

ASSESSING AND DEVELOPING POLICY OPTIONS FOR ADDRESSING CLIMATE CHANGE MITIGATION ACROSS THE ENERGY SECTOR OF LIBERIA



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ACRONYMS

BRE	Buchanan Renewable Energies
CBL	Central Bank of Liberia
CDM	Clean Development Mechanism
CSET	Center for Sustainable Energy Technology
ECOWAS	Economic Community of West African States
EPA	Environmental Protection Agency
EPP	Emergency Power Program
GDP	Gross Domestic Product
Gg	Gigagram
GHGs	Greenhouse Gases
GOL	Government of Liberia
IPPs	Independent Power Producers
LDCs	Least Developed Countries
LEC	Liberia Electricity Corporation
LPG	Liquefied petroleum Gas
LPRC	Liberia Petroleum Refining Company
MDGs	Millennium Development Goals
MLME	Ministry of Lands, Mines and Energy
MOCI	Ministry of Commerce and Industry
NACUL	National Charcoal Union of Liberia
NAPA	National Adaptation Program of Action
NEC	National Energy Committee
NEP	National Energy Policy
NESF	National Energy Stakeholders' Forum
NIC	National Investment Commission
NOCAL	National Oil Company of Liberia
NPHC	National Population and Housing Census
NREL	National Renewable Energy Laboratory
ODA	Official development Assistance
PPA	Power Purchase Agreement
PRS	Poverty Reduction Strategy
REFUND	Rural Energy Fund
RETs	Renewable Energy Technologies
RREA	Rural and renewable Energy Agency
SMEs	Small and medium Enterprises
SOE	State of the Environment Report
TJ	Terajoule
UNFCC	United Nations Framework Convention on Climate Change
USTDA	United States Trade and development Agency
WAPP	West African Power Pool

EXECUTIVE SUMMARY

Energy is an essential sector for Liberia because it cuts across all other sectors and serves as a vital input for social, economic and political growth and development. Furthermore there is a direct correlation between the country's overall development and its level of energy production, delivery and consumption. In spite of its positive impacts on the nation's development, the production and consumption of energy also has a devastating effect on the natural environment, especially the global climate.

The current energy situation in Liberia is characterized by a dominance of traditional biomass consumption and low access to poor quality and relatively expensive modern energy services. It was estimated that over 95% of the population relied on firewood, charcoal, and palm oil for their energy needs.¹ Modern energy services based on electricity and petroleum products are predominantly used for economic production and transportation. In the household sector, the use of modern energy services consists mainly of kerosene, electricity, and to a lesser extent liquefied petroleum gas.

According to the National Biodiversity Strategy and Action Plan of Liberia published in 2004, carbon dioxide (CO₂) is responsible for 50-60 per cent of the local GHG emissions into the atmosphere in Liberia. Most of these come from the consumption of petroleum products, while the remaining come from traditional farming practices where woody biomass is burned during cultivation. Therefore, large scale investment and financial flows to the energy sector specifically for the development of various renewable energy technologies (RETs) will be needed to reverse this trend. Moreover, appropriate national land-use policy framework needs to be developed in order to transform traditional farming practices and minimize the burning of woody biomass. Climate change mitigation within the energy sector will require reduction in the consumption of fossil fuel, used primarily for the electricity generation and transport sectors. This means making sound, informed energy supply choices with a focus on renewable energy options. The government must partner with actors in key economic sectors and relevant stakeholders to improve the efficiency with which energy is used and promote energy conservation measures, including support for the development of the carbon market nationally.

Apart from small scale renewable technology in solar power deployed by donors to increase energy access and spur socioeconomic growth, there is currently no public sector investment in new energy infrastructure with the specific objective of climate change mitigation in Liberia.²

In order to assess the level of investment and financial flows required to address climate change mitigation in the energy sector, there must be a well resourced cross-sectoral institutional framework with stakeholders' coordination mechanism in place to adequately conduct the assessment of investment and financial flows needed for

¹ CSET, 2004.

² MLME, 2008.

climate change mitigation in the energy sector. Therefore, well harmonized and structured tools must be designed for use in conducting and analyzing investment and financial flows to the energy sector for climate change mitigation. In considering means to analyze and enhance investment and financial flows to address climate change in Liberia, it is important to focus on the role of private-sector investments as they constitute the largest share of investment and financial flows. In addition, Official Development Assistance (ODA) funds represent a substantial share of the total investments, especially in LDC like Liberia. With appropriate energy policies and fiscal and tax incentives in place, a significant part of the additional investment and financial flows needed for climate change mitigation in the energy sector could be covered by the currently available Government sources and private local actors.

The recommended strategy for enhancing investment and financial flows for climate change mitigation in the energy sector by 2015 are:

- Scaling up the use of renewable energy technologies (RETs);
- Formulating and implementing policies on energy efficiency and conservation; and
- Introducing fiscal and tax incentives for users of RETs.

INTRODUCTION

Liberia has a population of about 3.5 million, and is one of the poorest countries in the world, with GDP per capita estimated at US\$190.³ Poverty is pervasive, and is particularly acute in rural areas and the most remote areas of the country. 68% of the country's population lives below the poverty line.⁴ Poverty has many dimensions, including low levels of income and consumption, poor nutrition and food security, low health and education indicators, and inadequate infrastructure. It is reinforced by inequities, especially access to justice and economic opportunities.

The country has been recovering rapidly following decades of economic mismanagement and fourteen years of brutal civil war. The economy is resuscitating rapidly, with the Government introducing a broad range of policies to foster peace, accelerate reconstruction and development, and build strong systems of governance. Liberia's Poverty Reduction Strategy (PRS), built on four pillars is the macroeconomic framework for the Government's overall socio-economic development and reconstruction program during the period 2008-2011. An unfavorable balance of trade in the amount of US\$765.76 million has been reported for 2008, compared to US\$280.05 million in 2007, representing nearly 141% of the previous year.

Energy as a Key Sector for Liberia

In formulating its development plans, the Government of Liberia has recognized energy as a vital input to national development, accelerating reconstruction and economic revitalization, and the achievement of the Millennium Development Goals (MDGs). Energy is an essential sector for Liberia because it cuts across all other sectors and serves as a catalyst for social, economic and political growth and development. Furthermore there is a direct relationship between the country's overall development and its level of energy production, delivery and consumption. The production and consumption of energy has a devastating effect on the natural environment, especially the global climate. Climate change is attributed to the buildup of green house gases (GHGs) in the atmosphere. Energy transformation is a major contributor to global climate change.

Relevance of the Energy Sector from Economic Viewpoint

The energy sector is a driving force for nearly all socio-economic activities of Liberia as it propels industrial and commercial activities and enhances the delivery of basic social services. Some of the key services that are inherently linked to the energy sector include transportation, electricity, communications, agriculture and fishery, health, education, and tourism. Besides its share of about 0.8%⁶ of the overall gross domestic product (GDP) of Liberia as a sector, energy also contributes to

³ PRS, 2008.

⁴ LISGIS, NPHC 2008.

⁵ MOCI, 2008.

⁶ CBL, 2008.

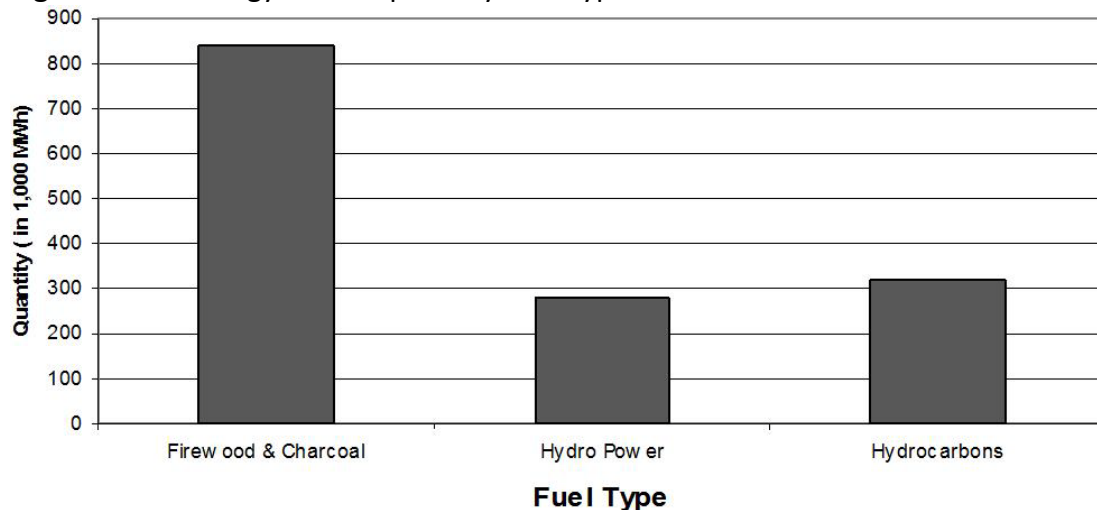
employment, trade, fiscal revenues, food security, and regional and sub-regional development.

The current energy market in Liberia is dominated by petroleum products that are imported in refined forms, and woody traditional biomass consumed primarily for cooking and heating as in nearly all of Sub-Sahara African countries. The market for petroleum products is formal in nature while that of woody biomass is informal. The national electricity grid, which had a total installed capacity of 191 MW of power by 1989, currently generates only 9.6 MW.

The production of fuel wood and charcoal is also an important source of employment and sale of these goods is a source of supplemental income for many low income and poor families. In some cases it supplements as much as 40 per cent of their total income (SOE, 2006). There is currently no reliable and sufficiently disaggregated data on the overall energy mix of Liberia from the production and consumption perspectives, including economic indicators such as its share of employment, contribution to GDP, fiscal revenues, trade equilibrium, food security, and others, etc.

⁷ NEP, 2008.

Figure 1: Net Energy Consumption by Fuel Type in 1987



Source: Ministry of Lands, Mines & Energy

National GHG Emissions and Mitigation Needs

Energy production and consumption plays a major role in the global warming and climate change phenomena. The energy sector alone emits about 4 Gg of greenhouse gases annually in Liberia. High consumption of fossil fuel and deforestation are the contributory factors identified in Liberia's climate change dynamics.

However, using biomass to produce energy is carbon neutral because it releases roughly as much carbon dioxide (CO₂) as it takes in. For every MWh of biomass power, approximately 1.6 tons of CO₂ are avoided depending on the conversion process and mechanism. (NREL, 2008). This figure includes 0.8 tons/MWh from avoided fossil fuel use and 0.8 tons/MWh avoided from biomass decomposition or open burning. CO₂ is the principal GHG that causes global warming and the increasing levels of its concentration in the atmosphere are of great concern. The use of biomass resources, managed in a sustainable way, would stabilize CO₂ emissions and help tackle global warming.

On a global scale, Liberia's contribution to global warming is negligible. But chances are if climate change continues, the country is likely to be disproportionately affected by its impacts considering current scenarios and indicators experienced in the country. Liberia ratified the United Nations Framework Convention on Climate Change (UNFCCC) in November 2002, and implemented an 18-month National Adaptation Programme of Action (NAPA) project in 2004. However, minimum climate change mitigation measures have been taken so far due to technological constraints, limited human resource capacity and data gathering capability. Plans are underway to formulate strategies for climate change mitigation within the framework of the ongoing national communication preparation.

⁸ Sandikie, Jacob S. (2007). An Inventory of GHG Emissions of the Energy Sector of Liberia.

Social and other Dimensions

While access to commercial energy can strengthen efforts to achieve national socioeconomic development and sustainable development goals such as the Millennium Development Goals (MDGs), it can also harm human health and undermine environmental quality if it is not produced and consumed in an environmentally sustainable manner. Though the level of pollution caused by the energy sector of Liberia appears to be practically negligible by global standards, its local health and environmental impacts could be significant due to the fact that traditional woody biomass is used by over 95% of the country's population for cooking and heating purposes. Particulate matter inhaled from the combustion of biomass does give rise to upper respiratory problems and their excessive extraction from the forest also give rise to deforestation and forest degradation. Thus quantifying the social costs of using biomass in Liberia could provide valuable inputs for developing policy options to address change mitigation in the country.

DESCRIPTION OF THE ENERGY SECTOR

In Liberia, as in nearly all of Sub-Sahara African countries, biomass, petroleum products, and electricity are widely used in the energy sector for a variety of applications such as domestic cooking and heating, lighting, transportation, electricity etc. Annual consumption of woody biomass was estimated at about 10.8 million m³ for fire wood⁹, and 36,500 tons for charcoal. In 2007, the national utility reported electrical energy production and consumption of about 8,230 GWh and 6,714 GWh respectively. Petroleum products consumption for 2008 was equivalent to about 8,450 TJ of energy.

In the past, there has been a lack of policy and regulatory framework for the energy sector of Liberia, thus making the sector fragmented with no coordination mechanism. As a remedy to this problem, the Government, through the Ministry of Lands, Mines & Energy formulated a National Energy Policy (NEP) in 2008 to detail the actions required to enable the country's energy sector to play its strategic supporting role. The principal objective of the NEP is to ensure universal access to modern energy services in an affordable, sustainable and environmentally-friendly manner in order to foster the political, social, and economic development of Liberia.

In line with the international community's efforts toward climate change mitigation and the principles of extending energy access to all Liberians through careful consideration of the environmental costs and benefits, and with the goal of maximizing efficiency to minimize costs and any adverse environmental impacts, the Government of Liberia states the following targets in the NEP using 2009 as the base year:

- Reducing greenhouse gas emissions by 10% by the energy sector in 2015.
- Improving energy efficiency by 20% by 2015.
- Raising the share of renewable energy from current level of 10% to 30% of electricity production in 2015.
- Increasing the level of biofuels in transport fuel to 5% by 2015.
- Implementing a long-term strategy to make Liberia a carbon neutral country, and eventually less carbon dependent by 2050.

⁹ CSET, 2004.

¹⁰ NACUL, 2005.

Table 1: Relevant Energy Sector Indicators

Indicator	Value	Source, year
% of energy sector share of national GDP	0.8	CBL, 2008
2008 petroleum product consumption (US gallons)	65,279, 917	LPRC, 2008
Current power generation (national grid)	9.6 MW	LEC, 2008
% of urban population with access to electricity	10	NEP, 2008
Current electricity tariff	US\$0.43/kWh	LEC, 2008
% of rural areas electrified by national grid	0	LEC, 2008
% of rural population with access to electricity (private)	<2	NEP, 2009
% of rural population with access to national grid (LEC)	0	LEC, 2008
Charcoal consumption in 2005	~36,500 tons	NACUL, 2005
Fire wood consumption in 2005	~10.8 million m ³	CSET, 2004

According to the NEP, the Government of Liberia (GOL) will seek to leverage the country's biomass resources as a source of carbon credits for energy development.

Total Supply and Share of Different Energy Sources

Total supply and share of energy sources for the sector can be described in following categories:

- Electricity production and industrial activities
- Transport
- Cooking and heating
- Domestic lighting and others

Table 2: Share of Energy Consumption per Source in 2008

Category	Share (%)
Electricity Production & Industrial Activities	
Fossil fuel	90
Hydro	9.7
Solar	0.3
Transport	
Fossil fuel	100
Cooking and Heating	
Charcoal	84.5
Firewood	15
Fossil fuel (kerosene & LPG)	0.5
Domestic Lighting and others	
Fossil fuel (kerosene)	55
Candles	37
Batteries	8

Primary Energy Resource Potential

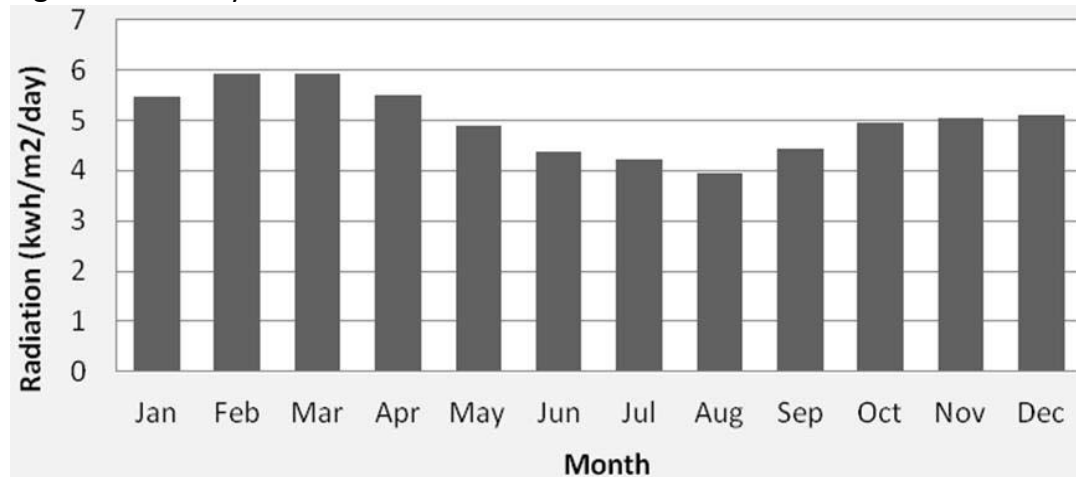
Liberia has great potential for primary energy sources including renewable sources such as biomass, hydro, solar, and wind. Liberia is endowed with biomass resources – rich forest, rubber plantations, oil palm, cassava, sugarcane, rice, and other crop residues. Woody biomass is the primary energy source used for household cooking and heating. Findings from a USAID funded biomass assessment in 2008 identified key biomass resource potential available in Liberia, their estimated quantity, and geographic distribution as described under section 3 below.

Table 3: Existing and Potential Biomass Resources

Existing Resources	Bio-Power (GWh/yr)	Biodiesel (dam ³ /yr)	Ethanol (dam ³ /yr)
Food Crop Residues	188		
Cash Crop Residues	5.889		
Biogas from Animal Manure	219		
Forest Residues	15.248		
MSW (biogenic material only)	52		
Total	21.596		
Potential Resources			
Vegetable Oil*	4.946	2.473	
Sugarcane**	-		1.527
Crop residues***	26.923		5.385

The country's equatorial position puts the sun almost directly overhead at noon throughout the year giving rise to intensive solar radiation in all parts of the country with little monthly variations. Although Liberia has high rainfall, annual solar insolation shows good prospects for the application of solar technologies. Monthly daily solar radiation is about 4 – 6 kWh/m²/day (NEP, 2009).

Figure 2: Monthly Solar Radiation on Horizontal Surface



Source: Solar Technology, Inc., Monrovia (2007).

Petroleum is still in exploration stage, and offshore exploration began in 1968 when seismic studies and drilling took place in the shallow waters of the continental shelf (SOE, 2006). Despite several encouraging findings since exploration started, oil is yet to be discovered in Liberia. Notwithstanding, the GOL has awarded offshore petroleum exploration licenses through production sharing contracts to seven companies (*Repsol Exploration S. A., Woodside Energy, Broadway Consolidated PLC, Oranto Petroleum, Regal Liberia/European hydrocarbons Ltd., Hong Kong Tong Tai petroleum International Corporation and Anadarko Liberia Company*). This suggests prospects for fossil fuel off the shore of Liberia.

Liberia has six major rivers, which drain about 66% of the country's water. These include the Mano, St. Paul, Lofa, St. John, Cestos, and Cavalla Rivers. Of these six major rivers in Liberia, the St. Paul has a potential of about 824 MW from which the Mt. Coffee Power Plant produced only 64 MW prior to the civil war. The Cavalla River has the single largest potential (225MW at Tiboto) but with more than half of this in Cote d'Ivoire, bilateral cooperation is required for its development. Similarly, the Mano River, with the potential of up to 180MW, has nearly a quarter of its basin in Sierra Leone. However, since four (4) of the six river basins are within Liberia's borders, they could be developed in the near term. The major drawback is that all suffer from the problem of low-head flow, requiring huge investment in storage or reservoir to maintain firm capacity during the dry season. Also a series of pre-feasibility studies were carried out prior to the 14-year Liberian civil war, which identified 24 potential small hydro power sites across the country.¹²

There is little or no data available on wind speeds in Liberia as no formal assessment has been performed to date. However, Liberia is situated in a low wind region, and except for mountainous and coastal areas, the wind resource is expected to be relatively insignificant in most rural areas. Direct observation along the coastal regions has indicated good prospects for the development of wind power. Unlike the

¹¹ NEP, 2009.

¹² NEP, 2008.

case of solar energy, no wind energy pilot project has been conducted in the country so far due to lack of national wind resource data.

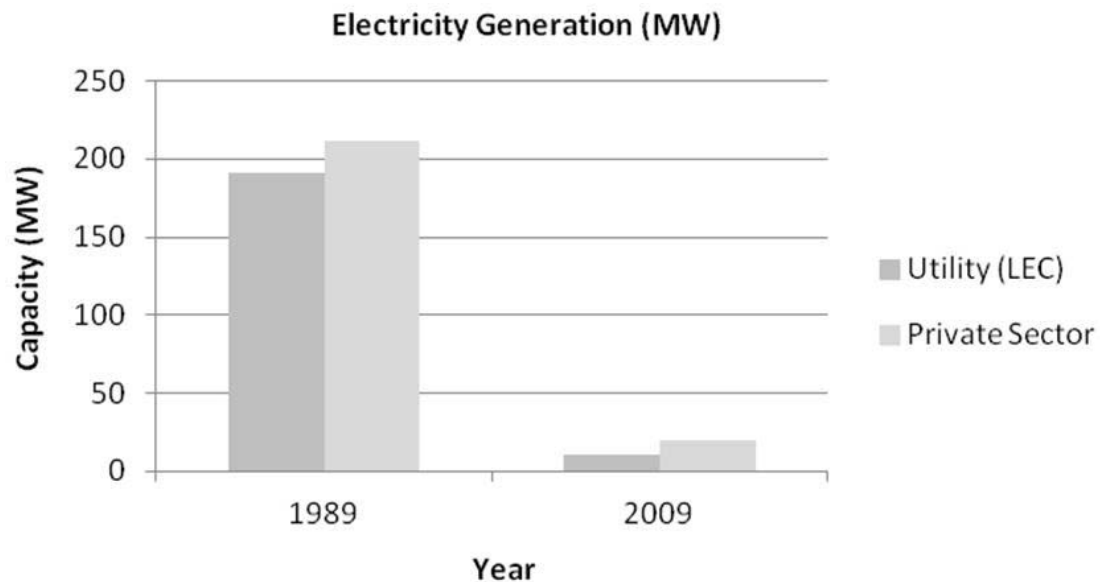
The Electricity Sector

Prior to the 14-year civil crisis, there were two main hydropower stations with a total generating capacity of 68MW or 17% of the total installed capacity of 412 MW in the country. These were the Mount Coffee hydro power plant (64 MW) and the Firestone hydro-power plant -Harbel plant (4 MW). A community micro-hydro power station of 30 kW was also located at Yandahun in Lofa County. The Mount Coffee and Yandahun Plants were destroyed during the war but the Harbel plant is still operational. The rehabilitation and/or reconstruction of these hydro power plants could lead to less use of fossil fuels and contribute to the reduction in GHG emissions. The remaining power plants were fossil based power plants owned by the Liberia Electricity Corporation (LEC) and private concessionaires.

Launched in 2006 following the inauguration of President Ellen Johnson Sirleaf, the Emergency Power Program (EPP) was designed to re-establish public power supply as part of the Government's political stabilization and economic reconstruction program. The LEC now has a system with 9.6 MW diesel generations, 80 km of transmission and distribution network, and will have about 1,000 street lights and over 2,500 customers in Monrovia within the first half of 2009 (NEP, 2008). Though this quick win intervention in the power sector is laudable, total reliance on fossil fuel increases GHG emissions. There is a need to switch to hydro for long term power production to reduce fossil fuel consumption and mitigate climate change.

The GOL has signed a 25-year Power Purchase Agreement (PPA) with Buchanan Renewable Energies (BRE), which is expected to construct a 35-megawatt biomass power plant valued at about US\$150 million to supply electricity to Monrovia and its surrounding communities. The plant will be fuelled with rubber wood woodchips from non-producing plantations, and will be located near Kakata, approximately 50 kilometers from Monrovia.

Figure 3: Pre-war vs. Post-war Electricity Generation

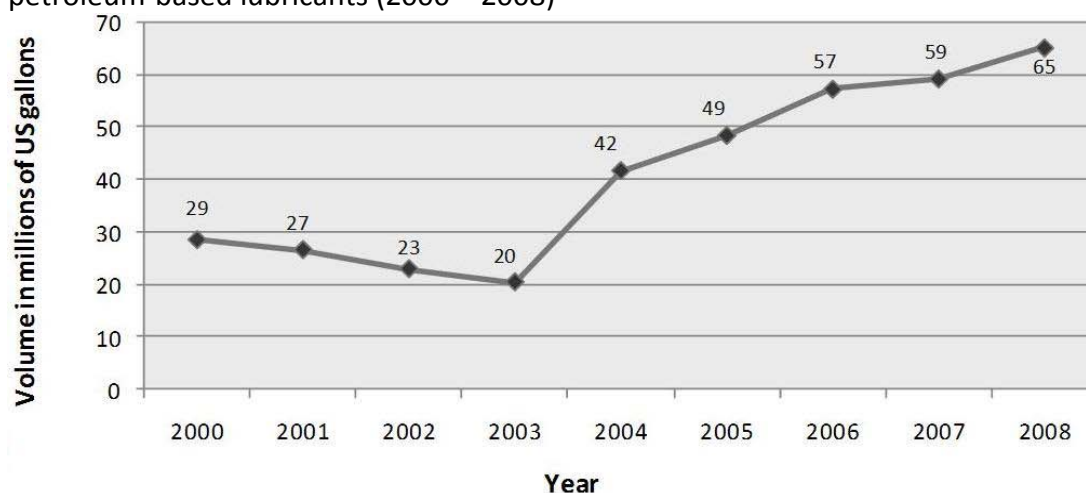


Source: Liberia Electricity Corporation

The Petroleum Sector

The National Oil Company (NOCAL) and Liberia Petroleum Refining Company (LPRC) are the two Government institutions established by law to administer and regulate the petroleum sector of Liberia under the policy guidance and supervision of the Ministry of Lands, Mines and Energy (MLME). NOCAL is responsible for the upstream petroleum sector, while the downstream petroleum is under the jurisdiction of the LPRC. In the upstream sector the GOL has awarded licenses to about seven foreign companies for offshore petroleum exploration in the country. As for the downstream sector, licensed private companies do the importation of products while LPRC oversees the storage and distribution. Petroleum products imports of approximately 65,279,917 US gallons, consisting predominantly of gasoline, diesel fuel, and to a lesser extent, jet fuel and kerosene was reported by the LPRC in 2008.

Figure 4: Annual Liquid Petroleum Products Consumption Trend in Liberia, excluding petroleum-based lubricants (2000 – 2008)



Source: LPRC 2000 – 2008 Annual Reports.

Decentralized Energy

The establishment of the Rural and Renewable Energy Agency (RREA) and the Rural Energy Fund (REFUND) of Liberia represent the most tangible evidence of the Government's commitment in the implementation of decentralized energy program in the country. With a dedicated institution that is resourced to deal with the special challenges of decentralized energy provision using renewables, there is likely to be a net reduction in fossil fuel consumption. Current interventions have been the installation of solar power systems in rural communities on a pilot basis. Total installed capacity across Liberia is about 80kW_p of solar power (CSET, 2009). The RREA is expected to manage a Rural Energy Fund to support the development of decentralized energy services in rural Liberia.

Regulatory Framework

Key policy and regulatory actors in Liberia's energy sector are the MLME, LEC, NOCAL and the LPRC. The MLME is the lead Government agency with oversight responsibility for the energy sector of Liberia. The three government parastatals established by law to manage the sub-sectors of the energy sector are the LEC, created in 1973; the LPRC, created in 1978; and NOCAL, created in 2002. These three institutions have been responsible for the electricity, downstream petroleum, and upstream petroleum sectors respectively. The MLME sets the policy and supervises their implementation by the LEC, LPRC, and NOCAL.

Business and Investment Environment

Buchanan Renewable Energies (BRE), with huge investments in the energy sector has three principal lines of activities – *renewable fuels, renewable power, and technical services in infrastructures*. The company produces high quality and low moisture content woodchips from non-producing rubber plantations. As mentioned earlier, the company has signed a US\$150 million concession agreement with the GOL to provide biomass generated electricity to Liberia for a period of 25 years.

Table 4: Doing Business in Liberia

Indicator	Rank		Change in rank
	2009	2008	
Doing business (overall)	157	167	+10
Starting a business	88	145	+57
Dealing with construction permit	177	179	+2
Employing workers	105	105	0
Registering property	172	170	-2
Getting credit	131	141	+10
Protecting investors	142	141	-1
Paying taxes	59	51	-8
Trading across borders	115	108	-7
Enforcing contracts	165	166	+1
Closing a business	146	147	+1

Source: World Bank/IFC, Doing Business 2009; see also: www.doingbusiness.org.

The National Investment Commission (NIC) is the Government institution with the mandate to promote and coordinate all investment related activities in all sectors of the Liberian economy.

The Investment Code of Liberia provides the kinds of economic activities the Government wishes to encourage and the types of incentives it will offer to investors engaged in those industrial activities. Depending on the amount of capital, sector, and location of the investment, investors may be eligible for investment incentives offered by the NIC.

Emission Trends

A draft *Inventory of GHG Emissions of the Energy Sector of Liberia* revealed the data in table 5 below.

Table 5: Energy Sector GHG Emissions in 1999

Greenhouse Gas Source and Sink Categories	CO ₂	CH ₄	N ₂ O	NO _x	CO	NMVOC
Emission (Gg)	3,696	36	37	50	173	32

Source: Inventory of GHG Emissions of the Energy Sector of Liberia, EPA (2007).

Due to the availability of the above baseline data on GHG emissions, Liberia can now begin to assess and develop policy options for addressing climate change mitigation across the energy sector. Considering a ten-year gap in the baseline data, there is a need for a periodic inventory of GHG emission to determine the emission trends. Key sources of greenhouse gases in Liberia from the perspective of the energy sector include fuel combustion in power plants and transport, and the use of charcoal and fuelwood. The breakdown in electricity supply over the years has led to the proliferation of private generators in the country. It is estimated that there are about

45,000 small and medium privately operated power generating units, concentrated mainly in Monrovia.¹³

PROPOSED MITIGATION OPTIONS FOR THE ENERGY SECTOR

Although an LDC like Liberia does not have quantitative emission reduction targets or commitments under the Kyoto Protocol, it is encouraged to take steps consistent with their development priorities to mitigate emissions of carbon dioxide and other harmful greenhouse gases into the earth's atmosphere. Fossil fuel based energy consumption and deforestation constitute two of the major sources of greenhouse gases in Liberia. Liberia's Environmental Protection Agency (EPA) has been given the mandate to supervise, coordinate, and consult on all environmental activities in the country. Following enactment of a global carbon regime, Liberia may receive financial payments for protecting these resources while contributing to the benefit of all humankind. In fact, the nation's valuable renewable resources – hydro, biomass, wind, and solar – may allow Liberia to lead the way in becoming one of the least carbon dependent nations in the world.

From the perspective of the energy sector, reducing the nation's GHG emissions means reduction in the consumption of fossil fuel, which is used primarily for the electricity and transport sectors. This requires making sound, informed energy supply choices with a focus on renewable energy options. The government must partner with actors in key economic sectors and relevant stakeholders to improve the efficiency with which energy is used and promote energy conservation measures. This should also include support for the development of the carbon market nationally.

Liberia's *"First State of the Environment Report"* broadly recommends a series of workshops on sustainable energy for potential economic, social and environmental benefits by developing and adapting small-scale decentralized power supplies that use renewable energy resources. While this recommendation attempts to address climate change, it lacks more tangible intervention for climate change mitigation.

Within the context of NEP and the GOL's current energy sector programs and initiatives, the following mitigation options are hereby recommended:

- Scale-up current renewable energy activities to include the large scale deployment of solar PV technology, solar cooking, heating, improved cook stoves, and ensuring that these contribute to climate, energy and environmental goals;
- Actively participate in the Clean Development Mechanism (CDM) and global carbon markets by harnessing and commercializing the nation's vast biomass, solar and hydro resources;
- Set up regulatory framework for promoting energy efficiency in different building and construction sectors and investigate how market mechanisms

¹³ SOE, 2006.

can support energy efficiency investments such as the dissemination of energy efficient equipment and bulbs;

- Support transport policy and programs that promote biofuels for transport and mobility options;
- Expeditiously set up and fund the new Rural and Renewable Energy Agency (RREA) to support clean energy enterprises in rural Liberia by providing enterprise development services and early stage seed finance for entrepreneurs and project developers;
- Provide fiscal and tax incentives such as import duty waiver or reduced duties for at least 5 years for renewable energy project developers and businesses to induce more private investments in the sector; and
- Speed up the implementation of the NEP to meet the nation's renewable energy and emissions reduction targets through both public and private sector investments in various renewable energy sub-sectors.

Given limited technical and financial resources, a growing population, and escalating energy demand and consumption, energy efficiency and conservation also represent important mitigation options. Investment in energy efficiency measures, which include the replacement of existing technologies and processes with new ones that provide equivalent or better energy service using less energy, could also serve as a valuable strategy for climate change mitigation. The value of the saved energy typically at least covers the cost of deploying the new technologies and processes. Energy efficiency programs could reduce future investment requirements, enhance competitiveness by lowering input and operating costs, free up capital for other social and economic development priorities, and contribute to environmental stewardship and climate change mitigation objectives.

The two major barriers preventing investments in clean energy for climate change mitigation in Liberia are

1. lack of financing; and
2. limited institutional and human capacity.

In order to increase investment in renewable energy and energy efficiency for climate change mitigation, more innovative financing mechanisms capacity development will be needed with the following tangible actions:

- Awareness about financing market-based clean energy technologies within and between existing financial institutions will help free-up funds.
- Capacity development and increasing the experience of clean energy and energy efficiency project implementation will enhance financing.
- Success stories about financing models for clean energy project implementation should be shared more widely and used to leverage funds from multilateral financial institutions such as the African Development Bank, World Bank, International Finance Corporation, etc.
- Financiers should expand their focus and build knowledge and experience of post-conflict and emerging economies such as Liberia.

- Addressing Liberia’s external debt arrears could also provide the possibility for loan to revive the energy sector and stimulate investment in renewable energy technologies.
- Including special package in development assistance through local financial institutions to provide lending facility for renewable energy project developers to stimulate more investment and market development in the sector.

Table 6: Recommended approaches for enhancing investment and financial flow to the energy sector to address climate change mitigation by 2015 based on current investment.

Approach	Mitigation Strategy	Current Investment (million US\$)	Recommended Investment (million US\$)	Revenue Sources
Scale up the use of renewable energy technologies	Deployment of solar photovoltaic power systems	1.064	18	Bilateral/multilateral donor institutions, conventions and other funds, Government, and end users finance
	Development of hydro-electric power plants of various sizes and scales	None	750	Private/public sector, conventions
	Development of wind power technologies	None	6	Public, private, end users and conventions funding.
	Development of bioenergy/biopower – biofuels, biogas, biomass power plants, and gasifiers, etc.	150	450	Public and private sector
Formulate and implement policies on energy efficiency and conservation	Conduct energy audit and replace all inefficient energy equipment and appliances with more efficient and energy saving ones; improved energy efficiency in all productive sectors, including the building sector	None	12	Government, private sector, convention funds, GEF Trust Funds, bilateral and multilateral financing facilities.
Introduce fiscal and tax incentives for users of renewable energy technologies (RETs)	Provide fiscal and tax incentives for individuals, institutions/businesses, and communities that use RETs	None	18	Government, Private sector, end users finance, levies and taxes from the petroleum sector

The setting up of a central repository for energy sector information, including information on investor/sponsor, technology deployed, location, capital costs, operation and maintenance costs, output, environmental benefits (climate change mitigation) relative to GOL programs and objectives could be the best mechanism for assessing financial flow to the energy sector. This could be done through a well resourced cross-sectoral institutional framework with stakeholders' coordination mechanism in place to adequately conduct the assessment of investment and financial flows in the sector. This institutional framework should be geared toward bridging the communication gaps existing between key players in the energy sector of Liberia. The country is uniquely placed in an advantageous financial position for energy sector investments due to the fact that the country's long run marginal costs of energy are lower than current prices – an unintended but advantageous consequence of the civil crisis. The civil crisis in Liberia destroyed the low-cost energy options of public utility and other bulk producers, and people are now very much aware of the much higher cost of having to provide energy through other means such as small expensive independent power producers (IPPs), self generation, etc.. Liberians with access to modern energy services are paying prices that are much higher than would be the case after significant investment into larger capacity generating units. Table 6 proposes the author's recommended approaches for enhancing investment and financial flow to the energy sector to address climate change mitigation in line with the GOL 2015 target. This is based on current investments driven mainly by donor interventions on a pilot basis.

ASSESSING INVESTMENT AND FINANCIAL FLOWS TO ADDRESS CLIMATE CHANGE MITIGATION IN THE ENERGY SECTOR

Assessing Investment Flow to Address Climate Change Mitigation in the Energy Sector

Apart from donor funded investments in a number of small scale renewable energy technologies (solar power systems) in rural Liberia, there is neither public nor private sector investment in new physical assets in the energy sector geared towards climate change mitigation in Liberia. However, the United States Trade and Development Agency (USTDA) funded Technical and Feasibility Study for the rehabilitation of the Mount Coffee Hydropower Plant estimate an investment of about US\$500 million for the reconstruction and upgrade of the hydro power plant. The Government has also signed a concession agreement worth about US\$150 million with the BRE for the construction of a 35-MW biomass power plant to supply electricity to Monrovia and its surrounding communities.

According to the Liberia Poverty Reduction Strategy (PRS), the Government planned investment for the energy sector over the next three years besides the Mt. Coffee hydro and BRE projects will be around US\$156.6 million. Part of this money will go towards the harnessing of solar, wind and biomass resources as well as the construction of mini hydro power facilities across the country. In addition, the Government intends to connect 18 communities with Cote d'Ivoire through the West African Power Pool (WAPP).

All the investments mentioned above were not driven by the need to mitigate climate change but high demand for the recovery and development of the energy sector. However, this situation could be used as an entry point for introducing climate change mitigation objectives in the energy sector.

How an Assessment of Financial Flow to Address Climate Change Mitigation in the Energy Sector could be done in Liberia

There is currently inadequate data on investment flow in energy infrastructure or physical assets that specifically target climate change mitigation in Liberia. Correspondingly, there is insufficient data on financial flow or ongoing expenditure to maintain the operational viability of such investment. Since climate change mitigation scenarios presume considerable improvements in energy efficiency, which reduces total energy supply, as well as shifts to low GHG emitting energy sources, there should be assessments to estimate investments and financial flows needed for energy supply under mitigation scenarios.

The following data should be used for conducting the I&FF assessment:

- Development and share of energy source in total primary energy supply
- Development and share of energy source in total power generation

- Development and share of renewable energy source in total power generation
- Power tariffs for private and industrial users
- Per capita energy consumption
- Share of local and imported energy sources
- Power consumption in (industry) sectors
- Wind energy sources
- Solar radiation
- Sources of biomass (including also traditional biomass for e.g. household energy)
- Sources for bio fuel
- Hydro power sources
- Share of energy sector contribution to GDP
- Disaggregated investment in renewable energy technologies
 - Private sector investment
 - Public Sector investment
 - Other investments (bi and multilateral donors).

Even if there a willingness nationally to carry out an assessment of financial flow to the energy sector, key obstacles to conducting the assessment are inadequate institutional framework, lack of baseline data, tools and resources. The best way to initiate the assessment is facilitating networking among existing institutions to ensure quick wins in addressing climate change mitigation. This institutional networking strategy could be the best way to initiate the assessment. This could be achieved by training a core group of people to conduct the assessment by interfacing with all energy related and financial institutions, relevant GOL ministries and agencies, bi- and multilateral development agencies and donors. The EPA of Liberia should be the coordinating institution for conducting the I&FF assessment in the mean time.

APPROACH FOR CONDUCTING THE ASSESSMENT OF INVESTMENT AND FINANCIAL FLOWS TO ADDRESS CLIMATE CHANGE MITIGATION IN THE ENERGY SECTOR

Institutional Arrangement for I & FF Assessment

There is a need for a multi-sectoral energy committee that will maintain linkages with the public and private sectors as well as international financial and development organizations involved in the energy sector. The GOL recognizing this need, proposed in the National Energy Policy the re-establishment of the National Energy Committee (NEC), in place before the civil crisis, to facilitate coordination between energy-oriented organizations in the public and private sector and developers and users of related infrastructure services. The NEC, chaired by the MLME, comprises relevant ministries and government agencies, NGOs, and development agencies. The National Energy Stakeholders' Forum (NESF) recommended the composition of the NEC as follows: Ministries of Planning and Economic Affairs, Agriculture, Internal Affairs, Finance, Education, Health and Social Welfare, Labor, Commerce and Industry, Transport, and Gender and Development; LEC; NOCAL; LPRC; EPA; Forestry Development Authority; National Fire Service; Conservation International; Center for Sustainable Energy Technology; and international development agencies. Representatives of development agencies would not be involved in policy making but would be invited for their expertise and to share their countries' experiences.

The NEC will also provide a forum for coordination among domestic, regional, and international stakeholders, thus fulfilling the ECOWAS recommendations for member countries to set up a cross-sectoral and multi-actor energy cooperation mechanism equipped with the human, technical, and financial resources required to discharge its coordination mandate.

With the reconstitution of the NEC as recommended by the NEP, it is needless set up a new institution, but to strengthen and support this unique institutional framework so that it can serve as the mechanism for assessing investment and financial flow to address climate change mitigation across the energy sector of Liberia. It will therefore be important to set up an expert committee nationally to be trained in the design of appropriate instruments and tools for the assessment of investment and financial flow to the energy sector.

Key Stakeholders and Sources of Finance for Investment

When considering means to enhance investment and financial flows to address climate change in Liberia, it is important to focus on the role of private-sector investments as they constitute the largest share of investment and financial flows. Key private sector partners whose investment could lead to considerable financial flow for climate change in Liberia include, BRE, AcelorMittal, Firestone, China Union, and petroleum exploration companies mentioned in Section 2.2. Official Development Assistance (ODA) funds also represent a substantial share of the total

investments, especially in LDC like Liberia. With appropriate energy policies and corresponding fiscal and tax incentives in place, a significant part of the additional investment and financial flows needed for climate change mitigation in the energy sector could be covered by GOL sources and local private actors. However, improvement in, and best possible combination of mechanisms such as the carbon markets and financial mechanism of the relevant Conventions, ODA, national budget, and, in some cases, new and additional resources, will be needed to mobilize the necessary investment and financial flows to address climate change across the energy sector.

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