated by previous exploration companies to provide the government independent evaluation of petroleum potential; c) Technical collaboration with Guinea and Liberia for a regional evaluation and promotion to provide greater incentive to oil companies and d) Review petroleum legislation and contracts. The government should review longer term balance between private and public sector involvement in the marketing and distribution of oil products.

Electricity

a) The NPA act should be reviewed and modified so as to permit NPA to manage its affairs without undue interference from MEWR. The Act should be made more explicit about the terms on which board members are appointed. The Act should also require the presence on the board respected members of the business and consumer community. To protect the board's independence, the Act should specify a minimum period (preferably two years) for which members are appointed to the board during which time they cannot be fired or replaced.

b) A mechanism should be devised to ensure that NPA regularly sets tariffs at levels which allow it to recover its costs and has access to sufficient forex for importing spare parts and carrying out routine equipment maintenance. In that regard, the following are recommended:

i) In return for greater legal and financial autonomy, NPA should be required to run on commercial basis for target rate returns and fully account to MEWR on performances and power supplies.

ii) MEWR should focus its efforts on power sector policy formulation and coordination. One of its tasks should be the development of policy statement outlining the government strategy for the sector in the short- and long-term.

iii) Remuneration for skilled NPA staff should be raised and competitive with the private sector, which will require payment of premium above public service sector.

c) Once institutional changes are implemented, the next step should be for government and NPA to agree on the scope and financing program to strengthen the organizational process of NPA. The following components should be in the program:

i) NPA senior management needs strengthening; replacing the management team should be considered by the

new board of directors. However, a plant superintendent (with a proven track record) should be appointed at Kingtom substation.

ii) Planning sections covering the engineering and corporate financial functions should be introduced. These planning functions should be set up to report directly to the General Manager.

iii) The government should actively review the viability of NPA provincial operation system options for decentralization and privatization.

iv) NPA technical training center (built with the help of the Federal Republic of Germany) for secondary school leavers should be fully supported by NPA in terms of funding and staffing. Consideration should be given to the adoption of externally recognizable technical qualification at the end of the course.

v) A management development program should be designed for middle tier management.

vi) On-Job-Training is required for technical staff at the intermediate and senior levels of NPA.

vii) Carry out independent review to determine the economic and technical viability of keeping the three MAN generator units at Kingtom substation in service. Contingency plans should also be made for new generating capacity to supplement the units and initiate replacement of the 11 kV switchgear at Wilberforce.

Supply cost and tariff

NPA should implement a tariff study to design a more logical tariff structure that would help to meet NPA's financial objectives, reduce the existing anomalies and distributions and make suggestions on how tariffs should be changed at a time of rapidly declining exchange rate and a transition to a hydro-based system. NPA should carry out a study to determine the most appropriate computer hardware and proceed without delay to procurement and develop an action plan for reducing arrears.

Bumbuna hydroelectric project

The Bumbuna Hydroelectric Project is attractive, compared to alternative thermal options over a wide range of load forecast and fuel price assumptions. The following steps are recommended for identifying the least cost strategy for meeting future power demands in Sierra Leone (especially so for the Bumbuna Hydro Project);

i) Preparation of comprehensive load forecast for the whole country, including survey on the need of auto-producers.

ii) Development of optimum sequence for Bumbuna Project and finalization of Phase I design.

iii) Investigation of prospects for export of surplus energy from Bumbuna to Guinea and the benefits of mutual power and energy exchange.

iv) Exchange of possibilities for interconnection of isolated provincial systems where economical and outline of technical standards for interconnections schemes.

v) Review of generating capacity of major mines and evaluation of utilization capacity feasibility for local demand and supply.

Fuelwood supply and utilization

i) Given the resource and constraints of forestry service and uncertainty about the competitiveness of wood supply from fuelwood plantation, the viability of such public sector projects and their relative priority in household energy/wood fuels strategy should be reviewed by government before implementing new projects.

ii) Because of the importance of fuelwood to the economy, limited investment can help give forestry service much needed experience in the field, lower cost options, including agro-forestry schemes. Joint ventures in association with the private sectors should also be considered.

iii) On supply strategy, emphasis should be placed on measures for better management and utilization of existing resources and relieving pressure on forest resources in areas along main road to urban centers.

iv) For better management and utilization of existing resources, the government should define programs for protecting nature by increasing management responsibility of villagers and improving supplies.

v) For improving supply to urban areas, the government should study the feasibility of city-gate collection of wood fuel tax from commercial supplies entering Freetown. Commercial cutting by independent loggers should be directed and controlled. Feasibility of building feeder roads and transporting fuelwood from surplus areas should be evaluated. Cost-benefit schemes for seasonal storage of wood fuel should be initiated along with attesting and demonstration programs for improved charcoal kilns.

vi) The government should seek technical assistance from donors to establish regulatory control over wood fuel supply to urban areas. Project components could include evaluation and establishment of the systems/programs mentioned in agro-forestry and fuelwood product. A higher proportion of the staff trained in extension methods should be allocated to fuelwood deficit regions.

vii) The government should seek support for strengthening forestry service and key reinvestment studies. Designing action plans for improving management of bush fallow and appraisals of joint-venture proposals with NGOs for establishing fuelwood plantation in the country and new forestry legislation for greater improvement of the statutory basis for forest resource management.

Biomass

i) It is possible for biomass fuel to substitute petroleum products in providing energy for low-level process in specific applications. Feasibility of such possibility needs

to be analyzed on a case-by-case basis. This is especially important in lieu of potentially vast quantities of wood wastes that may be available from clearing fallow lands. Every audit and process analysis should be undertaken at factory/mill level to determine appropriateness of direct biomass combustion or gasification alternatives to current methods.

ii) Exploration work on identifying the size, quality and location of existing reserves of lignite should be intensified. The geological survey should be provided with advanced equipment and technical assistance to make such efforts feasible.

Conclusion

Developing and expanding modern energy supply, including renewable energy, to the world population projected to grow from 6.1 billion in 2000 to 8.9 billion in 2050 (UN New York, 2004) in the coming decades and simultaneously devising ways to produce and use biofuel more sustainably is a daunting task. Within economic development and environment, this task is perhaps the strongest challenge facing the energy industry. All the above types of investments discussed are capable of generating satisfactory rates of returns and with satisfactory pricing policies for commercial energy, can be designed to be financially viable. However, no single investment program can be pushed to excess without greatly raising costs and reducing benefits. Thus appropriate energy policies combined with enlightened enabling conditions can have the best response. Along with human resource policies, enabling conditions provide desired foundation for broad-based income growth in rural as well as urban areas in Sierra Leone.

Investing in future energy is the touch-stone of economic development in Sierra Leone. Energy supply is part of the poverty eradication process this would allow the population to meet basic needs in a sustainable manner. The energy policy should focus on the following:

1. Developing linkages between the energy sector, poverty alleviation and economic growth.
2. Integrating the objectives of environmental sustainability with overall energy initiatives.
3. Proper management of demand supply and energy efficiency.
4. Developing the energy resource and disseminating key information.
5. Promoting private participation and developing competitive markets in energy technology and services.
6. Developing where necessary, appropriate regulatory framework and capacity.

The policy should form the basis for progressive expansion of investment into modern energy production, petroleum exploration and development, rural electrification, supply of well priced petroleum products and increased energy use efficiency from household biomass

consumption in cooking to large industrial and the transportation consumption. The technical aspect of energy policy is important, but not so much as the social dimension of it. Developing human resources is critical to effective utilization of energy and benefit guarantee. Significant resources are required to implement key policy actions in the short- and medium-terms. MEWR must dedicate to the economic, social and environmental sustainability of Sierra Leone's energy sector. In that regard, MEWR must seek to prioritize policies and translate priorities into strategies. It should be committed to developing concrete plans to activate policy strategies and undertake specific activities to ultimately make the plans workable with the support of the society and institutions of Sierra Leone.

To improve the quality of life of the peoples, bilateral and multilateral donors should continue to finance energy related projects and devise sustainable ways for producing and using biofuel (mainly through agricultural development and natural resource management projects). Government should strengthen markets for liquid fuel and renewable energy technologies. Donors should be willing to finance assistance and institutional capacity building for policy development. Technical assistances and programs for the completion of Bumbuna Hydroelectric Project which has languished in large measures because enabling environment and energy policies have not been favorable to otherwise the well-intended and well-conceived Bumbuna Hydroelectric Project. Economic and institutional reforms should be implemented by the new government and opening up substantive opportunities for both public and private initiative to improve the energy supply situation for literally a large number of people who cannot yet afford nor have access to modern energy forms in Sierra Leone. Both recent successes by the new government and disappointments from past decades should provide insightful options for sound policies and investments.

ACKNOWLEDGEMENTS

We would like to thank the Chinese Scholarship Council and the Sierra Leone Government for their assistance in the preparation of this paper. In addition we would also like to thank Dr. Paul Juana Moiwo and Dr. Josphert Ngui Kimatu for their useful comments on this paper.

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