

RURAL ENERGY STRATEGY AND MASTER PLAN FOR LIBERIA UNTIL 2030

# RURAL ENERGY STRATEGY AND MASTER PLAN FOR LIBERIA UNTIL 2030

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**Rural and Renewable Energy Agency**  
Securing modern energy access for all Liberians

RURAL ENERGY STRATEGY  
AND MASTER PLAN FOR  
**LIBERIA UNTIL 2030**



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# FOREWORD



**Hon. Patrick Sendolo**  
Minister of Lands, Mines and Energy  
Republic of Liberia

The Rural and Renewable Energy Agency (RREA) is mandated by its Legislation to develop in collaboration with the Ministry of Lands, Mines & Energy and other stakeholders a Rural Energy Strategy and Master Plan for Liberia. The Master Plan shall be formulated on the basis of well-defined project selection and prioritization criteria designed to ensure enhanced energy access with equity, sustainable development and optimal use of indigenous and renewable resources, and ensure that these are integrated into the national energy Master Plan. This document has been prepared in fulfillment of this very important mandate.

Recently we suffered one of the most tragic civil wars in modern African history, and then, just when we had substantially recovered and begun to grow our economy the Ebola crisis came. It is once again time to rebuild our nation, to recover productivity and growth, to strengthen our resilience and reduce vulnerability with sustainable public finances and real results. Energy is one of the key elements and priorities for our recovery and for our development. Together with roads and communication, energy is critical for economic activity, for health, for education and for security.

Liberia has one of the lowest electrification rates in the world and, at the same time, one of the highest electricity tariffs globally. It is a major impediment to growth and development in health, education and security of the people, a huge restraint economic activity and job creation.

Some progress has been made in Monrovia. With donors' contributions the Government is electrifying the city of Monrovia and its environs, and with the rehabilitation of Mount Coffee we expect that electricity will become more affordable and that many diesel generators and consumers currently outside of the grid will be connected to the main grid sooner than later.

On the other hand, we cannot ignore and leave the rest of the country without electricity. It is therefore imperative to invest in rural electrification because we still have to electrify the cities and towns in the rest of the country taking advantage of the vast renewable energy resource potential, where affordable electricity is supplied to support social and economic activities thus leading to productive uses, and job creation. This Rural Energy Master Plan serves as a strategic roadmap for providing access to improved energy services as well as integrating energy into rural development programs and activities in Liberia. Identifying viable projects that can be maintained by the private sector is the purpose of this Master Plan. Financing the implementation of this Master Plan will require a combination of grants, concessional finance, and private sector investment in order to achieve the 35% rural electrification target in 2030.

We need a consolidated effort of all stakeholders – the Government, development partners, civil society and the private sector – for the implementation of this Rural Energy Master Plan to increase energy access and ensure social and economic development in rural Liberia.



# EXECUTIVE SUMMARY

## Introduction

**“Small light today, big light tomorrow”.** This document presents Liberia’s Rural Energy Strategy and Master Plan (RESMP) for the period until 2030 and aims to set clear targets, to identify least-cost projects and technologies, to propose concrete investments for funding and implementation, with appropriate institutional framework and capacity to increase energy access and renewable energies to the country’s rural areas and population – meaning all areas and population outside of greater Monrovia. This document responds to Liberia’s President call for “Small Light Today, Big Light Tomorrow”, and also responds to two global development goals - the Sustainable Energy for All (SE4ALL) and Sustainable Development Goals (SDGs).

## Country context and background

**Energy access is a key component of Liberia’s Agenda for Transformation (AfT) and post-Ebola recovery strategy.** Liberia was finally on the path of growth and development after fourteen years of devastating civil war and ten years of uninterrupted peace when it was hit by the Ebola outbreak in 2014. The Ebola outbreak had a devastating impact on the nation’s economy and on the lives of millions of Liberians. A recovery plan was approved in 2015 with Energy Access and Renewable Energies being a key component as energy infrastructure is critical to enable economic activity, output and growth, but also a key lever to strengthen resilience, reduce vulnerability and promote gender equality through improved health, education and security services.

**Liberia's energy access is still today one of the lowest in the world.** Despite some progress on the electrification of Monrovia - the country capital - Liberia has still one of the lowest grid electrification rates in the world with less than 3% of the population connected to grid power – meaning less than 10% in Monrovia and less than 0.5% in the rest of the country. This leaves the vast majority of people reliant upon various informal and unreliable systems and leads also to an intensive use of diesel based generators in the less rural areas of the country.

**Despite high renewable energy potential, electrical energy cost is one of the highest in the world relying mostly on fossil fuels.** Liberia has more than 2.3 GW of hydro potential identified and a widespread solar irradiation and biomass vegetation. Many locations across the country offer the potential for lower cost renewable electricity. However, populations with electricity in Liberia face one of the highest costs of electricity in the world with the Liberian Energy Corporation (LEC) tariffs of USD 0.50 per kWh and power mostly generated from fossil fuels.

**The Master Plan is based on the principles and policies of Efficiency, Equity, Sustainability, Transparency, Private Sector participation and Regional cooperation.** The National Energy Policy principles remain effective, namely the principle of least cost development taking account of the economic, financial, social and environmental factors and the special needs of the poor; the principle of promoting equity across regions, social classes and genders while balancing efficiency on the allocation of the available resources; the principle of optimizing the use of our indigenous and renewable resources in a sustainable way; the policy of facilitating private sector investment; the policy of a transparent and independent regulatory process to ensure safe, secure, reliable and sustainable power at a cost-reflective but affordable price; and the policy of promoting regional cooperation.

## **Vision and objectives for rural energy until 2030**

**Building a long term vision.** Least cost studies show in the long term (potentially 2050) the most efficient way to bring “Big Light” to Liberia is to have the National Grid reach 89% of Liberia's population and 96% of potential consumption with the remaining 11% scattered among 7 000 off-grid small settlements. However, the Government of Liberia opted not to delay access to energy for those far away from the existing National Grid and to benefit from the country's immense renewable potential. The priority and scenario for rural energy is to start building the least cost long term vision based on Medium Voltage (MV) investments, Decentralized Grids and Renewable Energies that can maximize number of connections in an equitable way across the country until 2030 – from Monrovia to cities and towns, from cities and towns to more rural areas.

**Ambitious objectives until 2030 for a decentralized and equitable transition to the “large grid” long term vision:**

- Electrification rate for the population outside of Monrovia of 10% in 2020, 20% in 2025 and 35% in 2030, electrifying the largest cities and towns of the country first.
- All county capitals, health facility and secondary schools electrified already before 2025.
- 10 largest settlements in each County to be electrified by 2030 with minimum electrification of 15% per County.
- More than 75% of all electricity generated from renewables by 2030 with 19% coming from other than large hydro: Mini-hydro, Solar and Biomass.
- Universal access to affordable solar lamps, efficient appliances and cook stoves.
- Cooking gas available in all county capitals and efficiently produced charcoal widespread across the country.

## Rural Energy Action Plan

**Five Programs for rural electrification of Liberia.** The Master Plan identifies 92 projects and investments to electrify 265 000 homes and 1.34M people outside Monrovia until 2030. The action plan and rural energy projects are structured under 5 main programs

- **GTG: Growing the Grid Program:** Expanding Medium Voltage grid from the three planned corridors outside of Monrovia (Kakata, Kle and RIA), from new proposed corridors starting from Gbarnga and from the Côte d'Ivoire, Liberia, Sierra Leone and Guinea interconnection (CLSG) sub-stations and Shield Wire, representing a total investment of USD 308M and the electrification of 164 300 homes. Additionally, GTG includes additional USD 242M investment in on-grid renewable generation to be installed outside Monrovia.
- **DG: Decentralized Grids Program:** Building large decentralized grids supported by renewable generation, cross border inter-connections and Medium Voltage grids (Voinjama, Pleebo/Fishtown, Zwedru and Greenville); guaranteeing the electrification of the 10 largest settlements in each County, if not under GTG program, than through the development of transitional solar/diesel low voltage mini-grids. Represents a total investment of USD 292M and the electrification of 96 800 homes.
- **BTG: Beyond the Grid Program:** Electrifying community services, households and public buildings where the grid is not expected before 2025 through 100% solar based off-grid solutions, prioritizing health, education (secondary schools) and security (police stations, checkpoints, courthouses and public lighting); electrifying 75 future off-grid settlements in an equitable way across counties mainly through Solar Home Systems (SHS) while promoting the sale and rental of solar portable lamps or smaller Solar Home Systems across the country. Represents a total investment of USD 16M and the electrification of 4 000 homes.
- **OTP: Other than Power Program:** Promoting efficiency in buildings, appliances and cooking; developing Liquefied Petroleum Gas (LPG) storage and filling infra-structure while promoting availability of cooking gas in all county capitals; promoting efficient charcoal production and efficient cook stoves requires a total investment of USD 24M.
- **BC: Building capacity:** Creating the capacity, the institutional framework, the organization, the information and management systems and the infra-structure to implement the Master Plan requires a total investment of USD 52M.

## Investment requirements and funding strategy

**USD 746M still to be funded mostly for the period between 2020 and 2030.** From the required USD 935M, around USD 140.8M are already committed and an additional USD 45M secured, representing a total of USD 185M – mostly from African Development Bank, World Bank and European Union. Most of the secured funding will be deployed in the first phase (2016-2020) representing a significant part of the estimated investment of USD 262M during that period. A gap of USD 749M remains to implement the Rural Energy Master Plan with additional USD 102M being required in the next years, USD 303M between 2020 and 2025 and the remaining until 2030.

**A compelling case for funding.** The RESMP benefits from a strong initial focus on the electrification of the main cities and towns outside Monrovia (65% of all rural clients in 2030) where there is business activity and some capacity to pay for energy services.

The support studies show that if initial investments in distribution and renewable based generation have a strong component of grants and if consumers are charged for what they consume based on pre-paid meters and reasonable tariffs, it is possible to create a financially sustainable system that can maintain the assets, pay for running costs and fund a part of the growth investments, potentially leveraging on a robust Rural Energy Fund (REFUND) to mitigate risks and reduce interests. In the National Grid where generation cost is lower due to regional imports and large scale hydro investments, investments in renewable generation and distribution can also be funded using Development Finance Institutions (DFIs) and the private sector.

## **Institutional framework and private sector participation**

**RESMP institutional framework is based on a Public Private Partnership model.** The implementation challenge requires strong private sector involvement – in line with the recently approved electricity legislation. However, the need to combine a strong grant component to achieve affordable tariffs, also requires strong donor involvement with competent public sector interface and an acceptable asset ownership model.

**The Regional Distribution Companies.** At least 5 Regional Distribution Companies will be created to manage all Distribution activities in specific regions – one from LEC and others based on existing cross border grids, CLSG sub-stations and future large decentralized grids. Distribution companies will manage all distribution activities in their allocated region, either on or off national grid, except long term off-grid locations which may be managed by small local companies or cooperatives. Liberia Electricity Regulatory Commission (LERC) will regulate Distribution Companies revenues and tariffs guaranteeing an adequate cost recovery and return on investment while reducing differences in tariffs through use of REFUND as a balancing mechanism.

**LEC National Grid Company or Unit.** LEC Transmission and System Operation activities should be set up in an autonomous “LEC National Grid Company or Unit” that will treat all Distribution and Generation Companies without discrimination. This unit will also procure energy from on-grid Renewable Independent Power Producers (IIPP) and other grid connected generation units in order to guarantee a secure and competitive sourcing for all Distribution Companies connected to the National Grid. Regional Distribution Companies will be allowed to procure part of the energy they consume directly, under limits to be approved by LERC.

Other private operators will be involved in rental or retail/supply of solar portable lamps, and non-electrical energy efficient cook stoves or cooking gas and related equipment. Rural Services Unit(s) (RSU) will give support in procurement and wholesale of Solar Portable Lamps, in monitoring progress and to Distribution Companies on pre-paid meters. Petrol retailers will be required to distribute and make available cooking gas in different sizes down to at least 6 kg per bottle. The Liberian Petroleum Refining Company (LPRC) will also support LPG imports and storage.

## **Coordination, monitoring and communication**

**Coordination and monitoring.** RREA will coordinate, supervise, and report progress yearly on the implementation of the Master Plan, while the Ministry of Lands, Mines and Energy (MLME) will provide policy oversight and monitoring of the Master Plan, along with the National Energy Committee. The latter will include all relevant ministries, agencies, Civil Society, the private sector, and county official and shall meet at least once every year to review progress made on the implementation of the Master Plan.

**Communication.** A web-site will be developed by RREA to communicate the implementation and results of the Master Plan and the Rural Electrification database and statistics. Other means such as brochure, newsletter, etc. will be prepared to provide information to the general public on the implementation of the Master Plan.



# INTRODUCTION

# INTRODUCTION

**This document presents the Rural Energy Strategy and Master Plan** for Liberia (RESMP), which communicates the main elements of the Master Plan to key stakeholders. The RESMP for the period until 2030 aims to set clear targets, to identify least-cost projects and technologies, to propose concrete investments for funding and implementation, with appropriate institutional framework and capacity to increase energy access and renewable energies to the country's rural areas and population – meaning all areas and population outside of greater Monrovia.

**The Rural and Renewable Energy Agency Act mandates the Rural and Renewable Energy Agency (RREA) to develop a Rural Energy Strategy and Master Plan for Liberia.** The Master Plan and supporting study was developed under supervision of RREA. The Consultant, Gesto Energy, in collaboration with the Sustainable Engineering Lab of the Earth Institute at Columbia University performed the technical work between July 2015 and April 2016 under a contract with RREA funded by the European Development Fund (10th EDF). The work included consultation with stakeholders, namely more than 60 interviews to key decision makers across all 15 counties and a Validation Workshop held in Gbarnga on the 4th of February 2016 with more than 80 participants.

**Methodology.** Rural for the purpose of the Master Plan means all areas, settlements and inhabitants outside of Monrovia, either in the cities and towns or in small remote villages. Rural energy includes electricity, cooking gas and charcoal/wood for cooking. Energy consumption for transportation or large industries is not included in the scope of the Master Plan. The first comprehensive solar and hydro maps of Liberia were developed to, together with the comprehensive Geographic Information System (GIS) database developed in collaboration with the Liberia Institute for Statistics and Geo-Information Services (LISGIS), apply the least cost geo-spatial “Network Planner” methodology to Liberia. The RESMP was then formulated on the basis of well-defined project selection and prioritization criteria designed to ensure enhanced energy access with equity, sustainable development and optimal use of indigenous and renewable resources.

**Impact.** The RESMP represents Liberia's intentions and plans towards the objectives of the National Energy Policy, as well as regional and global initiatives such as the ECOWAS Renewable Energy and Energy Efficiency Action Plan, Sustainable Energy for All and Sustainable Development Goals. The RESMP also represents the firm intention of the Government of Liberia to provide the necessary infrastructure to enable the country's development and to contribute to the improvement of life for all Liberians. President Ellen Johnson Sirleaf in 2006 offered a guiding slogan for Liberia's energy policy and strategy: “Small light today, big light tomorrow”. The National Energy Policy set the policies to go from small light to big light. The Master Plan now identifies the projects and the investments to align, join and optimize all efforts of national authorities, international partners, civil society and private sector, towards the goal of having Big Light across Liberia in the future.



# COUNTRY CONTEXT AND BACKGROUND

# 2.1 COUNTRY BACKGROUND

**Liberia's geography and rural population.** Liberia is situated in West Africa, neighboring Sierra Leone, Guinea and Côte d'Ivoire. Liberia is divided into fifteen counties. Monrovia, Liberian capital located in Montserrado County, is the most populous city, with 28% of the total population of Liberia. For the purpose of the Master Plan, rural means all areas outside of Monrovia, meaning 72% of the country's population and around 14 000 settlements. This definition differs from the 2008 census where population in several County Capitals – 19% of the population – were accounted for as urban.

**Historical Background.** Liberia was created through a settlement of freed slaves from the United States in 1822 and by 1847 the Americo-Liberians were able to establish a republic, thus being Africa's oldest republic. In December 1989, the National Patriotic Front of Liberia (NPFL), led by Charles Taylor, started a long Civil War that lasted until August 11, 2003 when Charles Taylor stepped down and went into exile. After two years of rule by a transitional government, the 2005 Liberian general election were held. In these elections, President Ellen Johnson Sirleaf, former World Bank employee and Liberian Finance Minister, won the presidential elections and became the first democratically-elected female African head of state in January 2006, being reelected in 2011.

**Economic background.** Following the first post-war democratic elections in 2005, President Ellen Johnson Sirleaf had the challenge to rebuild Liberia's economy, and to reconcile a nation still recovering from 14 years of civil war. By the end of the 14 year conflict, most of Liberia's infrastructures had been destroyed, food insecurity was widespread, poverty rates were high, and many people had been displaced. The economic impact of the civil war was clear: in 2003 Liberia was the second country with lowest Gross Domestic Product (GDP) based on Power Purchase Parity per capita in the world. With the restoration of peace, Liberia faced a period of rapid economic growth, experiencing a GDP rate of 7.6% on average in the period of 2004-13, and its nominal GDP more than tripling during this period. The restart of iron ore production encouraged construction and service sector activities. An evolution of the Liberian GDP is shown in **Figure 2.1**.

**Human development and Gender inequality.** Due to this troubled and difficult past Liberia has one of the lowest Human Development Indexes in the world according to the United Nations Development Programme, ranking 177 out of 188. Although it improved significantly from 0.33 in 2005 to 0.43 in 2015, it remains well below the world's average (0.71) and also the Sub-Saharan Africa's average (0.52). One area where Liberia scores particularly low is on the Gender Inequality Index, being the 9th country out of 155 with the highest levels of gender inequality. Maternal mortality ratio, adolescent birth rate are high and access to education and jobs remain low for women in Liberia.

**Poverty reduction strategy and the agenda for transformation.** Following the inauguration of President Ellen Johnson Sirleaf in 2006, the Government of Liberia embarked on the *150-day Deliverables or Action Plan* (February – June 2006), and the *Interim Poverty Reduction Strategy (IPRS)* (July 2006 – June 2008), offering guidance to donor interventions in addition to continuing programs and activities previously initiated mostly with an emergency relief scope with short-term recovery strategies.

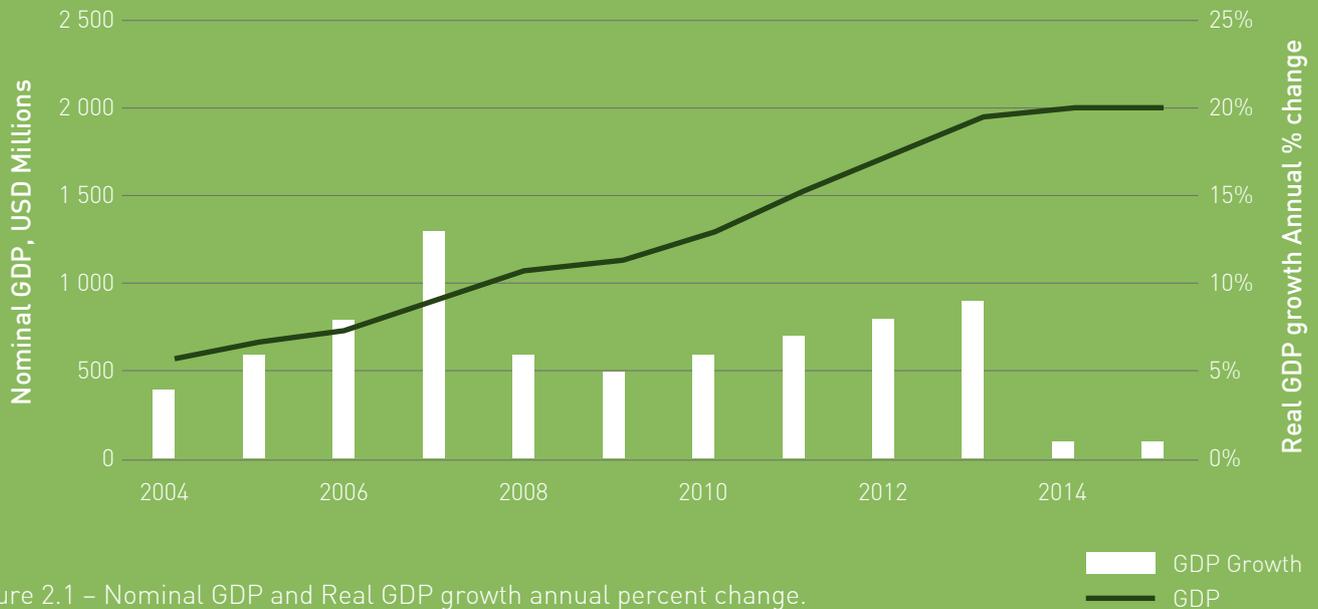


Figure 2.1 – Nominal GDP and Real GDP growth annual percent change.

In April 2008, the Government of Liberia finalized the Poverty Reduction Strategy (PRS) as a macroeconomic policy framework document to guide socioeconomic development activities and national reconstruction from July 1, 2008 to June 30, 2011. The PRS was designed and built around four pillars: 1) Consolidating Peace and Security; 2) Revitalizing the Economy; 3) Strengthening Governance and the Rule of Law; and 4) Rehabilitating Infrastructure and Delivering Basic Services.

*The Agenda for Transformation* (AfT) is the Government of Liberia’s five-year development strategy (2012 – 2017). It follows the Lift Liberia Poverty Reduction Strategy (PRS), which raised Liberia from post-conflict emergency reconstruction and positioned it for future growth. The AfT in itself will—in its five-year timeframe—not be able to achieve all that Liberia is poised to do. Rather it is the first step in achieving the goals set out in *Liberia Rising 2030*, Liberia’s long-term vision of socio-economic development. The AfT sets out precise goals and objectives that Liberia will achieve by 2017 in order to take the necessary steps toward its long-term goals, which are to become a more prosperous and a more inclusive society.

**Ebola outbreak.** Liberia experienced an epidemic of Ebola Virus Disease in 2014 and 2015, along with the neighboring countries of Guinea and Sierra Leone. World Health Organization (WHO) only declared the country free of transmission a final time on January 14, 2016. It is estimated that Liberia suffered 10 675 Ebola cases, 4 809 of which were fatal. Ebola had a severe impact in the Liberian economy across all sectors of employment. Indeed, many of those in wage employment were either asked to stay at home or lost their positions entirely. Markets closed, potential customers became more reserved in their spending, and travel restrictions disrupted supply. Moreover, Ebola drove up key food prices and led to food insecurity across the country. This along with the decrease of incoming Foreign Direct Investment (FDI) as many businesses departed, taking capital and expertise with them, and a decline in exports of 38%, imposed a serious slowdown in Liberia’s economy. Indeed, Liberia’s GDP growth rate declined 8 pp. from 8.7% in 2013 to 0.7% in 2014.

**Energy access is a key component of Liberia’s post-Ebola recovery strategy.** A recovery plan for Liberia after the Ebola outbreak was approved in 2015 with Energy Access and Renewable Energies being a key component as energy infrastructure is critical to enable economic activity, output and growth, but also a key lever to strengthen resilience, reduce vulnerability and promote gender equality through improved Health, Education and Security services.

# 2.2 LIBERIA'S ENERGY SECTOR AND POTENTIAL

**Liberia's civil war had severe consequences on the country's power sector.** Before the civil war, more than 7% of the population had access to public electricity – around 35 000 costumers – with a total installed capacity of 191 MW, of which approximately 98% were in and around Monrovia. With the destruction of most of the generation facilities during the war, including the Mount Coffee hydropower plant, as well as of transmission and distribution lines, the Liberian Energy Corporation – national utility in charge of generation, transmission and distribution of electricity – had to cease operations.

**On-going reconstruction focused in Monrovia.** In the last few years, much effort has been made to resume operations and restore the power sector to pre-war levels in Monrovia. An emergency program allowed for the installation of 22.6 MW of diesel based generators with very high generation costs. In July 2010, LEC had around 2 500 customers, a number that increased to around 20 000 by end of 2015: a significant growth, but still less than expectations and less than 10% of Monrovia's population. Potential customers still rely heavily on self-generation given the very high tariff charged by LEC of 55 USD cents per kWh (one of the highest in the world). Several investments to reduce costs and facilitate adoption are currently ongoing: 48 MW of Heavy Fuel Oil based generation at Bushrod and the reconstruction of Mount Coffee Hydro – all focused in Monrovia.

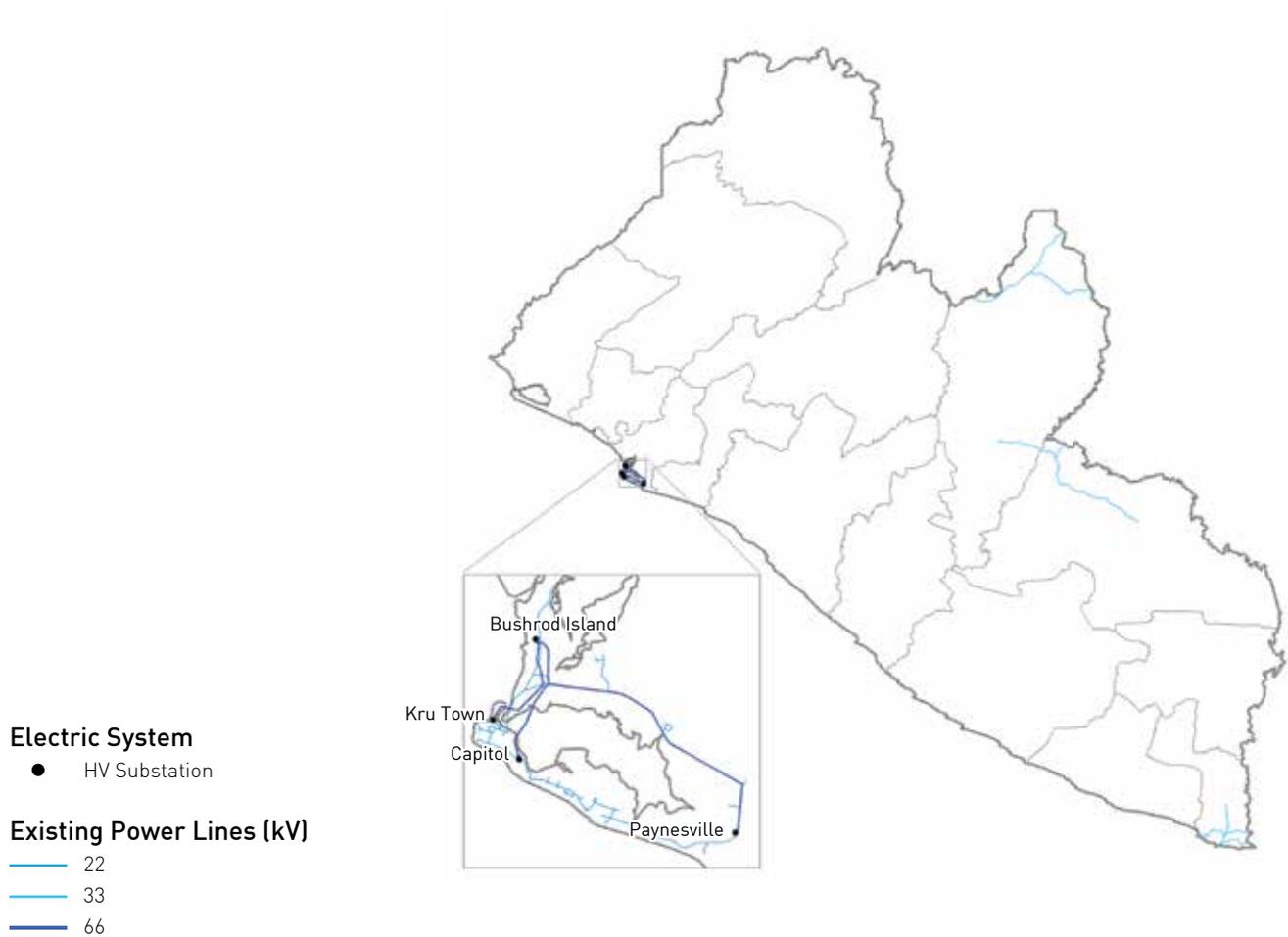


Figure 2.2 – Existing electrical power grid of Liberia (2015).

**Liberia’s rural energy access is almost nonexistent.** Despite some progress on the electrification of Monrovia, as seen in **Figure 2.2**, and the implementation of three Cross-Border Medium Voltage grids with Côte d’Ivoire (with planned electrification of 2 800 customers), Liberia still has one of the lowest grid electrification rates in the world with less than 3% of the population connected to grid power and less than 0.5% of the rural population being connected. This means the majority of the County Capitals and large towns, except Monrovia, are currently in the “dark” or dependent on the use of individual or “community current” diesel based generators. The vast majority of the country’s population, that cannot afford diesel based generation, are reliant upon various informal and unreliable systems with almost no energy access. For cooking, people rely mostly on charcoal in the County Capitals and large towns and on wood in the more rural areas. Cooking gas is almost only available in Monrovia at very high prices (50 USD per 12 kg bottle).

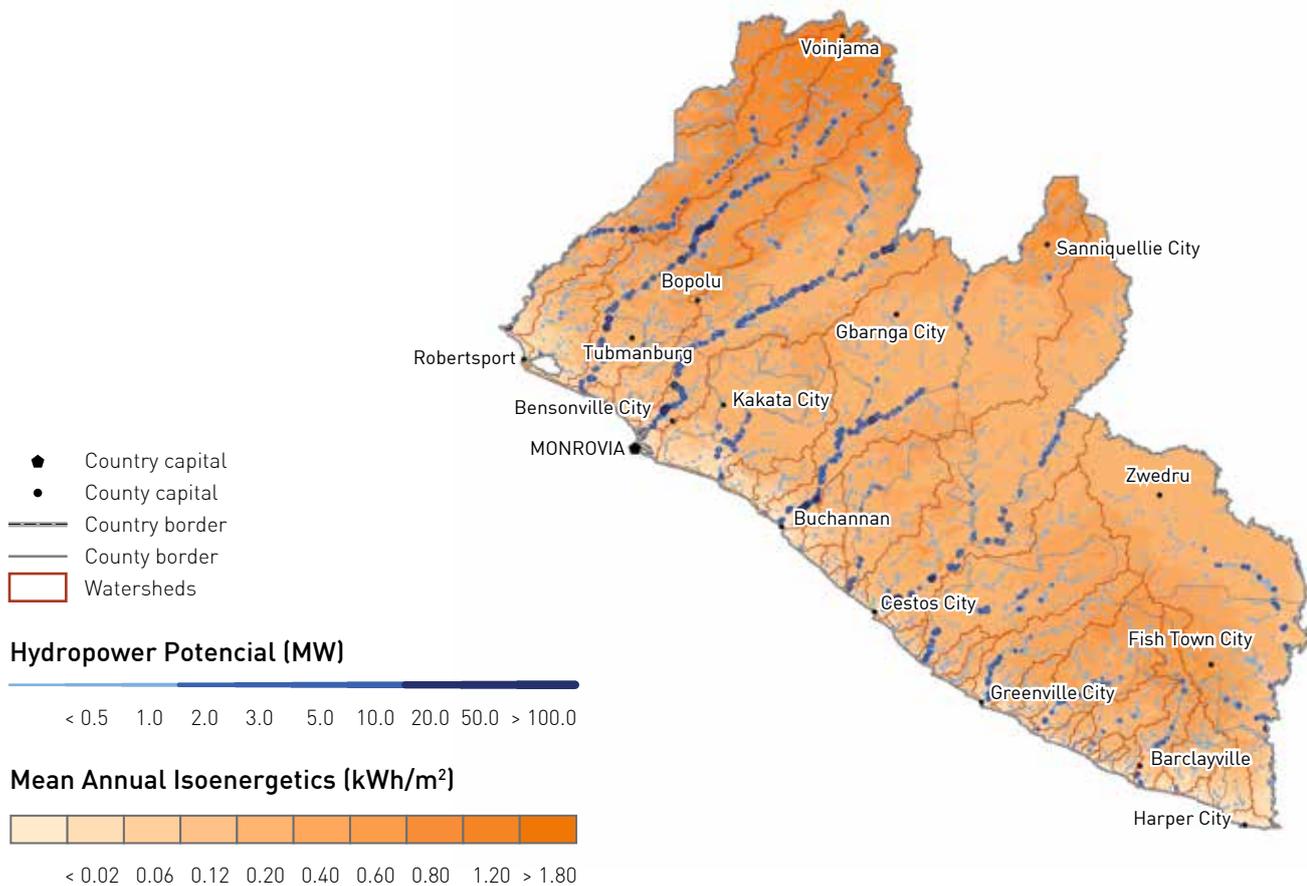


Figure 2.3 – Hydropower potential map.

**High hydropower potential across the country.** Liberia is a tropical country with a very rainy wet season that lasts between April and November and a long sea coast where many rivers end. Hydro potential is very significant in Liberia with 2 300 MW of hydro power potential having been identified under the RESMP study, as shown in **Figure 2.3** and **Figure 2.4** (despite the absence of a comprehensive country hydro atlas study). Liberia hydro potential is concentrated on large rivers with high mean annual flow and low heads – given Liberia’s “plain” topography. However, the hydro assessment study of the RESMP identified several locations with high natural heads and flows above 50 m<sup>3</sup>/s – optimal for above 5 MW hydro schemes with low levelized costs of electricity which can supply the national grid or large decentralized grids across the country. Liberia’s hydro potential is subject to high intra-annual variation with significant reduction in production during the dry season requiring combination with other generation sources and benefitting from inclusion of peaking ponds.

**Solar and Biomass renewable potential also significant.** Additionally to hydro, Liberia’s climate also favors two other types of renewable energy with potential for rural electrification: Biomass and Solar. Biomass gasification technology – which has been tested in Liberia with promising results but some challenges in terms of operation – can become a lower cost alternative to diesel.

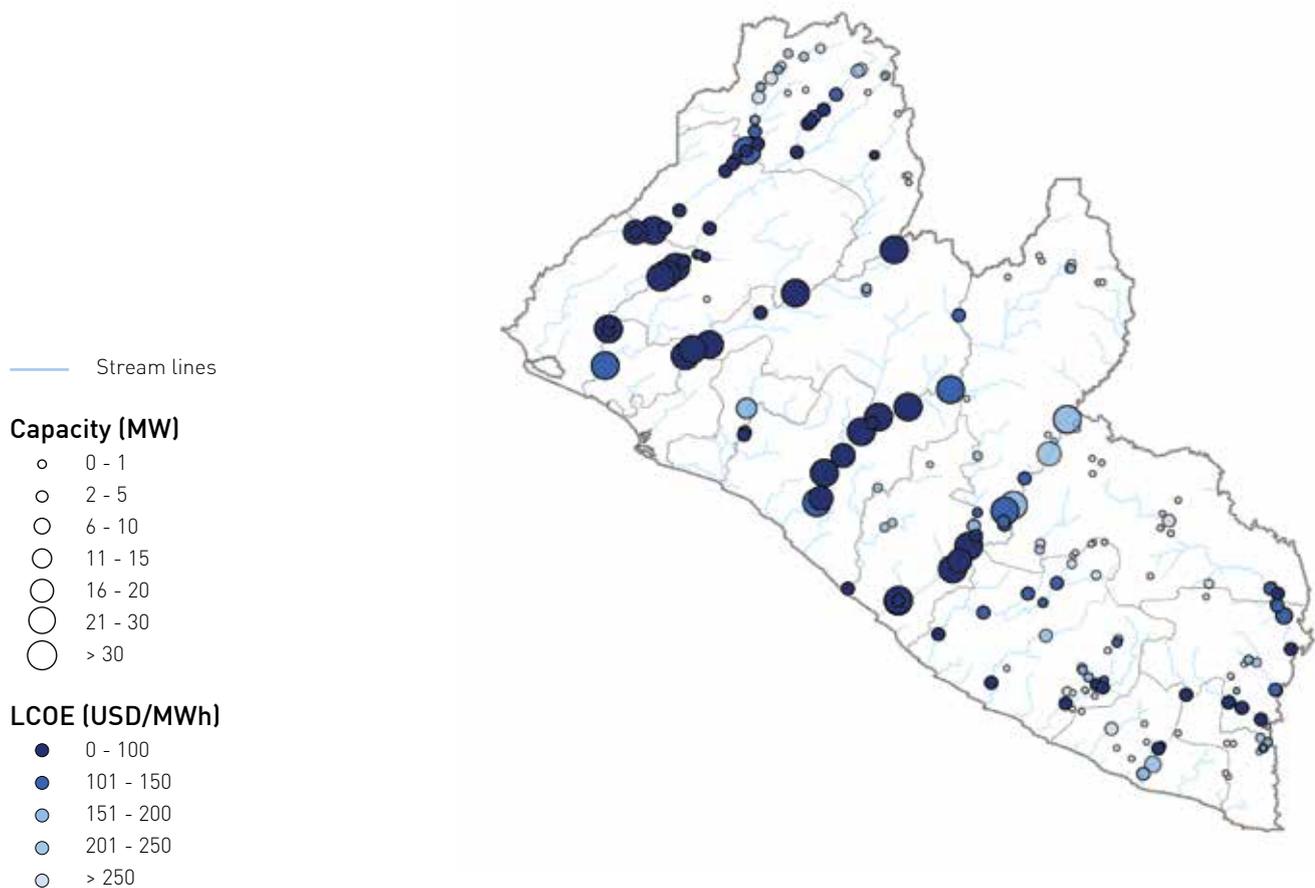


Figure 2.4 – 2 300 MW of Hydropower projects identified in Liberia.

Solar resource – which has been mapped by RESMP study (see **Figure 2.5**) – is high and consistent across the country with an average level of 1 712 kWh/m<sup>2</sup>/year and potential for generation of 1 400 to 1 500 kWh/kWp. Solar technology is the most appropriate for small/medium scale rural electrification in Liberia with the potential to be combined with diesel and batteries to support Low Voltage Transitional mini-grids which could electrify even County Capitals and large towns before the national grid arrives.

**Despite high renewable energy potential, power cost relies mostly on fossil fuels and is one of the most expensive in the world.** Many locations across the country offer the potential for lower cost renewable electricity. However, people with electricity access in Liberia face one of the highest costs of electricity in the world with LEC tariffs of USD 0.50 per kWh in Monrovia, and USD 0.25 per kWh in Cross Border project areas with electricity. LEC power is currently generated from fossil fuels, with the Mount Coffee Hydropower expected to come online by the end of 2016.

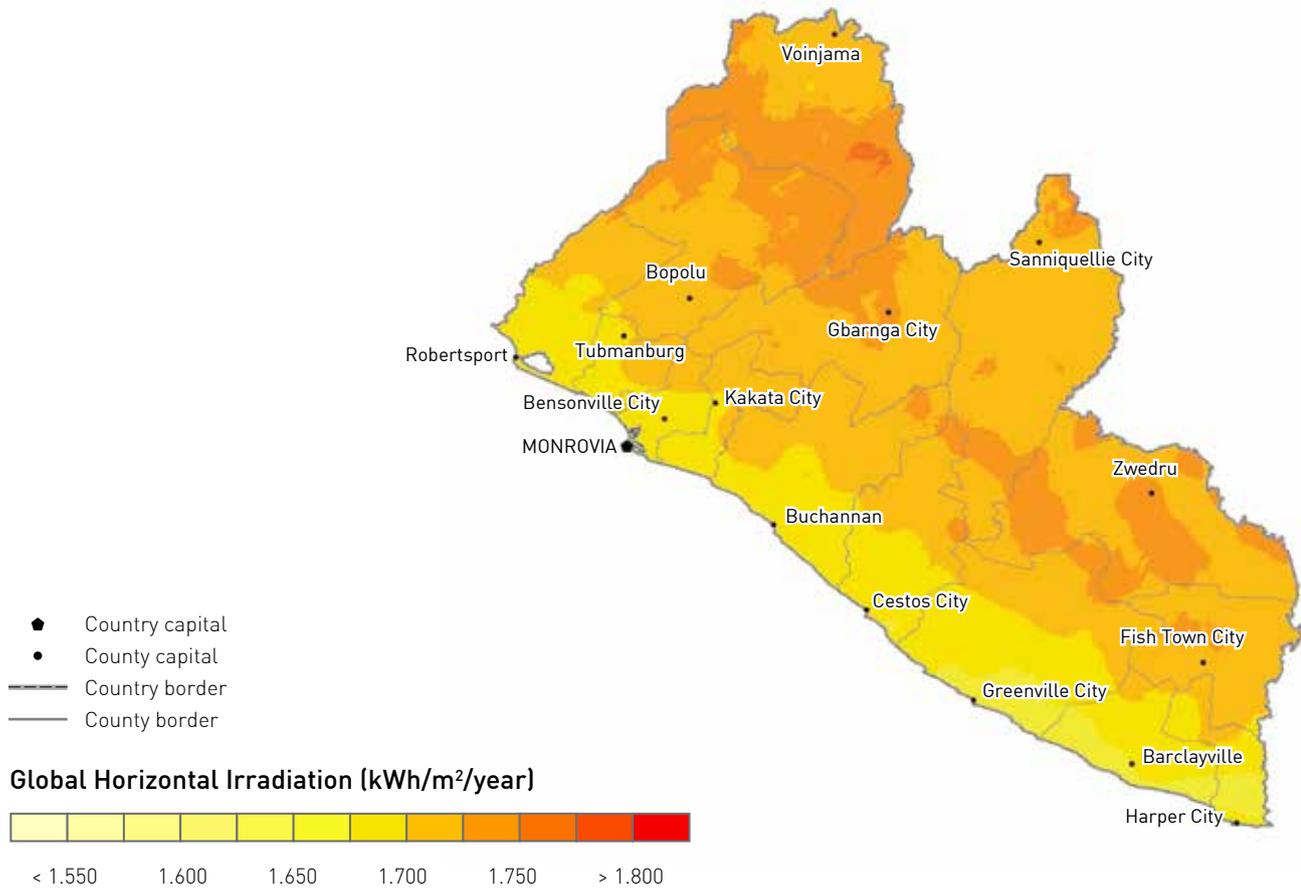


Figure 2.5 – Solar Potential Atlas for Liberia.

**On-going and planned rural electrification initiatives.** RREA has several funded projects on-going with a strong renewable component, notably the Scaling-up Renewable Energy Program (SREP) Projects in Low Income Countries initiative with USD 50M committed by the Climate Investment Fund (CIF) through the World Bank and African Development Bank to deploy hydro and other renewable generation and mini-grids in Northwest and Southeast areas of the country. Regarding Grid extension the only projects already implemented are the Cross Border grids from Ivory Coast that currently electrify the County Capitals of Pleebo, Zwedru and Ganta and are expected to connect 2 800 clients. The international CLSG High Voltage (HV) line is under-way and includes the installation of 4 sub-stations across Liberia: Mano, Mount Coffee, Buchanan and Yekepa. Liberia Accelerated Electricity Expansion Project (LACEEP) and Local Enterprise Assistance Program (LEAP) on-going projects include also some grid extension from Monrovia to Kakata, Kle and RIA (the “three corridors”).

# 2.3 RURAL ENERGY POLICY AND PRIORITIES

**Country agenda and policy.** Liberia aspires to become a middle income country by 2030 and has approved its Agenda for Transformation - Liberia Rising 2030 - with the focus not only on accelerating growth, but also on ensuring that growth can be sustained and lead to a more inclusive society. Equity is a key principle of Liberia's policy which is reflected not only on the Agenda for Transformation but also on the National Gender Policy which aims to guide the country towards achieving gender equity and equality, building and utilizing the potential of women and men, boys and girls in pursuing and benefiting from national development goals.

**National Energy Policy principles.** The National Energy Policy approved in 2009 with a focus on 4 key strategic issues and objectives: **Access** with **Quality** and reasonable **Cost** with an adequate **Institutional Framework**. President Ellen Johnson Sirleaf defined the following guiding principles for Liberia's Energy Policy in the keynote address to the National Energy Stakeholders Forum in 2006 which still remain valid:

- Leveraging enhanced energy access for improvements in education, health and economic development;
- Providing access to modern energy (fuels and electricity) for previously neglected rural consumers;
- Enhancing transparency and accountability at every stage of energy operations;
- Ensuring the long-term financial viability of electric utilities and other energy companies;
- Ensuring the affordability of all energy forms for poor consumers;
- Balancing the environmental costs and benefits of all energy programs, taking into account the collective global effort to control harmful greenhouse gases responsible for climate change;
- Maximizing energy efficiency and demand-side management to minimize the financial and environmental costs of energy development;
- Ensuring the involvement of the private sector to the "greatest degree possible" throughout the energy sector;
- Ensuring that Liberia takes all requisite actions on a timely basis to integrate its domestic energy policies into Economic Community of West African States (ECOWAS) Protocol and other regional and international projects, commitments, standards and obligations.

**Rural and Renewable Energy.** The National Energy Policy calls for the establishment of the Rural and Renewable Energy Agency, the Rural Energy Fund and the need to develop the Rural Energy Master Plan in order to promote renewable energy technologies as a key tool and development program to achieve universal energy access in Liberia.

**The following key Policies and Principles shall apply to the Rural Energy Strategy and Master Plan:**

**1. Least Cost development taking account of the economic, financial, social and environmental factors and the special needs of the poor through the use of targeted and transparent capital subsidies.** The Rural Energy Master Plan shall be developed on the basis of a “Least Cost Universal Access” long term vision. All locations, people, businesses and services shall be electrified using the technology that minimizes the cost of service to that particular location, person or business. Only in such a way will Liberia be able to achieve universal access at the lowest cost possible. Subsidies for the poor will be transparently applied to the least cost solution.

**2. Equity across regions, social classes and genders while balancing efficiency on the allocation of available resources.** All Liberians, independently if they are at Montserrado, Maryland or other parts of the country, independently if they are rich or poor or independently if they are men or women, have equal right to access energy services. However, resources are limited and therefore the Master Plan has to decide who to electrify first and with which level of service or support – considering also the fact that some precedent investments may be required to electrify a given area or location. The Master Plan is formulated on the basis of well-defined project selection and prioritization criteria which considers first Equity but also Efficiency.

**3. Priority to electrification of community services and health facilities.** Key decision makers across Liberia share the perspective that electrification should start with Health Facilities, than Schools and Public Lighting (Education and Security), and only after households and businesses. The common services shall have priority relative to the individual solutions.

**4. Use of indigenous and renewable resources in a sustainable way while avoiding dependence on solutions with very high running costs.** If it is possible to use indigenous and renewable resources instead of importing oil or other fuels in a competitive and reliable way, the Master Plan shall opt for the use of such indigenous and renewable resources. Sustainability means, among other things, that the utilization of biomass or other sources of renewable energy do not contribute to deforestation or to food insecurity. Diesel only based electrification is considered as very expensive to maintain, environmentally unfriendly and unsustainable.

**5. Facilitating private sector investment through the unbundling of power sector activities, the implementation of clear and transparent award and remuneration mechanisms and the targeted use of subsidies and grants.** It is the Government intention to involve the private sector to the “greatest degree possible”. Unbundling of Power Sector activities and the award of some of those activities to Independent Private Operators through clear and transparent mechanisms will facilitate private sector participation. The Government shall ensure the long term financial viability of power sector players allowing full cost-recovery at affordable tariffs by reducing capital expenditure (CAPEX) and remuneration through the targeted use of “grants” and capital subsidies.

**6. Transparent and independent regulatory process to ensure safe, secure, reliable and sustainable power at a cost-reflective but affordable price.** Regulation is the most effective mechanism of control for natural monopolies such as Power Transmission or Distribution. Regulation offers transparency and also risk mitigation which can provide confidence both for private investors, donors and lenders. Cost-reflectiveness and affordability trade-offs in rural areas can be also mitigated through the use of regulatory mechanisms. Where feasible the regulator shall promote free and fair competition – namely in Generation and in Procurement of goods and services – to enable consumers to get the best prices.

**7. Promoting regional cooperation.** Liberia is a member of the Economic Community of West African States. Rural Energy Strategy shall promote the participation of the key actors in the regional market to enhance international trade of electricity and to maximize opportunities for cost reduction, for investment and for cross-border electrification.

**Sustainable Development Goals and Sustainable Energy for All.** The National Energy Policy established targets in line with the Millennium Development Goals having 2015 into perspective. The Millennium Development Goals have been updated with the Sustainable Development Goals which incorporate the Sustainable Energy for All initiative and goals of universal energy access, doubling of renewable energy and energy efficiency. Liberia is fully committed to the Sustainable Energy for All initiative and therefore the Rural Energy Strategy and Master Plan updates the rural energy targets with the 2030 horizon and new more ambitious goals into perspective.

**ECOWAS Renewable Energy Policy.** The ECOWAS Renewable Energy Policy was adopted by the 43rd Ordinary Session of the ECOWAS Authority of Heads of State and Government, which held in Abuja, Nigeria, from 17 to 18 July 2013. This policy on renewable energy aims at ensuring increased use of renewable energy sources such as solar, wind, small-scale hydro and bioenergy for grid electricity supply and for the provision of access to energy services in rural areas. The ECOWAS region set a clear target to increase the share of renewable energy in the region's overall electricity mix to 10% in 2020 and 19% in 2030. Including large hydro, the share would reach 35% in 2020 and 48% in 2030. Around 25% of the rural ECOWAS population will be served by mini-grids and stand-alone systems by 2030.





VISION AND OBJECTIVES  
FOR RURAL ENERGY UNTIL 2030

3

# 3.1 LONG TERM VISION

**Least Cost Long term vision.** The starting point for the Rural Energy Master Plan was the development of a long term vision for the universal electrification of all Liberians - most likely only achievable on the 2050 horizon - using the most advanced geo-spatial network and off-grid planning tools developed by Earth Institute of Columbia University. The resulting Medium Voltage optimal network was then processed by the Consultant to develop a conceptual High Voltage infra-structure with adequate levels of tension for estimated loads and location of HV/MV sub-stations and generation centers that can minimize investments in HV infra-structure while offering adequate n-1 redundancy. The vision is presented in **Figure 3.1**.

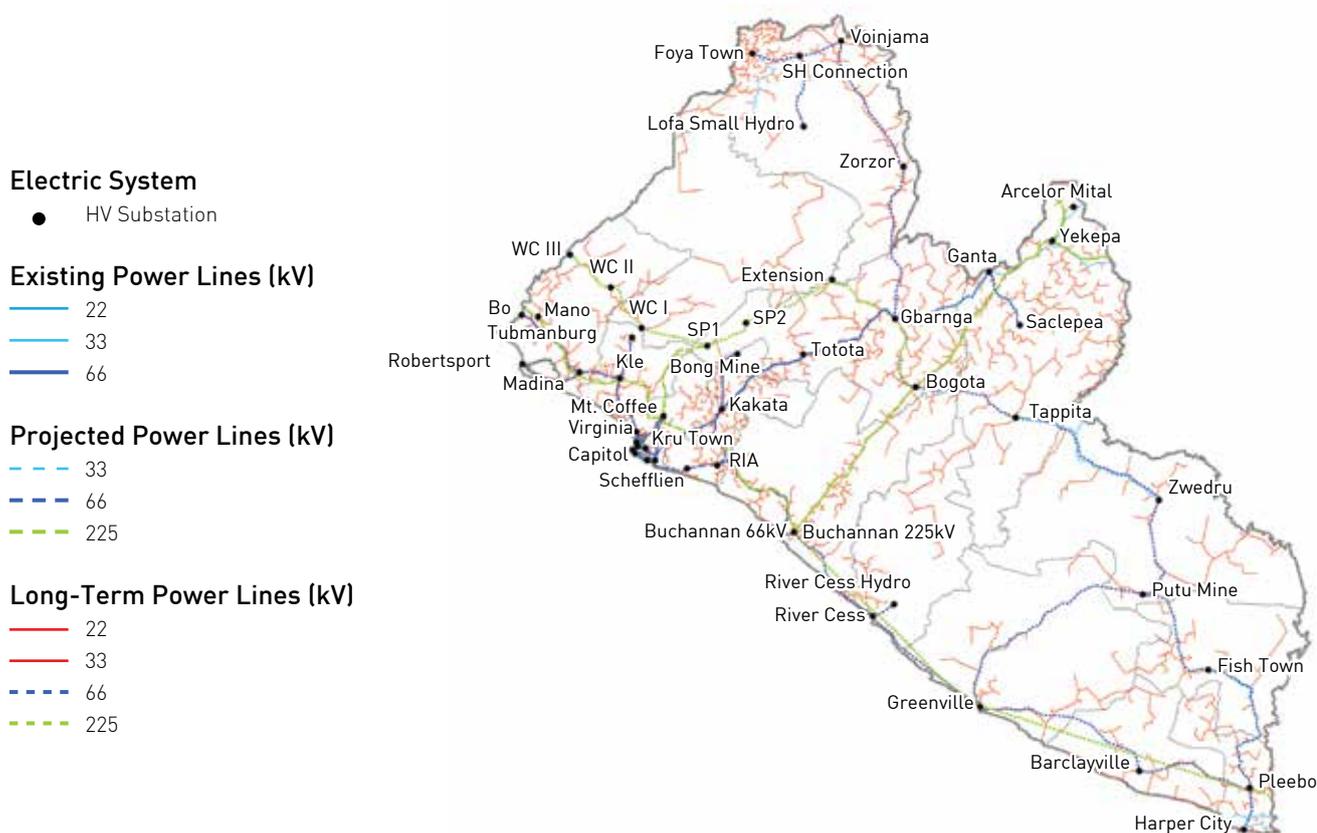


Figure 3.1 – Vision for the long term national grid of Liberia.

**Long term grid results.** As can be seen, the resulting National Grid covers a great part of the Country's populated areas and connects all County Capitals. In the long term the national grid will connect more than 89% of all population, corresponding to 97% of total energy demand. Although the majority of the population is grid connected, only 40% of the inhabited settlements (>5000) are covered by the long term grid. For the remaining 60% (>7000), the least cost option was the off-grid solution based on solar home systems. These off-grid locations are mainly small size settlements with an average size of 115 inhabitants scattered across the country far away from the main roads.

**Backwards to 2030.** The Rural Energy Master Plan studied four alternative scenarios for the electricity sector in 2030, as seen in Figure 3.2, to reflect the vision and expectations of the different stakeholders interviewed. All the scenarios were based and moved towards the long term vision, but varied the electrification approach and the level of ambition:

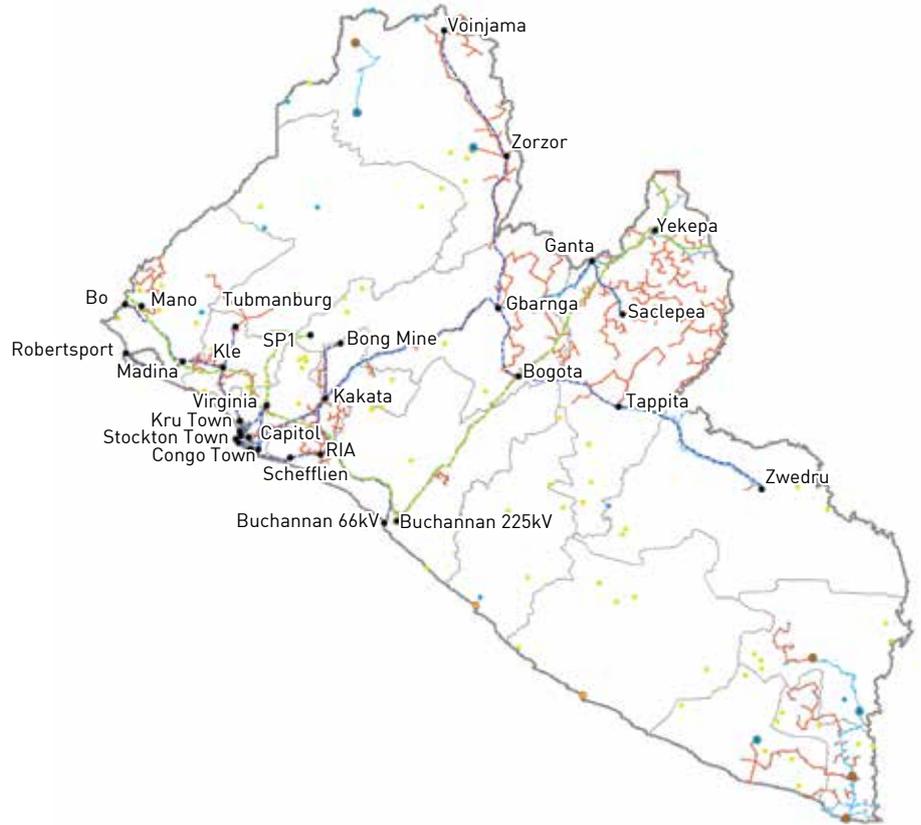
- Scenario 1A focused on traditional grid extension with a target of 35% rural electrification by 2030;
- Scenario 1B proposed an accelerated and more decentralized electrification approach to reach 35%;
- Scenario 2A defended an aggressive national grid extension to reach 50% rural electrification by 2030;
- Scenario 2B defended an aggressive investment program both on national grid, large decentralized grids and mini-grids to reach 50%.

**Scenario analysis.** Scenarios that targeted 50% implied a total investment in excess of USD 1Bi which would represent a non-realistic implementation and funding challenge. Scenarios that were in line with Government of Liberia target of 35% remain ambitious but require a funding level that can be realistically mobilized. Traditional grid extension alternative would concentrate the electrification effort around the Growth Corridor with some Counties remaining in 2030 with very low electrification rates and would require additional investment to extend the High Voltage infra-structure. Scenario 1B was selected and validated at the stakeholder workshop held in Gbarnga on February 2016.

**A decentralized and equitable transition to the “large grid” long term vision.** The Government of Liberia opted not to delay access to energy for those far away from the existing National Grid and to benefit from the country’s immense renewable potential in enabling the setup of mini and decentralized grids. The priority for rural energy is to start building the least cost long term vision based on Medium Voltage investments, Decentralized Grids and Renewable Energies that can maximize number of connections in an equitable way across the country until 2030 – from Monrovia to cities and towns, from cities and towns to more rural areas.

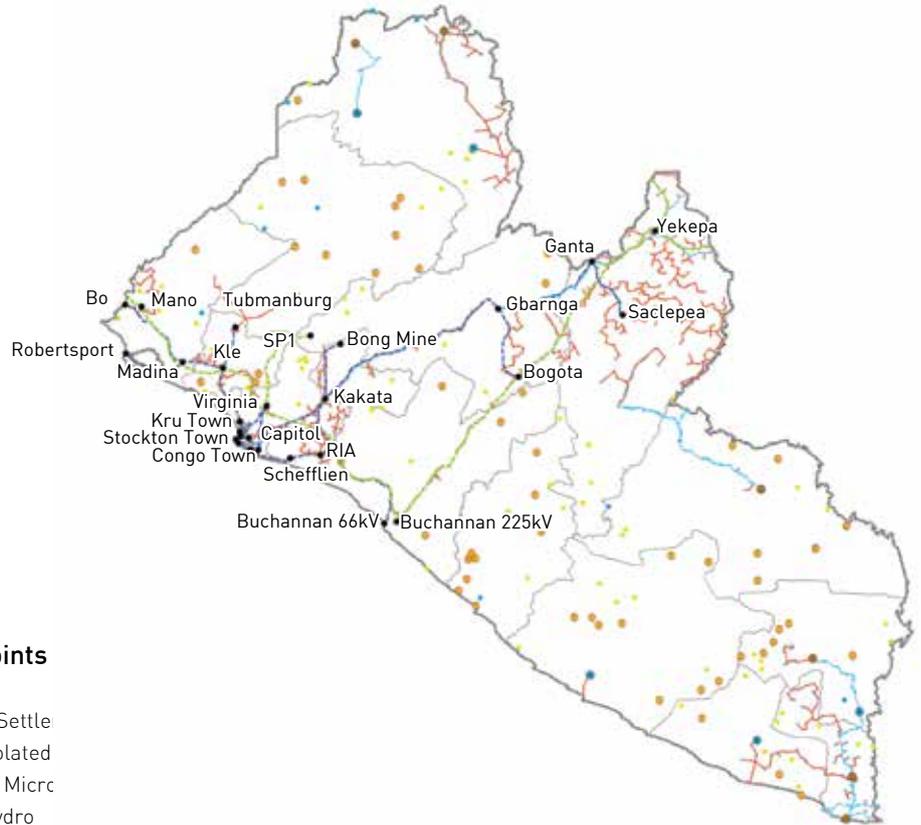
# 1A

Current Policy



# 1B

Accelerated Electrification through decentralized grids alongside grid extension



### Electric System

- HV Substation

### Generation Plants (kV)

- 22
- 33
- - - 66
- - - 225
- Proposed MV Grid

### Generation Plants (Connected to National or Large Isolated Grids)

- Hydro Plants
- Biomass / Diesel Hybrid

### Electrified Points (Technology)

- On-Grid Settle
- Large Isolated
- Biomass Micro
- Micro-Hydro
- Solar Villages
- Solar / Diesel System

Figure 3.2 – Four scenarios studied for the 2030 horizon.

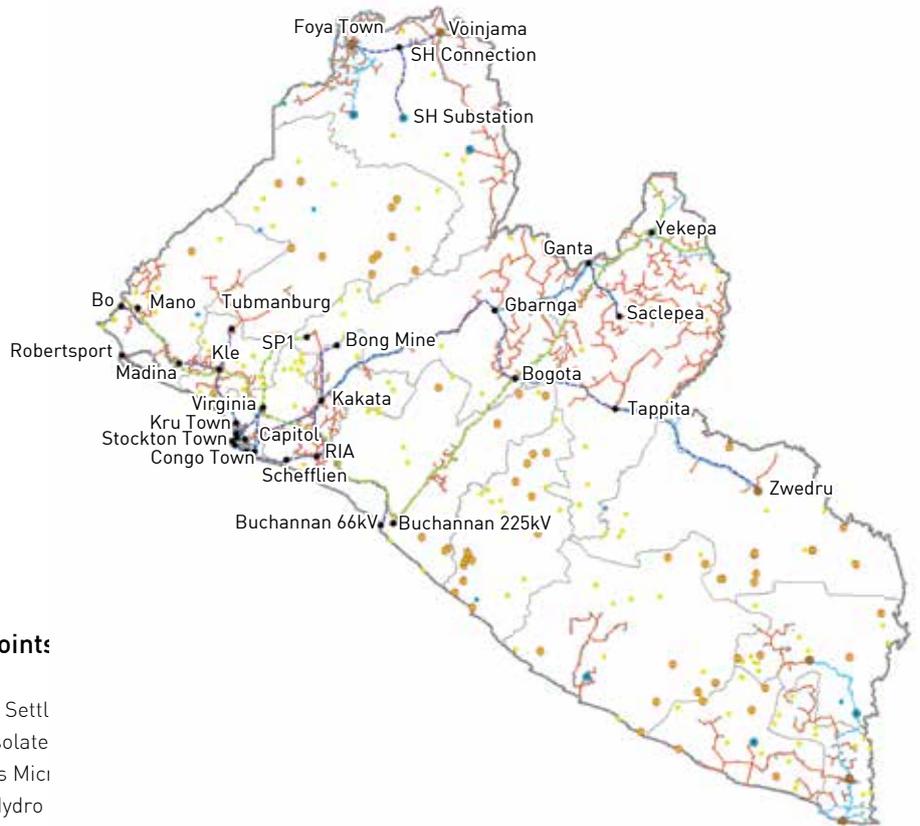
# 2A

## Agressive Grid Extension



# 2B

## Agressive Mini-grid and Grid Extension Electrification



### Electric System

- HV Substation

### Generation Plants (kV)

- 22
- 33
- - - 66
- - - 225
- Proposed MV Grid

### Generation Plants (Connected to National or Large Isolated Grids)

- Hydro Plants
- Biomass / Diesel Hybrid

### Electrified Points (Technology)

- On-Grid Settl
- Large Isolate
- Biomass Micr
- Micro-Hydro
- Solar Villages
- Solar / Dlesel System

Figure 3.2 – Four scenarios studied for the 2030 horizon.

# 3.2 RURAL ELECTRIFICATION ACCESS TARGETS AND MAP

In line with the Sustainable Energy 4 All initiative and the Sustainable Development Goals, Liberia aims to achieve the following in terms of rural electricity access:

- **Electrification rate for the population outside of Monrovia of 10% in 2020, 20% in 2025 and 35% in 2030.** We intend to electrify outside of Monrovia more than 65 000 customers already by 2020, 140 000 by 2025 and 265 000 by 2035;
- **Electrify at least 2 000 settlements with grid infra-structure (national, decentralized or mini grids) connecting at least 50% of those settlement's population by 2030;**
- **All County capitals will be already electrified before 2025.** Electrification of County Capitals either through the National Grid, Decentralized Grids or Transitional Mini-Grids will be a priority of the Government.
- **All Health facilities and Secondary schools electrified already before 2025.** We intend to bring electricity to all health facilities and all secondary schools in Liberia either through grid-based electrification or through 100% solar based individual solutions. Leveraging enhanced energy access for improvements in education, health and economic development;
- **10 largest settlements in every County will be electrified and no County will have less than 15% electrification rate by 2030.** We intend to take electricity to the largest settlements across the country guaranteeing equity between Counties;
- **Establish a credit/subsidy mechanism for connection of poor and woman-led households through REFUND and promote active participation of women in the jobs that will be created for electrifying the country.** Energy access has to be inclusive offering opportunities for women and poorer settlements.

**Rural Electrification map.** The following map in **Figure 3.3** shows the future map of the power sector infra-structures if the targets are met and all projects of the Master Plan are implemented by 2030. The National Grid will be complemented by Large Decentralized Grids in Lofa, the Southeast Counties and Grand Gedeh that will extend from the on-going SREP and Cross Border initiatives. Multiple Solar/Diesel Low Voltage Transitional mini-grids will enable the electrification of the 10 largest settlements in each County in anticipation of the National Grid.

### Electric System

- HV Substation

### Existing Power Lines (kV)

- 22
- 33
- 66

### Projected Power Lines (kV)

- - - 33
- - - 66
- - - 225

### Rural Power Lines (kV)

- 22
- 33
- - - 66

### Generation Plants

(Connected to National or Large Isolated Grids)

- Hydro Plants
- Biomass / Diesel Hybrid

### Electrified Points (Technology)

- On-Grid Settlements
- Large Isolated Grid
- Biomass Micro-System
- Micro-Hydro
- Solar Villages
- Solar / Diesel System

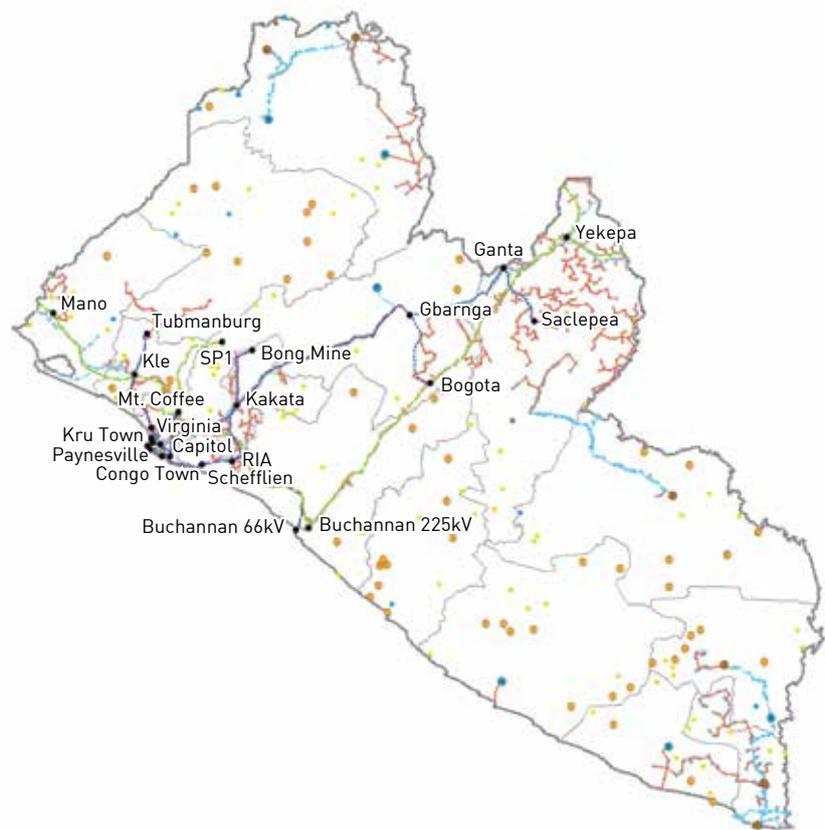


Figure 3.3 – Map of the Liberia's Power System in 2030.

**Combining grid extension with decentralized grids to electrify 1.3M people.** The National Grid will develop mostly in the Growth Corridor area where the majority of the population are concentrated thus electrifying 66% of all rural consumers. The large decentralized grids will represent 27% of the consumers with 5% for mini-grids. Individual off-grid solutions will only bring electricity to 18 900 people (around 1%). 33% will be served by decentralized grids in excess of the 25% target established under Renewable Energy Policy of ECOWAS. The number of people electrified per type of technology in 2030 is shown in **Figure 3.4**.

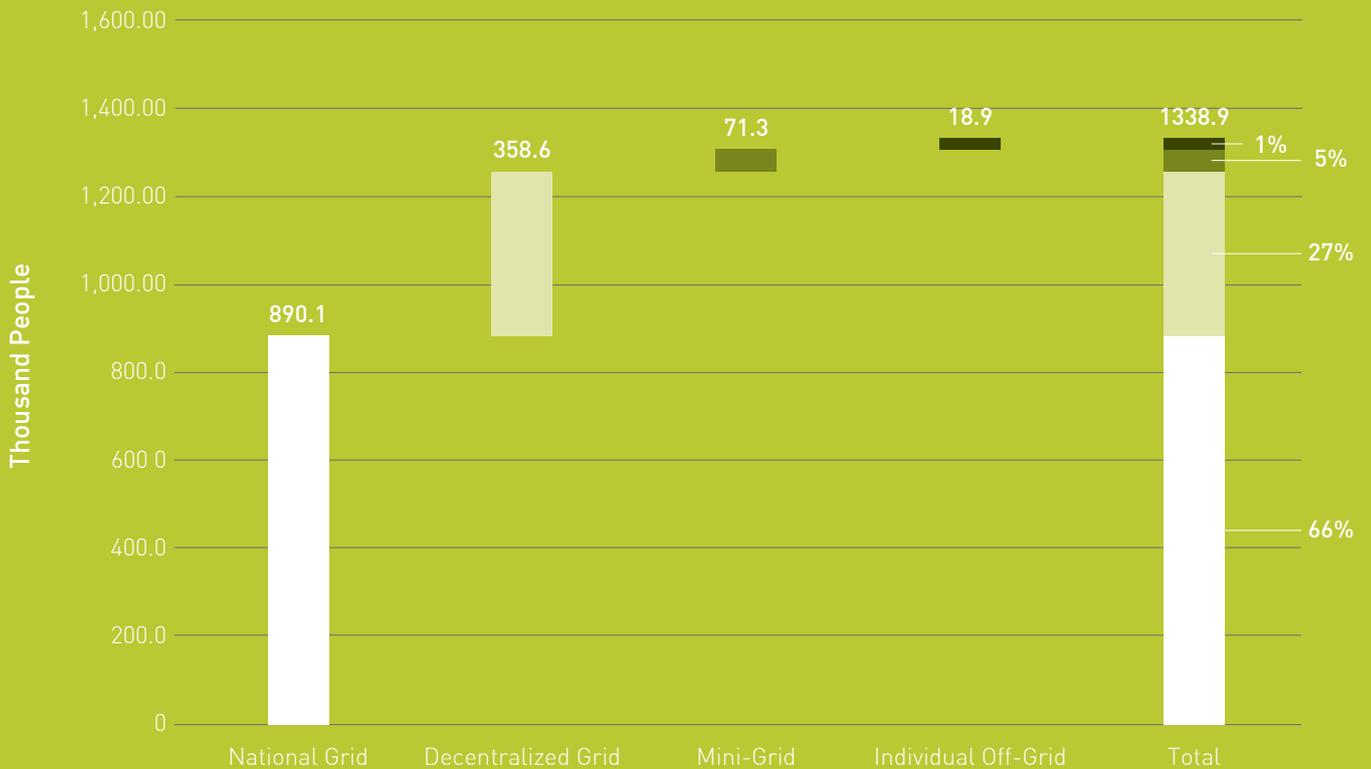


Figure 3.4 – Number of people per type of technology in 2030 – nationwide values.

**Minimum rural electrification rate per County of 15%.** Rural electrification rate will vary per County according to the level of concentration of population and the proximity to the existing grid infra-structure, as depicted in **Figure 3.5**. Nevertheless, decentralized grids allow for a more equitable electrification with no County having less than 15% of its population electrified by 2030.

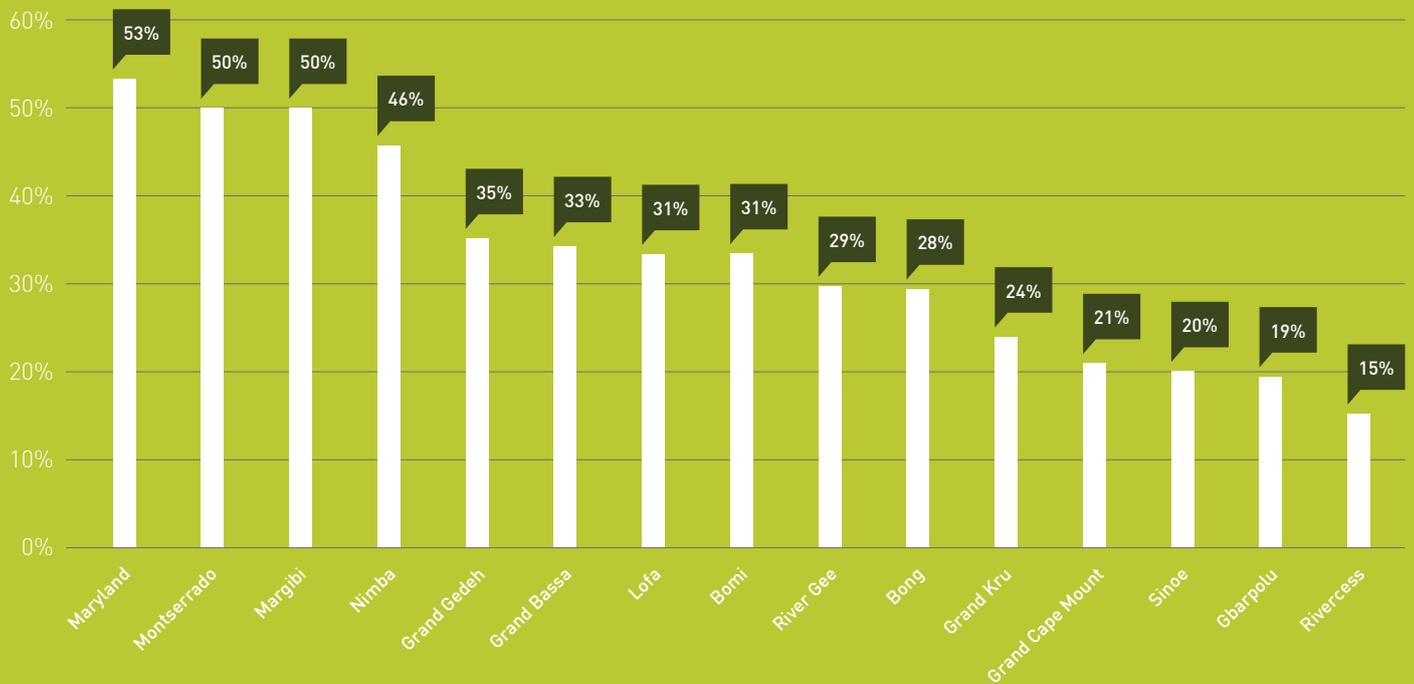


Figure 3.5 – Rural electrification rate per County in 2030.

# 3.3 RENEWABLE ENERGY TARGETS AND ENERGY MIX

In line with the ECOWAS Regional Renewable Energy Policy, the Sustainable Energy for All initiative and the Sustainable Development Goals, Liberia aims to achieve the following in terms of renewable electricity to be installed outside Monrovia:

- **Total share of renewable electricity in the electricity mix from renewable energies excluding large hydro (mini-hydro, solar and biomass) of 10% in 2020 and 19% in 2030.** In line with the target of 10% in 2020 and 19% in 2030 established under ECOWAS Regional Renewable Energy Policy;
- **Total share of renewable electricity (including large hydro) in the electricity mix in excess of 45% by 2020 and 75% by 2030.** Considering the new target of 10 and 19% for renewables without large hydro plus the planned 200 MW large hydro developments of Mount Coffee, St. Paul and VIA reservoir. In excess of the 48% regional target;
- **Develop a Renewable Atlas and Strategy for Liberia, including a more detailed and comprehensive hydro potential assessment.** In order to select the most adequate locations and renewable energy mix for the goal of 10% and 19% incorporation;
- **Installation of at least 150 MW of renewable generation - excluding large hydro - by 2030 and 45 MW already by 2020.** Target capacity estimated according to tentative renewable mix and the goal of 10% and 19% incorporation;
  - **On the National Grid: More than 25 MW until 2020 and 100 MW until 2030;**
  - **Outside the National Grid: More than 20 MW until 2020 and 50 MW until 2030.**
- **On Solar Energy: At least 20 MW on the National Grid by 2020 and 60 MW by 2030.** At least 15% of total estimated peak load can be implemented without significant impact on the system and no requirement for storage – being already competitive with HFO;
- **On Biomass: At least one 5 MW biomass power plant on the National Grid already by 2020. In large decentralized grids to install as much diesel capacity as biomass gasifiers in order to minimize diesel generation.** Biomass energy should be developed in areas and in a way without significant competition with biomass for charcoal;
- **Universal access to affordable solar renewable lamps (to all non-electrified population) with the target of 250.000 solar renewable lamps sold in Liberia by 2030.**

**Renewable share.** Figure 3.6 shows the estimated evolution of electricity consumption in all of Liberia (both Monrovia and rural) that results from combining the Least Cost Power Development Plan (LCPDP) with the Rural Energy Master Plan. The large hydro generation results from the proposed development plan of the LCPDP which considers the implementation before 2030 of Mount Coffee, VIA reservoir and St. Paul hydro schemes in a total of 200 MW and 1 369 GWh generation per year. The other renewables (Solar, Biomass and Mini-hydro) result from the Rural Energy Master Plan and the targets set above. Estimated generation by HFO/Diesel and imports will depend on available regional opportunities. Between 2020 and 2025 a significant growth in non-renewable generation will be required as the St. Paul hydro scheme with 120 MW is only expected to commence delivery after 2025.



Figure 3.6 – Electricity supply mix for Liberia (Monrovia and Rural) until 2030.

**Flexibility for project location in the National Grid.** Rural Energy Master Plan targets the installation of a total of 150 MW of renewable based generation until 2030, as shown in **Figure 3.7**. On Decentralized Grids the locations for project installation have already been selected, subject to more detailed feasibility studies. On the National Grid the possibilities are innumerable for the location of solar, biomass or mini-hydro power plants and even different combinations to achieve the 10% and 19% targets are possible. The Rural Energy Master Plan proposes a tentative distribution without identifying concrete projects or locations. A comprehensive renewable atlas and strategy taking into consideration the levelized cost of electricity of the different options, the technical feasibility and the capacity of the grid to absorb such projects should be completed and a tendering Legislative, Regulatory and Administrative framework defined.

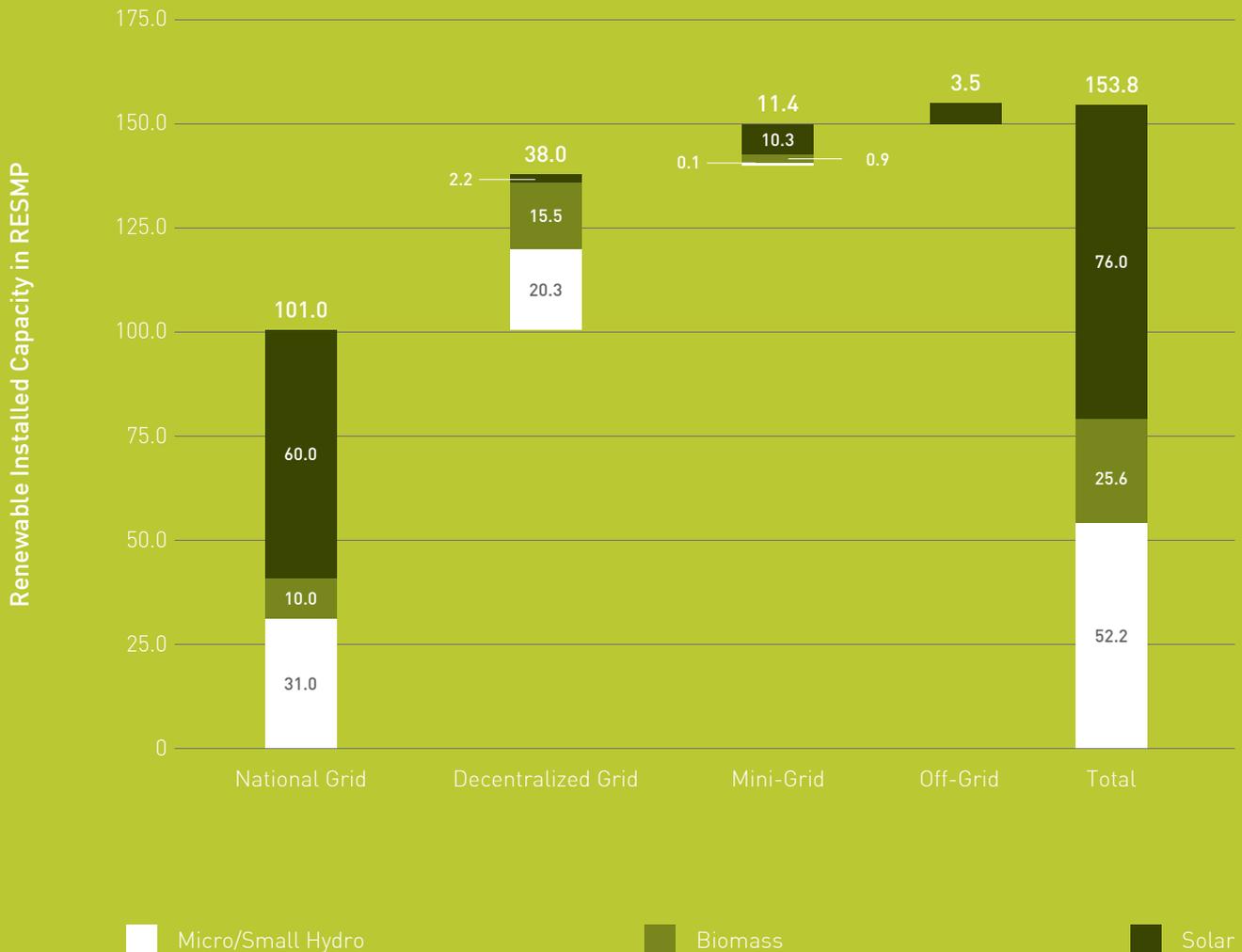


Figure 3.7 – Capacity to be installed until 2030 by type of renewable (excluding large hydro).

# 3.4 ENERGY EFFICIENCY AND COOKING FUELS TARGETS

**Other than power.** Rural Energy is not only about consumption of electricity. It is also about the electricity one does not consume because it makes better options on usage and appliances and also about the thermal energy used for cooking or water heating.

**In line with the Sustainable Energy 4 All initiative, the Sustainable Development Goals and ECOWAS Regional Renewable Energy Policy which establishes clear targets also for cooking fuels, Liberia aims to achieve the following in terms of energy efficiency and cooking fuels:**

- **Universal use of pre-paid meters from 2020 onwards and availability of 1 Amp social tariff to make electricity affordable to the Poor and less wealthy.** Universal access means also affordability which depends not only on the price of electricity but also on the ability to pay and control your consumption. Fixed tariffs without a variable charge do not promote energy efficiency and good use of resources;
- **Total energy losses on rural electricity below 12% by 2030.** Current levels of losses reported by LEC are significant with relevant impact on the economics of the power sector and on investment. Reducing power sector losses also outside of Monrovia will be a key priority;
- **Universal access to efficient lights, TVs, refrigerators and freezers at affordable prices.** Electricity affordability is not only about electricity price. If appliances are inefficient the running cost can be significantly higher and the overall demand will be unnecessarily high. People tend to make decisions on initial price and available budget – not considering many times the total cost;
- **Solar Water Heating suppliers and installers available in every County Capital.** Availability of services and equipment for Solar Water Heating is a key first step for its adoption as high prices of electricity make such technology already least cost;
- **Cooking gas available in all County Capitals and gas stations at affordable prices with at least one reception and storage facility in Liberia.** Incentivizing cooking gas is the most effective way to reduce charcoal consumption and reduce the pressure on deforestation;
- **Universal access to affordable and efficient locally manufactured cook stoves with the target of 250.000 efficient cook stoves sold until 2030.** Efficient cook stoves are already being manufactured in Liberia. Increased adoption should be promoted;
- **Increase the share of efficient charcoal production to 60% by 2020 and 100% by 2030.** In line with ECOWAS Renewable Energy Policy goals.





RURAL ENERGY INVESTMENT  
AND ACTION PLAN

# 4.1 RURAL ENERGY PROGRAM STRUCTURE

**5 Programs for rural electrification of Liberia.** The Master Plan is organized under 5 main programs, sub-divided into 21 initiatives which are then composed of 92 concrete projects and investments, shown in **Figure 4.1**:

**GTG: Growing the National Grid Program.** The Program includes all rural energy investments related with the National Grid, either Distribution, High Voltage transmission (>60 kV) or Renewable generation. It is composed of 4 initiatives and 15 projects.

**DG: Decentralized Grids Program.** The Program includes all “grid based” rural electrification investments in areas to be connected to the national grid only after 2030, such as Large Decentralized Grids, Solar/Diesel transitional mini-grids and generation to supply those grids. It is composed of 4 initiatives and 24 Projects.

**BTG: Beyond the Grid Program.** The Program is dedicated to electrification based on stand-alone individual solutions – mostly outside of the future national grid. It includes the electrification of community services and public buildings where the grid is not expected before 2025, the electrification of future off-grid villages based on Solar Home Systems and the supply and incentive to individual solar lamps. It is composed of 3 initiatives and 9 projects.

**OTP: Other than Power Program.** The Program is dedicated to energy efficiency and access to other sources of energy for cooking or heating. It is composed of 4 initiatives and 12 projects.

**BC: Building Capacity Program.** The Program is dedicated to creating the capacity, the institutional framework, the organization, the information systems and human resources to implement the Master Plan. It is composed of 6 initiatives and 32 projects.

<p><b>I. GTG</b> Growing the National Grid</p>	<p>National Grid extension</p>	<p>4 initiatives</p> <ul style="list-style-type: none"> <li>• 15 Projects</li> </ul>
<p><b>II. DG</b> Decentralized Grids</p>	<p>Solar/Diesel transitional mini-grids, decentralized grids and renewable energy</p>	<p>4 initiatives</p> <ul style="list-style-type: none"> <li>• 24 Projects</li> </ul>
<p><b>III. BTG</b> Beyond the Grid</p>	<p>Small scale off-grid initiatives in non-grid and rural areas</p>	<p>3 initiatives</p> <ul style="list-style-type: none"> <li>• 9 Projects</li> </ul>
<p><b>IV. OTP</b> Other than Power</p>	<p>LPG and efficient cook stove  Energy Efficiency</p>	<p>4 initiatives</p> <ul style="list-style-type: none"> <li>• 12 Projects</li> </ul>
<p><b>V. BC</b> Building Capacity</p>	<p>Building capacity and systems for implementation and operation</p>	<p>6 initiatives</p> <ul style="list-style-type: none"> <li>• 32 Projects</li> </ul>

Figure 4.1 – Outline of the 5 Rural Energy Master Plan Programs.

# 4.2 PROGRAM CALENDAR

**A 3 Phase Approach.** The Program is structured in 3 main phases, as presented in **Figure 4.2:**

- Phase 1 – From now until 2020 with a strong emphasis on the setup of the rural energy master plan and the implementation of ongoing/planned projects;
- Phase 2 – From 2020 to 2025, with acceleration and roll out of the main initiatives;
- Phase 3 – From 2025 to 2030, the consolidation phase when most people will be electrified.

The following maps show the rural energy sector infra-structures already deployed at the end of each phase:

## Phase 1

### Electric System

- HV Substation

### Existing Power Lines (kV)

- 22
- 33
- 66

### Projected Power Lines (kV)

- - - 33
- - - 66
- - - 225

### 2030 Rural Master Plan (kV)

- 22
- 33
- - - 66

### Generation Plants

#### (Connected to National or Large Isolated Grids)

- Hydro Plants
- Biomass / Diesel Hybrid

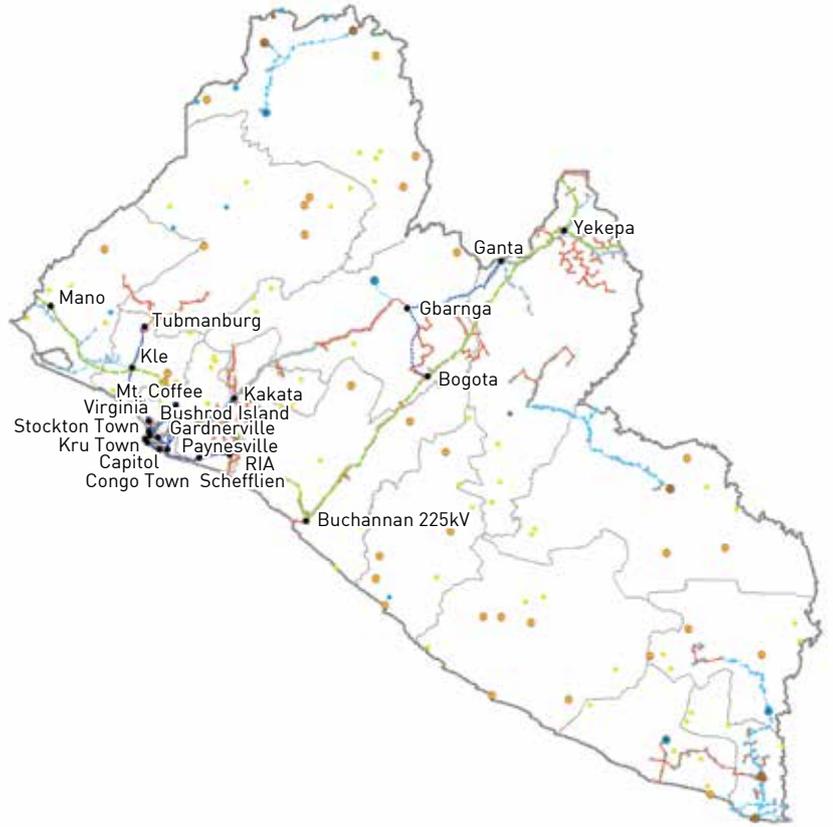
### Electrified Points (Technology)

- On-Grid Settlements
- Large Isolated Grid
- Biomass Micro-System
- Micro-Hydro
- Solar Villages
- Solar / Diesel System



Figure 4.2 – Evolution of Liberia’s Power System – Phases 1, 2 and 3

# Phase 2



# Phase 3

## Electric System

- HV Substation

## Existing Power Lines (kV)

- 22
- 33
- 66

## Projected Power Lines (kV)

- - - 33
- - - 66
- - - 225

## 2030 Rural Master Plan (kV)

- 22
- 33
- - - 66

## Generation Plants

### (Connected to National or Large Isolated Grids)

- Hydro Plants
- Biomass / Diesel Hybrid

## Electrified Points (Technology)

- On-Grid Settlements
- Large Isolated Grid
- Biomass Micro-System
- Micro-Hydro
- Solar Villages
- Solar / Diesel System

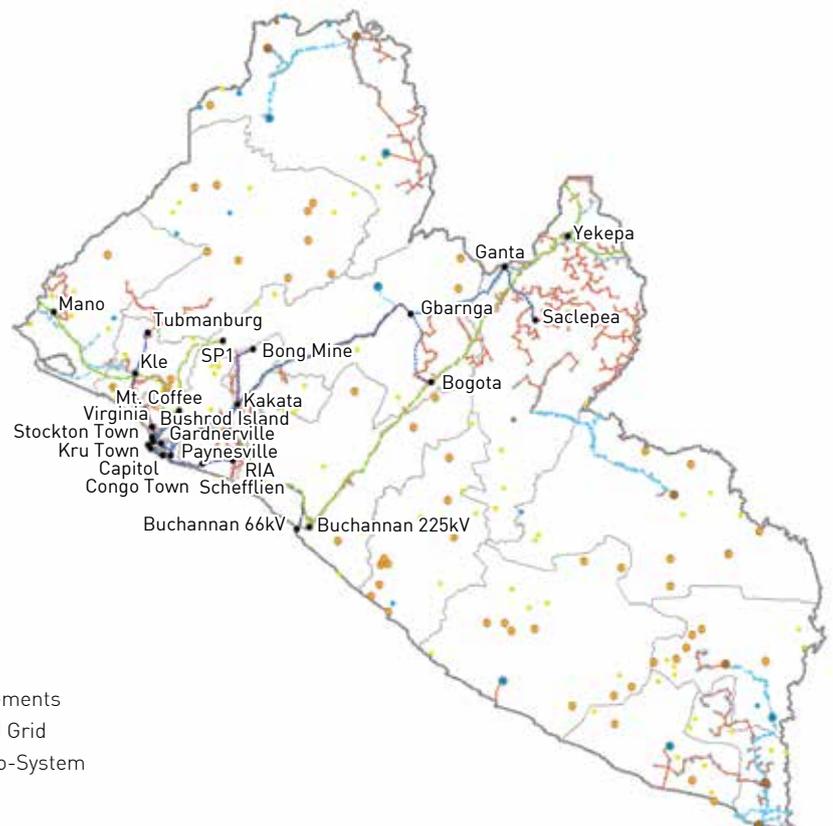


Figure 4.2 – Evolution of Liberia’s Power System – Phases 1, 2 and 3

# 4.3 GROWING THE NATIONAL GRID

## I. GTG

**GTG – Growing the National Grid Program:** The GTG Program represents a total investment of USD 550M and will enable the electrification of 164 000 homes and 830 thousand people and the addition of 100 MW of renewable based generation to the National Grid. The GTG Program investment will occur mostly in Phase 2 and 3 where most clients will be connected. Currently, except for generation, most of Phase 1 is funded with total secured funding estimated to be USD 55M in several on-going projects, notably CLSG related electrification and grid extension around Monrovia.

**The GTG Program is composed of four main initiatives:**

**GTG.1 – Monrovia corridors electrification initiative.** The objective of this Initiative is to promote the extension of Monrovia’s existing network to the West, North and East of the Capital. Six projects are to be implemented regarding the transmission network and major cities electrification, as well as rural distribution, in the three mentioned regions.

**GTG.2 – Gbarnga corridors electrification initiative.** The objective of this Initiative is to promote the extension of the national network from the future substation of Gbarnga, which due to its location presents a strategic point for the future grid expansion. It is located near a proposed future switching station of the CLSG and can allow the extension of the grid to support the densification of distribution in Nimba County and, in the long term, the interconnection of the Lofa and Zwedru Decentralized grids to the National Grid.

**GTG.3 – CLSG electrification initiative.** The objective of this Initiative is to promote the extension of the national network from the future substations of the CLSG system, and from the power line itself, since it is planned for it to be prepared for distribution through its shield wires. Four projects are to be implemented, mainly regarding client connection and rural grid extension in the counties of Nimba, Bong, Grand Bassa and Grand Cape Mount.

**GTG.4 – On-Grid Renewable IPP.** The objective of this Initiative is to launch the procurement of renewable on-grid generation based on solar, biomass or mini-hydro.

**Table 4.1** summarizes the investments and impact per initiative and the estimated level of already secured funding. A map outlining the geo-location of the investments of the GTG Program is presented in **Figure 4.3**.

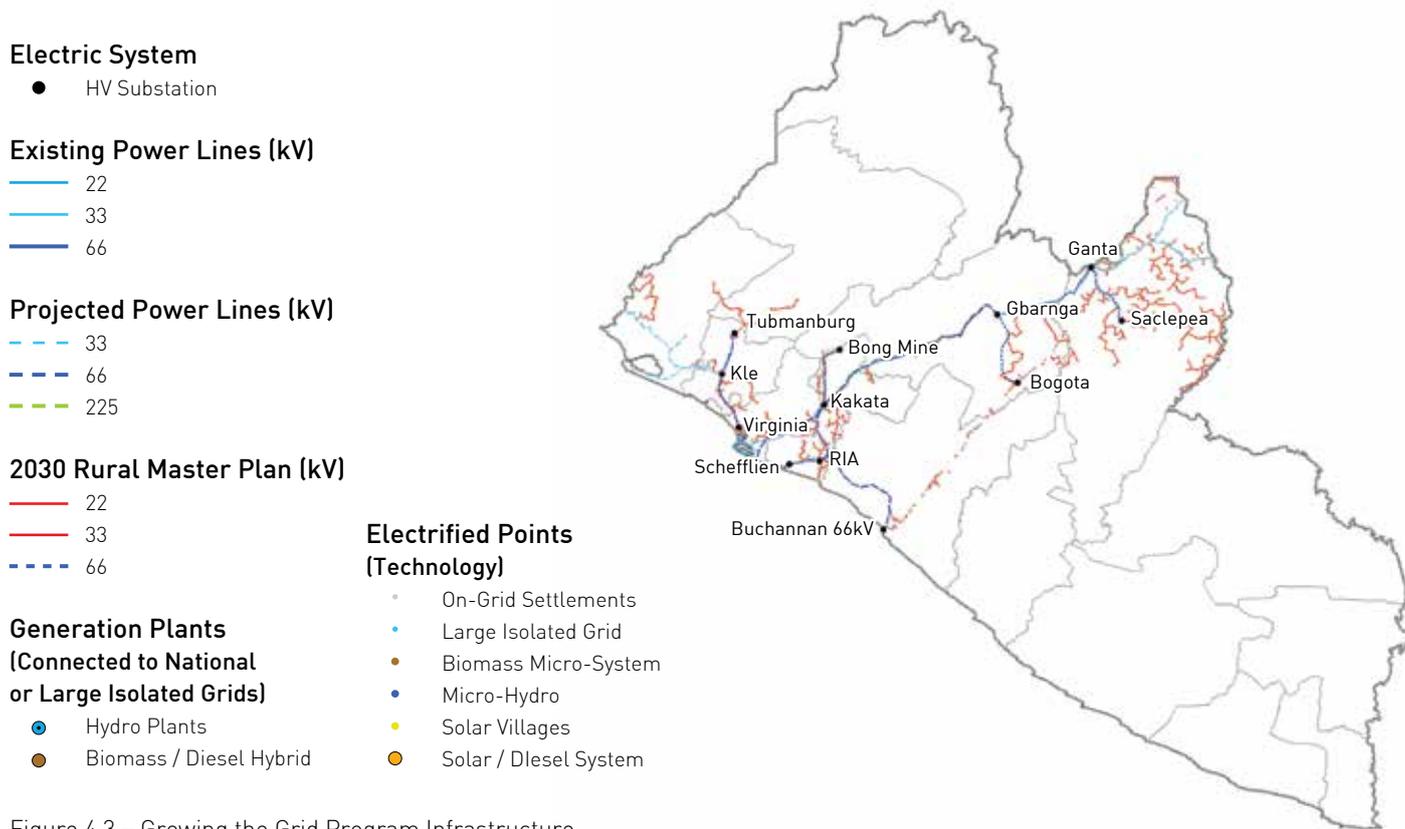


Figure 4.3 – Growing the Grid Program Infrastructure

	Impact		Investments per phase (MUSD)				Estimated funding committed (MUSD)			
	Number of People (Thousands)	MW	Phase 1	Phase 2	Phase 3	Total	Phase 1 Committed	Phase 2 Committed	Phase 3 Committed	Committed funding (estimate)
<b>I. GTG - GROWING THE GRID PROGRAM</b>	<b>831</b>	<b>100</b>	<b>102</b>	<b>220</b>	<b>230</b>	<b>551</b>	<b>55</b>	<b>26</b>	<b>0</b>	<b>81</b>
GTG.1 Monrovia Corridors Electrification	391	0	48	58	51	157	47	16	0	63
GTG.2 Gbarnga Corridors Electrification	212	0	0	31	68	100	0	0	0	0
GTG.3 CLSG Electrification	228	0	7	25	21	52	8	10	0	18
GTG.4 Renewable On-Grid Generation	0	100	47	105	90	242	0	0	0	0

Table 4.1 - Investments and impact of the GTG initiatives

# 4.4 DECENTRALIZED GRIDS

## II. DG

**DG - Decentralized grids program:** The DG Program represents a total investment of USD 292M and will enable the electrification of 96 800 homes and 489 thousand people and the addition of 53 MW of decentralized renewable generation. The DG Program investment is more concentrated in the first phase due to the Solar/Diesel transitional grids which enable the short term electrification of several County Capitals and large cities. Currently, USD 60M are estimated to be funded – mostly dedicated to hydro - with several projects on-going. The investments and impacts for the DG program are presented in Table 4.2Table 4.1, and a map of the DG Program infrastructure is presented in Figure 4.4.

### **Decentralized Grids Program is composed of main initiatives:**

- **DG.1 – Diesel/Solar transitional mini-grids initiative.** The objective of this Initiative is to promote the anticipation of electrification in several large and medium sized settlements, located in areas where the grid coverage is not expected in the short and medium term. In total four main projects are to be executed in all regions of the country. These projects will consist in the implementation of solar/diesel hybrid systems and the electrification of the town's residential and services clients. The distribution grids are to remain in operation when grid coverage is available;
- **DG.2 – Decentralized grids and cross border consolidation initiative.** The objective of this Initiative is to promote the consolidation and extension of the Cross Border grids connected to Cote d'Ivoire, and the creation of Large Decentralized Grids that will have some extent, although not being connected to the national system. In total, eight projected are to be implemented in Regions 1, 2 and 4;
- **DG.3 – Generation for decentralized grid initiatives.** This Initiative relates with the construction of generation projects for energy supply to the previously mentioned Decentralized Grids. In total, this initiative is composed by seven main generation projects to be implemented in different parts of the country;
- **DG.4 - Micro Systems. Biomass and micro-hydro generation.** This Initiative relates with the implementation of micro-generation systems in several communities using hydro and biomass resources, as well as the electrification of those communities. This initiative is composed by five projects to be implemented in Gbarpolu, Grand Cape Mount, Lofa, Nimba, River Cess and River Gee counties.

### Electric System

- HV Substation

### Existing Power Lines (kV)

- 22
- 33
- 66

### Projected Power Lines (kV)

- - - 33
- - - 66
- - - 225

### 2030 Rural Master Plan (kV)

- 22
- 33
- - - 66

### Generation Plants

#### (Connected to National or Large Isolated Grids)

- Hydro Plants
- Biomass / Diesel Hybrid

### Electrified Points (Technology)

- On-Grid Settlements
- Large Isolated Grid
- Biomass Micro-System
- Micro-Hydro
- Solar Villages
- Solar / Diesel System
- CC & MC Solar / Diesel Systems

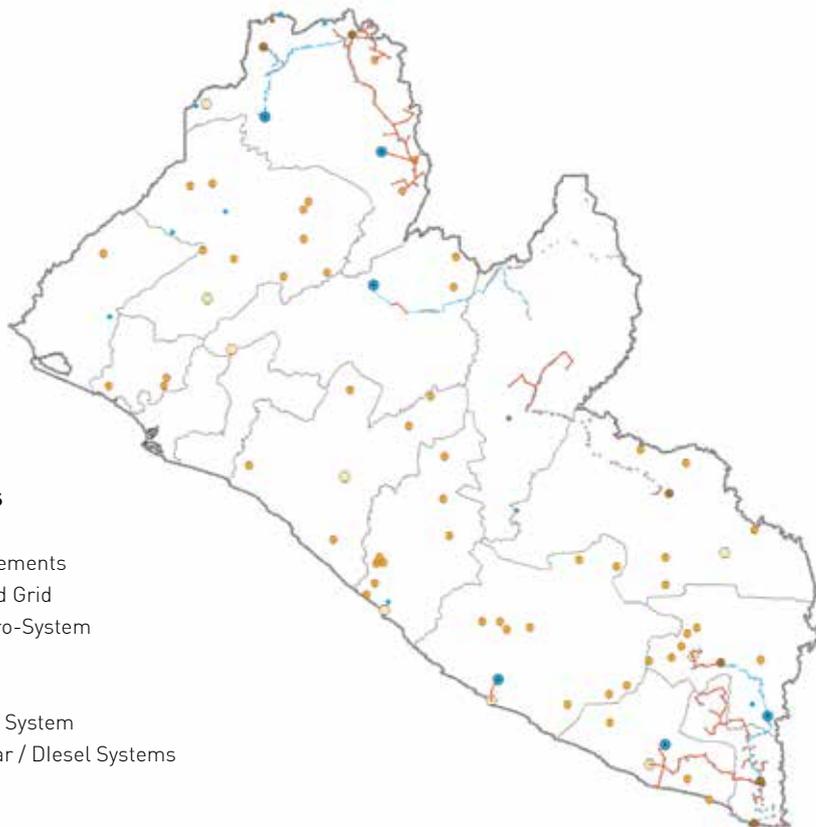


Figure 4.4 – Decentralized Grids Program Infrastructure

	Impact		Investments per phase (MUSD)				Estimated funding committed (MUSD)			
	Number of People (Thousands)	MW	Phase 1	Phase 2	Phase 3	Total	Phase 1 Committed	Phase 2 Committed	Phase 3 Committed	Committed funding (estimate)
<b>II. DG DECENTRALIZED GRIDS PROGRAM</b>	<b>489.1</b>	<b>62.5</b>	<b>117.4</b>	<b>84.8</b>	<b>89.7</b>	<b>291.8</b>	<b>60.0</b>	<b>0.0</b>	<b>0.0</b>	<b>60.0</b>
DG.1 Diesel/Solar Transitional Mini-Grids	101.8	25.1	28.9	11.4	7.5	47.8	2.8	0.0	0	2.8
DG.2 Decentralized grids and Cross Border consolidation	382.1	0.0	34.9	24.3	45.4	<b>104.6</b>	13.1	0.0	0.0	13.1
DG.3 Generation IPP for decentralized grids	0.0	36.8	53.0	41.0	34.9	<b>128.9</b>	43.7	0.0	0.0	43.7
DG.4 Micro-Systems	5.2	0.6	0.5	8.0	1.9	10.5	0.5	0.0	0.0	0.5

Table 4.2 - Investments and impacts of the DG initiatives

# 4.5 BEYOND THE GRID

## III. BTG

**BTG - Beyond the Grid Program:** The BTG Program represents a total investment of USD 16M and will enable the electrification of 3 600 homes and 19 000 people and the addition of 2.2 MW of decentralized renewable generation. The BTG Program investment is mostly dedicated to the first phase where most of the electrification of health clinics around the country will occur. Currently no funding is committed to any of the 9 Projects of the Program. The investments and impacts for the DG program are presented in **Table 4.3**, and a map of the DG Program infrastructure is presented in **Figure 4.5**.

**Beyond the Grid Program has three main initiatives:**

- **BTG.1 – Solar Villages & Home Systems initiative.** This initiative is associated with the creation of solar villages throughout the Country. These systems are intended for communities that, due to its small size (and consequently reduced consumption levels) and high distance to electric grids, are not viable for grid connection in the long term. Until 2030, five communities in each County will be connected with these systems, totaling 75 solar systems nationwide.
- **BTG.2 – Solar Community Services initiative.** This initiative consist in implementing solar systems in non-electrified important community services, related with Health, Security and Education – Hospitals, health centers and clinics, police stations and courthouses and secondary schools. This initiative is composed by three projects, phased through the years. In the first phase, all health facilities will benefit, and the anticipation of all services that will be electrified only between 2025 and 2030 by the national grid will also be implemented. In the second phase and third phase solar community services will gradually be implemented in facilities that are not expected to be electrified by the national grid before 2030.
- **BTG.3 – Solar Portable Lamps initiative.** This initiative consists on the continuation and reinforcement of the existing Solar Portable Lamp initiative through the creation of the Rural Services Unit(s) who will manage the imports while RREA will maintain responsibility for procurement and for communication/information campaign. Additionally, a tender to attract the best rental model operators to Liberia will also be launched. This initiative is composed of 2 projects.

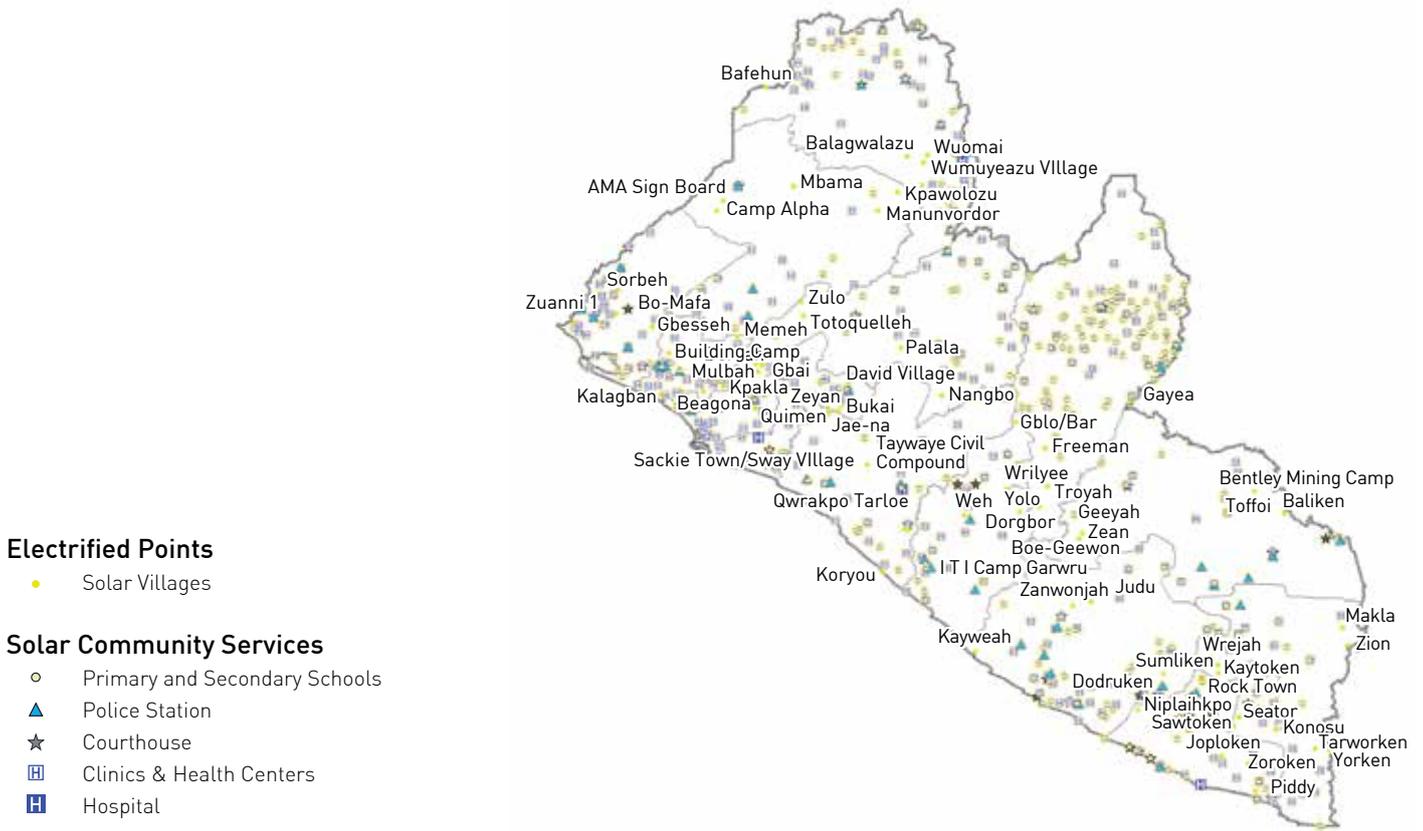


Figure 4.5 – Beyond the Grid Program impacted locations

	Impact		Investments per phase (MUSD)				Estimated funding committed (MUSD)			
	Number of People (Thousands)	MW	Phase 1	Phase 2	Phase 3	Total	Phase 1 Committed	Phase 2 Committed	Phase 3 Committed	Committed funding (estimate)
<b>III. BTG - BEYOND THE GRID PROGRAM</b>	<b>18.9</b>	<b>3.5</b>	<b>8.1</b>	<b>4.7</b>	<b>3.2</b>	<b>16.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>
BTG.1 Solar Villages & Home Systems	18.9	2.2	3.4	2.1	0.9	6.5	0.0	0.0	0.0	0.0
BTG.2 Solar Community Services	0.0	1.3	2.8	0.7	0.5	4.0	0.0	0.0	0.0	0.0
BTG.3 Solar Portable Lamps	0.0	0.0	1.8	1.8	1.8	5.5	0.0	0.0	0.0	0.0

Table 4.3 - Investments and impact of the GTG initiatives

# 4.6 OTHER THAN POWER

## IV. OTP

**OTP: Other than Power Program:** The OTP Program represents a total investment of USD 24M and will enable the installation of pre-paid meters in all rural electricity clients and promote the use of energy efficient appliances, of cooking gas and efficient cook stoves across Liberia. The OTP Program has significant setup investments in the first phase, but on prepaid meters grows with the number of electrified clients being also significant in Phase 3. The Program has no funding committed at the present stage, as shown in **Table 4.4**.

**Other than Power Program is composed of 4 main initiatives:**

- **OTP.1 – Efficient Light & Appliances initiative.** This initiative intends to reduce the acquisition of inefficient appliances and lamps in Liberia, thus making power consumption more affordable to people living in rural areas. It includes the creation of a rating system and brand for energy efficient appliances and lamps which will be required to obtain import tax exemptions, thus making the more efficient appliances and lamps more competitive. The tax will be adjusted to avoid reduction in tax income. The initiative includes also the creation of service centers across the country to support installation of Solar Water Heating systems.
- **OTP.2 – Prepaid meters and power loss reduction initiative.** This initiative intends to enable the universal use of prepaid meters in Liberia with a similar tariff structure across the country and to deploy the metering infra-structure that allows for a clear identification of where power losses are generated. Given the potential for multiple companies acting in the distribution area, this initiative will allow for a centralized management of the prepaid metering system and support the creation of an adequate georeferenced information system.
- **OTP.3 – City cooking gas initiative.** This initiative intends to make cooking gas bottles available in the main cities of the country and increase competition in retail through an obligation to petrol sellers to sell cooking gas in their stations. Additionally, to increase competition and access to LPG import, storage and filling infrastructure, a new facility will be built initially by LPRC but with the intention to be privatized and owned also by petrol sellers and other private entities.
- **OTP.4 – Efficient biomass for cooking initiative.** This initiative intends to increase efficiency in the utilization of biomass for cooking in order to reduce deforestation and energy costs for consumers. It includes support to improvements on existing efficient cook stove manufacturing and marketing activity, including the organization of multiple trial sessions where potential consumers in a community are given training and borrowed a cook stove for trial and possible future acquisition. Additionally, it includes also a Project dedicated to branding and certification of efficient charcoal production.

	Impact		Investments per phase (MUSD)				Estimated funding committed (MUSD)			
	Number of People (Thousands)	MW	Phase 1	Phase 2	Phase 3	Total	Phase 1 Committed	Phase 2 Committed	Phase 3 Committed	Committed funding (estimate)
<b>IV. OTP - OTHER THAN POWER</b>	<b>0.0</b>	<b>0.0</b>	<b>10.3</b>	<b>5.8</b>	<b>8.2</b>	<b>24.3</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>
OTP.1 Efficient Light & Appliances	0.0	0.0	0.8	0.2	0.2	1.2	0.0	0.0	0.0	0.0
OTP.2 Prepaid meters & loss reduction	0.0	0.0	5.5	3.8	6.2	15.4	0.0	0.0	0.0	0.0
OTP.3 City cooking gas	0.0	0.0	3.0	1.0	1.0	5.0	0.0	0.0	0.0	0.0
OTP.4 Efficient cooking biomass	0.0	0.0	1.1	0.9	0.9	2.8	0.0	0.0	0.0	0.0

Table 4.4 - Investments and impact of the OTP initiatives

# 4.7 BUILDING CAPACITY

## V. BC

**BC: Building capacity:** The BC Program is transversal to all the other four and supports the implementation and impact of all the other programs. The total estimated investment of the BC Program is USD 52M, shown in **Table 4.5**.

**Building Capacity Program is composed of 6 main initiatives:**

- **BC.1 – Public sector scale up initiative.** This initiative intends to strengthen the internal capacity of key public sector entities dedicated to rural energy. RREA will have a key role and its organizational structure and competencies need to be adjusted to the challenges of the Master Plan and a training and capacity building plan needs to be designed. The initiative includes funding for the creation of several new units inside RREA, MLME and LERC for the management of the Rural Energy Master Plan Programs and initiatives. Additionally, the initiative includes also the creation of a Rural Energy Management Information System (MIS) which will support monitoring and reporting of the progress of the Master Plan.
- **BC.2 – Owners engineering and procurement initiative.** This initiative intends to bring external qualified support to the deployment of the key projects and investments led by the public sector with grant or concessional loan funding. “Owners engineering” contracts are to be celebrated for most of the investments to be deployed including design of technical specifications, management of procurement process and supervision of construction. This initiative also includes the support to setup and manage the renewable IPP procurement program and the “affermage” contracts to be celebrated for management of distribution activities in Decentralized Grids – with deficit expected mostly in phase 1.
- **BC.3 – Sector reorganization initiative.** This initiative intends to support the creation of the new institutional framework. It includes creation of laws and regulations, the support and operational budget for the Rural Services Unit(s), all activities regarding the setup of the Regional Distribution Companies and the restructuring of LEC to separate the Distribution activities from the Transmission and Power sourcing.
- **BC.4 – Rural Energy Training and accreditation Centers initiative.** This initiative intends to create four Rural Energy Training and Accreditation Centers for Rural Energy, one in each of the country’s regions, who will train and/or accredit electricians, mechanics and other technicians required for the operation of the future rural energy infra-structure. The Centers will be created in existing educational entities and will correspond to a New Department of such entities. A scholarship program to incentivize the enrollment of women will be created.

- **BC.5 – REFUND initiative.** This initiative intends to start the operationalization of the Rural Energy Fund with concrete projects and measures. It includes the creation of stable sources of revenue - the Power and Petrol Contribution (PPC) and the Lease Fee (LF) – and the creation of several credit lines to be made available by local banks to retailers: for acquisition of efficient appliances; to Distribution Companies: for grid connection and house electrification (to be recuperated from clients on a monthly basis) and/or for other growth investments; to new companies and business models such as Solar Portable Lamp rental or efficient cook stove manufacturing. Additionally, the use of REFUND to support renewable off-taking together with Partial Risk Guarantee schemes will be studied.
- **BC.6 – Communication initiative.** This initiative includes the communication on the implementation of the Rural Energy Master Plan to key stakeholders, the communication to the general public on areas that require more awareness such as Solar Portable Lamps, efficient cooking or appliances, and finally the communication to potential donors for fund raising.

	Impact		Investments per phase (MUSD)				Estimated funding committed (MUSD)			
	Number of People (Thousands)	MW	Phase 1	Phase 2	Phase 3	Total	Phase 1 Committed	Phase 2 Committed	Phase 3 Committed	Committed funding (estimate)
<b>V. BC - BUILDING CAPACITY</b>	<b>0.0</b>	<b>0.0</b>	<b>24.2</b>	<b>14.2</b>	<b>13.6</b>	<b>51.9</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>
BC.1 Public sector scale up	0.0	0.0	1.4	0.9	0.9	3.2	0.0	0.0	0.0	0.0
BC.2 Owners engineering & procurement	0.0	0.0	14.9	8.4	7.8	31.1	0.0	0.0	0.0	0.0
BC.3 Sector reorganization	0.0	0.0	3.5	1.0	1.0	5.5	0.0	0.0	0.0	0.0
BC.4 Rural Energy Training and Accreditation Centers	0.0	0.0	1.2	1.2	1.2	3.5	0.0	0.0	0.0	0.0
BC.5 REFUND	0.0	0.0	2.7	2.3	2.3	7.2	0.0	0.0	0.0	0.0
BC.6 Communication	0.0	0.0	0.7	0.5	0.5	1.6	0.0	0.0	0.0	0.0

Table 4.5 - Investments and impact of the BC initiatives





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FUNDING REQUIREMENTS  
AND STRATEGY

5

# 5.1 FUNDING GAP, SOURCES AND CONSTRAINS

**USD 935M investments for rural electrification.** The graph in **Figure 5.1** shows a summary of the Rural Energy Master Plan investments per Program and type of investment (Generation, High Voltage Transmission, Distribution and other). The GTG and DG Programs represent around 90% of the total investment with significant investments both in generation and distribution. GTG Program by itself represents more than 50% of the Rural Energy Master Plan investments.

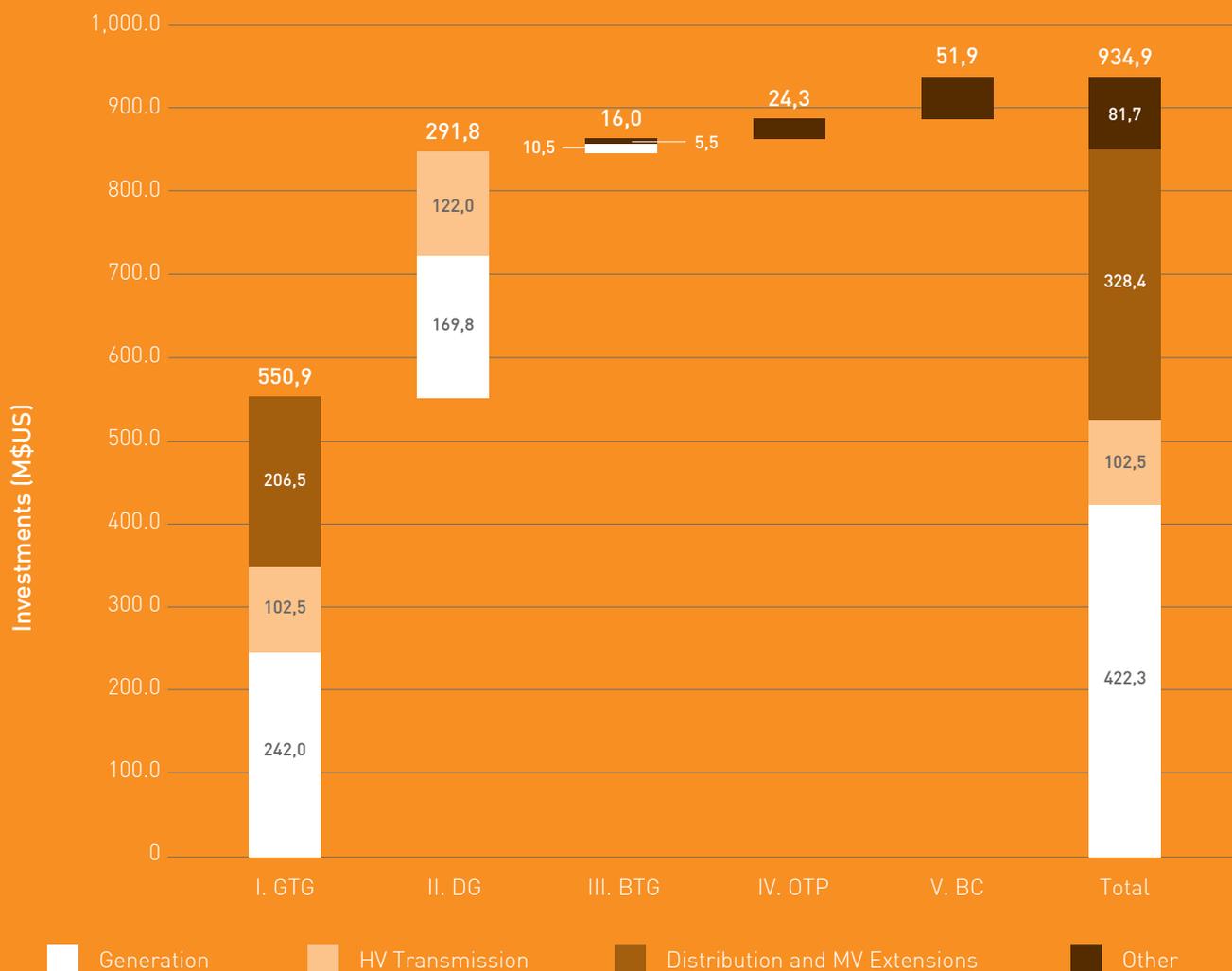


Figure 5.1 – Investment per Program.

**USD 749M still to be funded mostly for the period between 2020 and 2030, as shown in Figure 5 .2.** From the required USD 935M, around USD 140M are already committed and an additional USD 45M secured and not yet allocated, representing a total of USD 185M – mostly from African Development Bank, World Bank and European Union. Most of the secured funding will be deployed in the first phase, representing a significant part of the estimated investment of USD 262M. A gap of USD 746M remains to implement the Rural Energy Master Plan with additional USD 102M being required until 2020, USD 303M between 2020 and 2025 and USD 344M until 2030.



Figure 5.2 – Investment per Phase and Funding gap.



# 5.2 TAX POLICY AND GOVERNMENT INCENTIVES

**Investment incentive code.** Liberia has a liberal business climate intended to attract foreign investment and stimulate economic growth and development. Incentives granted under the Investment Incentive Code include exemption from custom duties, income tax, stamp fees and other benefits to new and expanding businesses, and for approved investment projects in manufacturing, agriculture, forestry, fishing, mining, building and construction, transport and communication. Approved investment projects may also be eligible for support in securing loans and guaranteeing credit by the Central Bank.

- Exemptions from Trade Taxes:
  - > Machinery, equipment, raw materials, semi-finished products and other supplies to be used in a project are exempt from import duty up to 90% of their dutiable value; and
  - > Manufactured goods exported from the production of the project are entitled to full rebate on import duties and full refund of both income tax and excise tax.
- Exemptions from Income Tax:
  - > Reinvested profits are exempt from income tax.
  - > Profits not reinvested are exempt from 50% of the income tax otherwise payable.
- Other benefits:
  - > Approved investment projects may receive certain additional benefits on application to the government, such as the lease of land in government-owned industrial parks at a preferential rate, reasonable tariff protection, purchase of project products by government agencies, etc.

**Tax regime for energy.** Currently the application of existing exemptions to energy is not clear. Applicable taxes can reach 25% (e.g. in the case of Solar Portable Lamps) and may further increase the already significant investment identified above – which did not include tax. A tax regime for rural electrification and renewable energy investments will be developed to limit import duties and Goods and Services Tax (GST) impact on the total investment and funding required. The future regime will also include tax exemptions for private sector investment on energy in order to incentivize private and commercial funding.

# 5.3 FUNDING STRATEGY

**Exploring all potential sources of funding.** Given the high amount of funding still required, the Rural Energy Master Plan shall explore all possible funding sources, giving always priority to those that generate smaller yearly costs (with lower interest rates and higher maturities).

## Country related funding

**Development Assistance.** Although Liberia is sometimes seen as a very high ODA recipient country on a GDP basis (the first in Sub-Saharan Africa) such fact derives not so much from the level of ODA received but from the very low income of the country – due to one of the most severe and long-lasting civil wars in Africa and, most recently, due to the Ebola outbreak. Considering ODA total value, on average between 2006 and 2014, Liberia was only the 22nd Sub-Saharan African country in terms of ODA received, as seen in **Figure 5.3**.

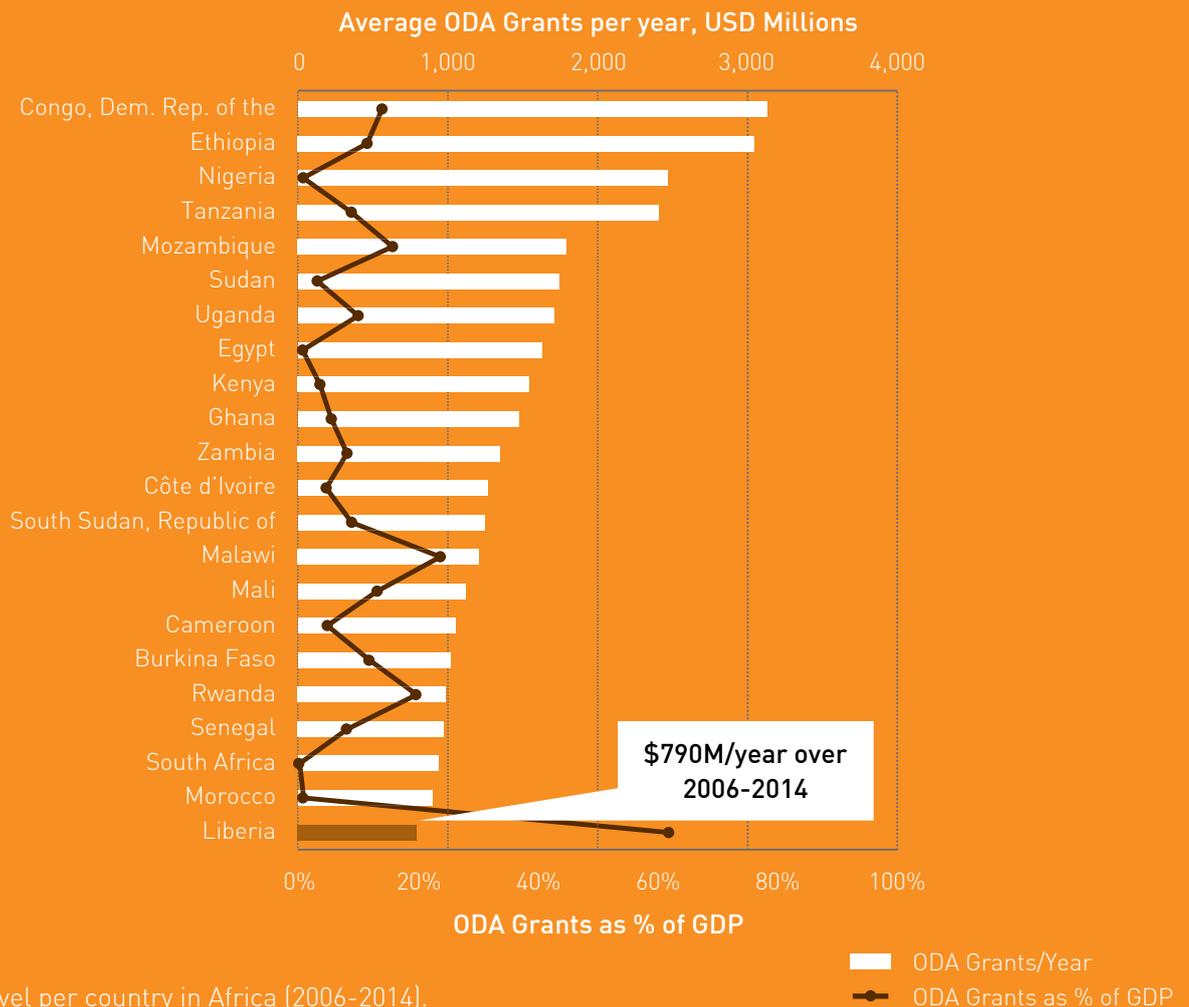


Figure 5.3 – ODA level per country in Africa (2006-2014).

**Maintaining energy sector as ODA priority may generate funding in excess of USD 474M.** ODA has been and is expected to continue being the main source of funding for the needed infra-structure on roads, energy and communications. ODA statistics show that Liberia allocated on average 10.5% of its total ODA received between 2006 and 2013 to the energy sector, much above West African countries average of 3.3%. Considering an intermediate allocation of future ODA to energy (6.9%) and a more balanced allocation of funding to rural energy vs. Monrovia electrification after 2020, ODA funding for rural energy could reach USD 474M until 2030. It could even be higher if priority to energy and rural areas is also higher.

**Concessional loans with limited funding potential.** While Liberia received on average 60% of its GDP as ODA every year since 2006, its total cumulated debt is currently around 41% of GDP – meaning that the total debt incurred over the last years is only a portion of the average ODA received each year and that additional debt will be dependent on GDP growth. If we consider IMF policy and limitations on Heavily Indebted Poor Countries (HIPC) and similar criteria to grants on the allocation of country available concessional loans between sectors and, for energy, between rural and Monrovia electrification, the estimated funding potential of concessional loans would be only USD 75M.

**A compelling case for Grant and Concessional funding.** The Master Plan benefits from a strong initial focus on the electrification of the main cities and towns outside Monrovia (65% of all rural clients in 2030) where there is business activity and some capacity to pay for energy services. The support studies show that if initial investments have a strong component of grants and if consumers are charged for what they consume based on pre-paid meters and reasonable tariffs, it is possible to create a financially sustainable system that can maintain the assets, pay for running costs and fund a part of the growth investments... potentially leveraging on a robust Rural Energy Fund to mitigate risks and reduce interests.

## **Project related funding**

**Free Cash Flow analysis.** Figure 5.4 shows a simulation of the rural energy sector cash flows on an intermediate year (half of 2030). The potential power sector revenues have been estimated considering demand and an electricity price, inclusive of GST, of 0.35 USD/kWh. The revenues are discounted of the operational expenditures (OPEX) associated with generation, transmission and distribution of power consumed and lost. On an intermediate year the Power Sector could generate USD 50M of Free Cash Flow. However, with commercial loans and private sector equity required returns such Free Cash Flow would only allow for the repayment of approximately one third of the USD 935M required. This means running costs can be paid by the Power Sector at reasonable prices and some funding could be raised by the Sector, but majority of energy infra-structure investment or CAPEX in rural Liberia needs a significant level of Grants and external support.

**USD 303M Funding potential mostly on the National Grid.** The Free Cash Flow Analysis also shows that around 85% of the Free Cash Flow generated would come from the National Grid where generation cost is lower due to regional imports and large scale hydro investments. This offers the potential to have On-grid Renewables and part of the National Grid Distribution investments around Monrovia and the Growth Corridor funded by Development Finance Institutions together with Regional Distribution Companies or Independent Power Producers. An estimated funding of USD 303M could be raised coming from DFI (USD 232M) and Private Sector (USD 71M).

**Tariff structure.** Demand can have a relevant impact on Free Cash Flow if tariff structure is based only on average costs. Generation units have different marginal costs. As tariffs go below the price of diesel most of the self-generated consumption in National Grid is expected to connect into the grid creating a sudden increase in demand that will require response from expensive backup generation or result in blackouts. The same phenomena tends to happen in smaller Solar/Diesel mini-grids where consumption growth requires more diesel and the response tends to be the reduction in the number of hours of service. Power sector sustainability requires a progressive tariff structure that increases to marginal cost as consumption approaches the available generation capacity.

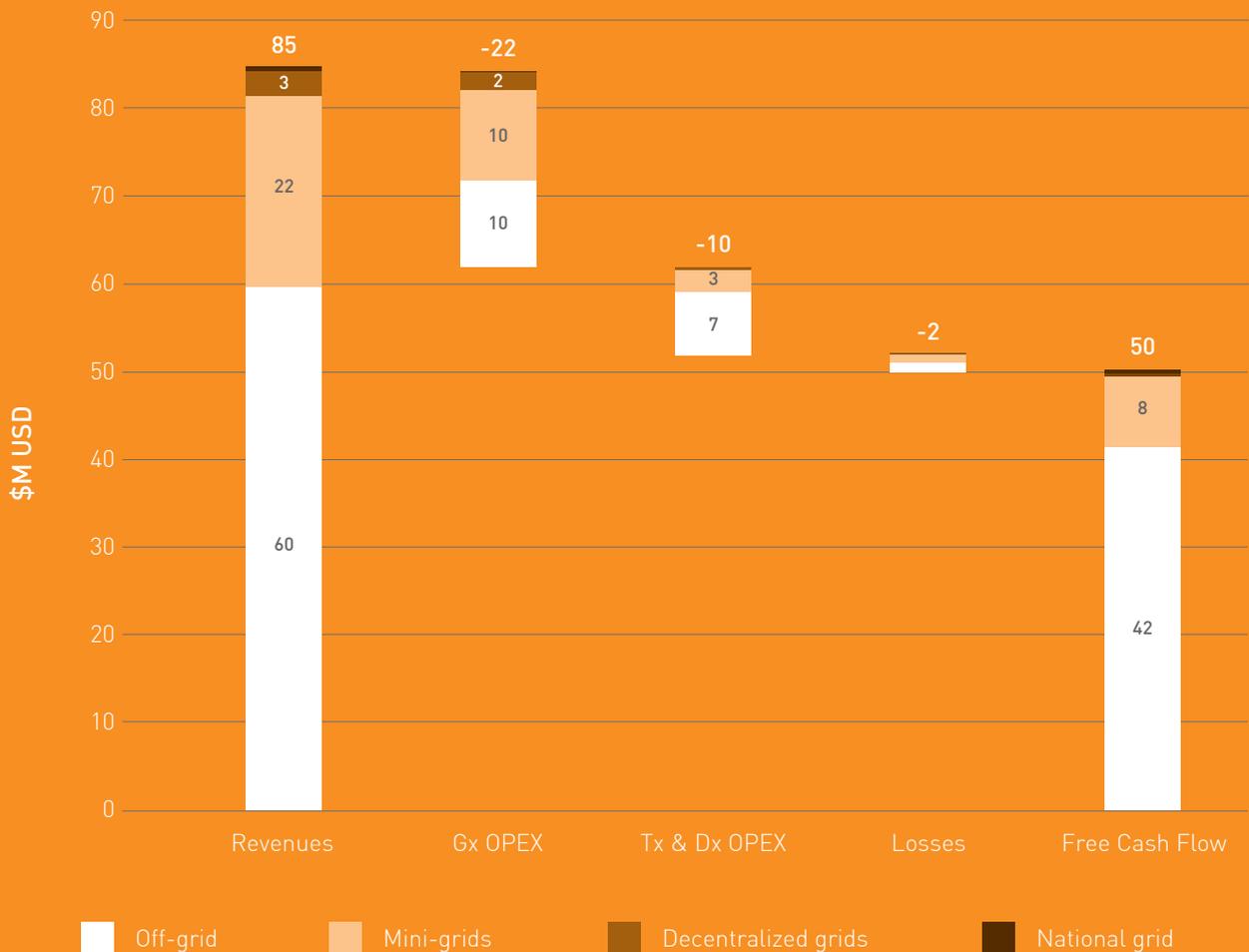


Figure 5.4 – Estimated Rural Energy Sector total Free Cash Flow in intermediate year (half of 2030).

## Funding sources summary and other funding

**Funding summary.** The following graph in **Figure 5.5** summarizes the potential of the different sources of funding towards the required USD 935M investment (around USD 60M/year). Grants and ODA funding will be the key source of funding. On-Grid renewables and part of the National Grid investments will be funded mostly by DFI – representing the second largest contribution to funding the Master Plan. Concessional loans and commercial lending or equity will have a smaller but still relevant role.

**Need for other funding.** An additional USD 83M funding is required to reach the USD 935M. The Master Plan proposes the creation of a Power and Petrol Contribution and of Lease Fees that can be directed to REFUND and leveraged with financial institutions to obtain the missing USD 83M.

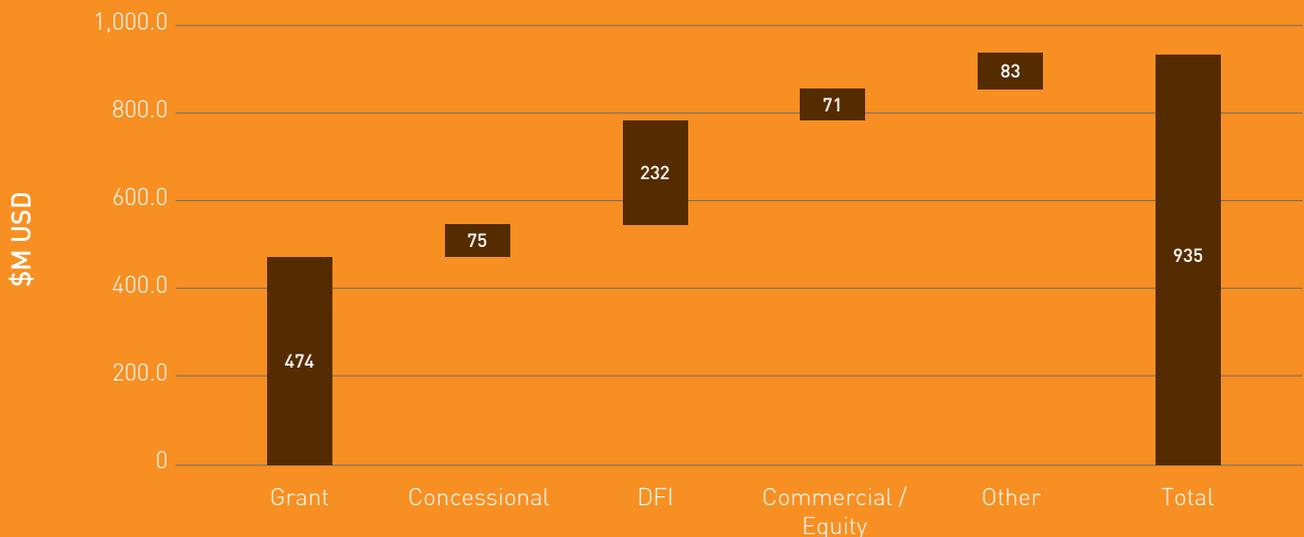


Figure 5.5 – Funding strategy summary.

# 5.4 REFUND

**Objective of the Fund.** As per the Act that created the Rural Energy Fund, its objective is to provide for the coordinated and sustainable financing of projects and programs for the development of rural and/or renewable energy projects and delivery of modern energy services for rural development in a manner such that the Fund becomes a channel through which domestic and international financial resources intended for rural and renewable energy delivery in Liberia shall be managed.

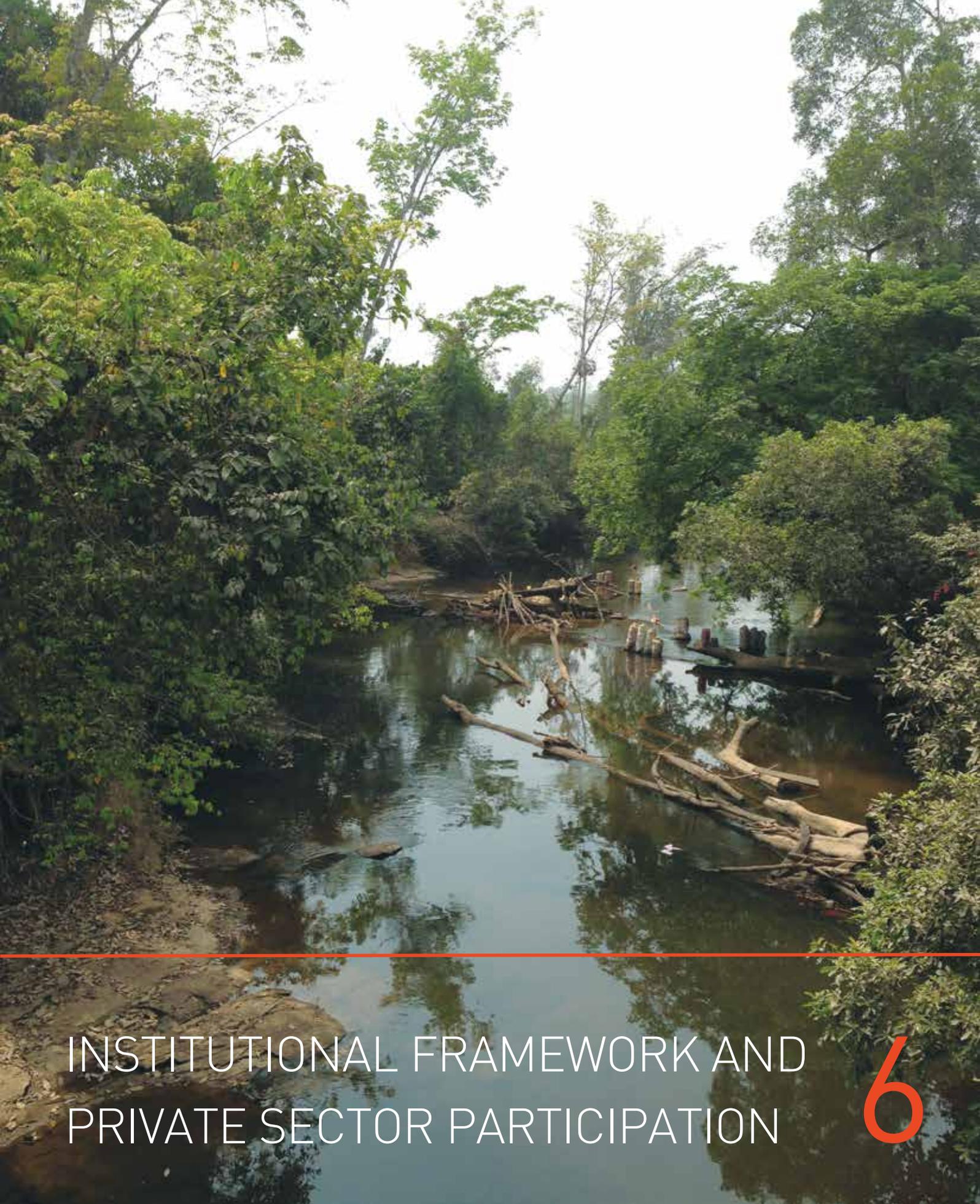
**Financial management and asset ownership.** REFUND is not a single bank account into which funds are paid and disbursed. It is a financial management system for channeling various sources of funding in a coordinated manner. Additionally, given the important role of grant based funding and the fact that many donors can only fund public held assets, it will be necessary for REFUND to own part of the assets and lease them to private Distribution Companies.

**Transparency, accountability and use of funds.** Transparency and accountability is critical for donors. Also most donors want and need to decide on which investments their contribution will be applied to. As currently the resources of REFUND can be used to pay operational costs and remunerations many donors prefer to manage their grants independently. Towards the future, REFUND shall allow donors to direct their contributions to separate accounts directly linked and only used in specific projects. Also, operational costs shall be paid only by Sector generated revenues and not by Donor contributions.

**REFUND revenues.** REFUND operationalization requires the creation of stable sources of revenue. The Power and Petrol Contribution to REFUND will be created. The PPC consists of a small levy (initially 1% of final price) charged to electricity generators and diesel/gasoline wholesalers. Additionally, REFUND will charge a Lease Fee to Regional Distribution Companies for the assets owned by REFUND and managed by the Regional Distribution Companies. The Lease Fee – to be agreed with LERC - will depend on the calculated tariff level and on the results of revenue collection, mitigating demand risk and reducing tariff differences among Distribution areas.

**Credit lines with local banks and Partial Risk Guarantee.** REFUND will promote the creation of several credit lines to be made available by local banks to promote acquisition of efficient appliances, financing of grid connections, household internal wiring or other grid growth investments as well as innovative business models and activities. REFUND will reduce risk and will only be used as a guarantee mechanism to support 50% of the eventual defaults.

**Risk mitigation for renewable off-taking.** The use of REFUND as a means of risk mitigation for renewable off-taking will be explored either through the creation of ESCROW accounts to secure payments or as an interface for Partial Risk Guarantee schemes with multilateral organizations.



INSTITUTIONAL FRAMEWORK AND  
PRIVATE SECTOR PARTICIPATION

# 6.1 STRUCTURE AND ROLES

**Need for an adequate institutional framework.** An effective and successful implementation of the Rural Energy Master Plan requires not only adequate funding, but also competent and well aligned entities with clear roles for implementation, both on the public and private sectors.

**2015 Electricity law of Liberia.** The Senate and House of Representatives of the Republic of Liberia approved in October 2015 a bill entitled 2015 Electricity Law of Liberia. The new electricity law sets the guiding principles for the power sector organization and gives some guidance on the roles of the different entities without too much detail. The Law offers sufficient flexibility for different institutional approaches regarding rural energy. The Master Plan study evaluated different alternatives, all with pros and cons, and proposes the ones with the potential to be more effective.

**Power sector structure.** Although now-a-days all power sector activities are provided by Liberia Electricity Corporation, the new Electricity Law structures the power sector in the following different activities which all – except system operation - can now be licensed to the private sector:

- Generation;
- Transmission;
- Transmission system operation;
- Distribution;
- Import and export of electricity;
- Trading of electricity.

**Micro-utilities.** Micro utilities or operations, such as “Community Current” – common business in Liberia where an entrepreneur operates and distributes power from a small diesel generator – can be exempted from licensing.

**LEC.** LEC is the State owned Utility which by law continues to be the transmission system operator and the national grid company and is entitled to engage in all other activities at its election. As transmission system operator LEC has to guarantee an instantaneous balance at any given time between the total generation and the total consumption of power taking account of the power exchanges with interconnected foreign systems. The role and scope of the “National Grid Company” is not clearly defined in the Law.

**Ministry of Lands, Mines and Energy.** Ministry is responsible for the formulation and development of national energy policies and the administration of the Law.

**Liberia Electricity Regulatory Commission.** LERC is the newly created regulatory agency in charge of licensing activities, issuing regulations to implement the electricity law, approving tariff setting methodologies and to establish, monitor and enforce technical, performance and security regulations and standards.

**Rural and Renewable Energy Agency.** RREA is an autonomous agency owned by the Government of Liberia with the objective of acting for and on behalf of the Government to promote energy access in rural areas with an emphasis on locally available renewable resources.

# 6.2 ALTERNATIVE MODELS AND PROPOSED POWER SECTOR ORGANIZATION

**Alternative models for Distribution.** Distribution is by Law a licensed activity that can be executed by different companies. Different models for the long term functioning of the Distribution activity were considered:

- **LEC as the National Grid Distribution Company,** with transitional grids being managed by Local Companies transitorily until they are connected to the National Grid and transferred to LEC.
- **Regional Distribution Companies.** Country being divided into regions with each region awarded to a different regional distribution company. Regional Distribution Companies may operate on decentralized grids or on the National Grid.
- **Local Distribution Companies or Cooperatives.** Transitional grids managed by multiple small Local Companies that would remain as independent Distribution Companies even after connected to the National Grid.

**Regional Distribution Companies.** The Regional Distribution Companies model was selected as it allows for a stronger private sector involvement in the future with a scale that can attract robust private sector companies. LEC model would maintain the more centralized public sector status quo, previous to the new legislation, with a high risk of continued lack of focus on the rural areas and difficulty to implement such a large investment program. The Cooperative model would represent a risk of too many under-capitalized and under-staffed distribution companies without scale or capacity to adequately respond to the challenge of implementing the Master Plan.

**Model for Transmission and System Operation: “The National Grid Company or Unit”.** The Rural Energy Master Plan does not propose any High Voltage Transmission (>60 kV) investment outside the National Grid. The Electricity Law mandates LEC as the “National Grid Company” and transmission system operator. Therefore, all Transmission in the National Grid – except for CLSG which is owned and operated by TRANSCO CLSG - should be operated by LEC. The Medium Voltage infra-structure will be operated by Regional Distribution Companies and LEC will transfer electricity to Distribution Companies in the future Sub-stations that transform energy from High Voltage to Medium Voltage. Conflict of interest coming from LEC being also a Distribution operator recommends that the Transmission and System Operation be set up as an autonomous unit or even company inside LEC – the National Grid Company or Unit.

**Alternative models for wholesale activities of trading and import/export.** Electricity trading and import/export of electricity are licensed activities under the new Law and normal activities in developed power markets where generation unit dispatch is decided primarily by the market – meaning arrangements between generators and suppliers or clients. However, the Electricity Law awards the responsibility to dispatch generation units connected to transmission to the Transmission System Operator. Several alternative models are possible:

- **Unique Buyer.** Each Grid has a unique Buyer, responsible to procure, dispatch generation in its grid, guarantee all imports and exports and to sell to Distribution at a regulated price. Model can be applied only to National Grid or also to Decentralized Grids.
- **Regulated or Last Resource Buyer.** A regulated entity is in charge of off-taking renewable Independent Power Producers, and highly subsidized sources of generation in the Grid and resell them to Distribution Companies at a regulated price. However, Distribution Companies are allowed, under certain limits established by LERC, to procure part of their power either in Liberia or West African Power Pool (WAPP).
- **Multiple Buyers or free market.** Each Distribution Company is free to procure its electricity in Liberia or in the West African Power Pool. Each generation unit is free to sell its electricity. Transmission System Operator manages dispatch after receiving information on bilateral agreements.

**Regulated Buyer model.** The Regulated Buyer model was selected as it offers security for Renewable Independent Power Producers favoring investment, it allows to share the benefits of grants on generation among Distribution Companies and large industrial clients and it mitigates price differences across the country while offering opportunities to progressively start a more competitive market approach. The Unique Buyer model limits private participation dynamics and the Free Market model brings in the current stage of the Liberian Power Sector too much risk to investors in Generation and Distribution.

**The National Grid Company or Unit will be the Regulated Buyer in the National Grid.** In each Decentralized Grids – until it is connected to the National Grid – a Regional Distribution Company will be awarded the role of Regulated Buyer.

**Model for Generation.** Each and all generation units will act under the Independent Power Producer model with a Power Purchase Agreement to be celebrated, after approval of LERC, with either a Regulated Buyer, a large industrial client or the trading unit of a Regional Distribution Company. Agreements with Regulated Buyers – except for own generation – require transparent and competitive procurement processes.

**Proposed Power Sector organization. Figure 6.1** summarizes the selected models and proposed power sector organization outlining the responsible entities for each Power Sector activity along the value chain according to the type of grid. The proposed system will not apply to off-grid villages and systems where rural cooperatives will be incentivized to promote higher involvement of local communities, more local job creation and to facilitate more fractioned payments.

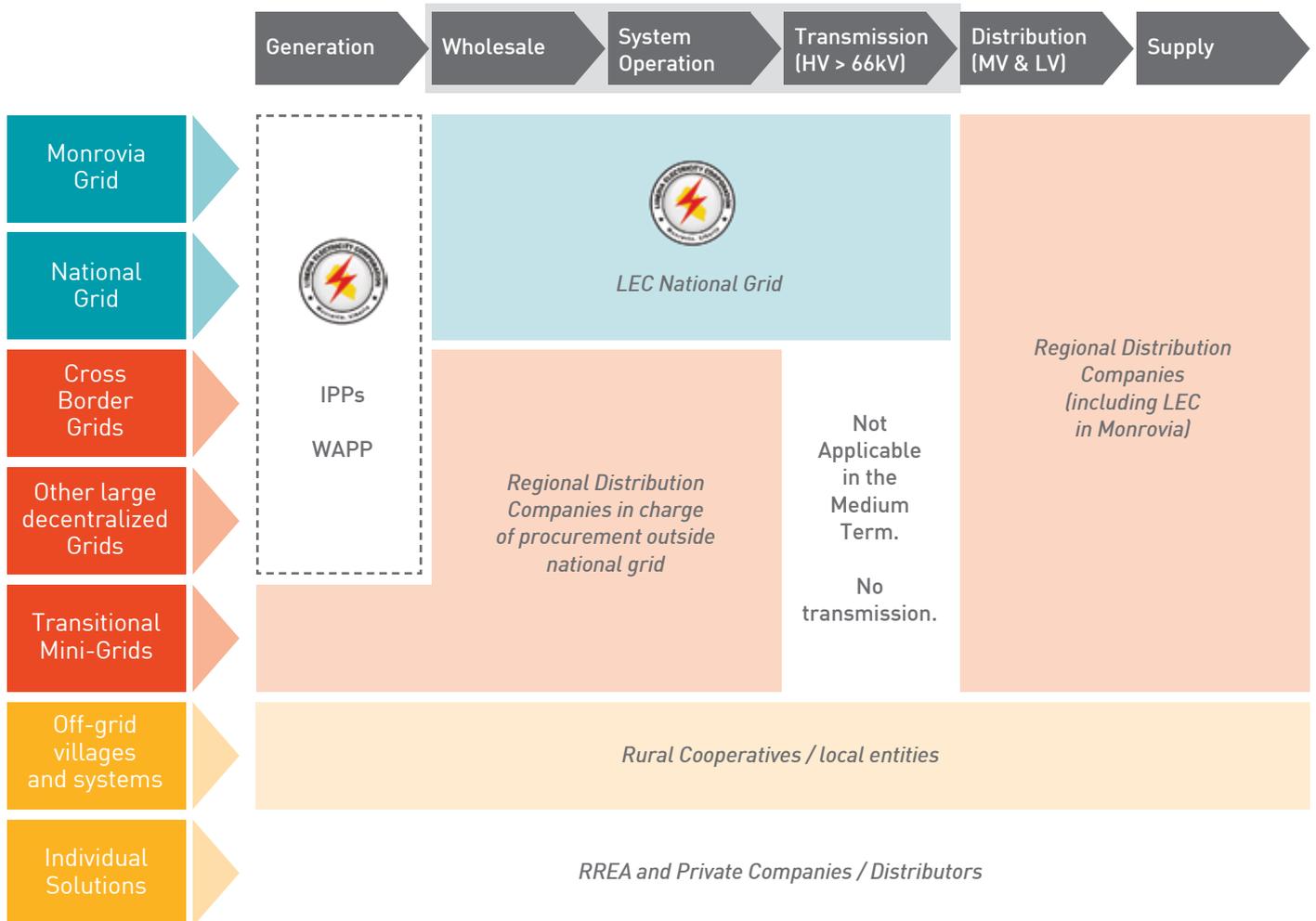


Figure 6.1 - Proposed Power Sector organization

# 6.3 PRIVATE SECTOR PARTICIPATION IN THE ENERGY SECTOR

**Context.** Private sector investment in the Sub-Saharan African electricity sector started in the early 90's. Back then, with the support of international development institutions, some African countries started to restructure their electrical systems, unbundling generation, transmission and distribution, and providing incentives for private investment in the sector. According to the World Bank, between 1990 e 2013 more than 150 projects reached financial closure in Sub-Saharan Africa.

**Value chain.** Similarly to what happens at a global scale, generation was the segment with more private investment in the region, totaling 147 projects which included a generation component, 128 of which were exclusively generation projects. Distribution was the second segment with most projects: of the 26 projects contemplating distribution, 5 were exclusively distribution projects. Finally, transmission was the sector that received the least private investment, having had 19 projects, of which only one was exclusively dedicated to transmission.

**Participation models.** Current practice in Sub-Saharan Africa is not much different from what happens worldwide. The BOO (Build, Own, Operate) model was also the most used, totaling 63 projects, all of them generation projects. The second most used Public-Private Partnerships (PPP) model was BOT (Build, Operate, Transfer), with 27 projects, almost all in the generation sector. Additionally, rental or operational leasing is also common in generation projects. **Table 6.1** provides the number of projects where each type of contract was used.

**In Distribution,** the lease or "*affermage*" model seems to be the most used - also common in water and sanitation. In the water sector in recent years in West Africa, a hybrid *affermage*/concession arrangement has been adopted successfully in Cote d'Ivoire, Senegal, Cameroon and other countries.

**Public Private Partnership principles.** The implementation challenge requires strong private sector involvement – in line with the recently approved energy legislation. However, the need to combine a strong grant component to achieve affordable tariffs, requires also strong donor involvement with competent public sector interface and an acceptable asset ownership model.

**Objectives of private sector participation.** Among the main objectives of private sector participation are (i) the on-time implementation of the investment program, targeting the increase of electricity access and renewable energy, and (ii) the improvement of the economic efficiency of the sector, with the optimization of investment and the reduction of technical, non-technical and commercial losses.

- **On-time implementation of the investment program.** It is expected that the private sector accelerates the implementation of the investment program for rural energy, contributing toward the mobilization of additional financial, human and material assets.
- **Improvement of the electric sector's economic efficiency.** Additionally, private sector participation should contribute to the improvement of the electricity sector's economic efficiency. This improvement may result, essentially, from the optimization of costs, regarding the life-cycle of the project, or from the maximization of the profits, by reducing the system's total losses.

**License model.** The new Electricity Law considers private participation under a “License” model, with clear asset ownership clause by the licensee (Section 6.6 of the Law). Such license model is close to a BOO model of participation of the private sector which may constitute a constrain for Donor and Grant participation in the Rural Energy Master Plan – even if the Law establishes that tariffs shall not reflect costs of a “regulated entity’s asset base that was acquired by contribution from a third party”.

**Asset ownership guidelines.** In order to maximize funding, the BOO model will apply to LEC and to renewable on-grid generation companies that will procure their funding from Development Finance Institutions. Off-grid and decentralized grid investments and assets – coming mostly from grants – will be managed in a hybrid license/affermage model where grant-funded assets will be owned by REFUND and “leased” to licensed private operators who will operate, maintain and upgrade such assets in exchange for a variable lease fee. Licensees will be allowed to invest and own new assets which are not grant funded.

**Other sectors.** Private participation in other sectors can be done through traditional commercial approaches: for example, private operators may be involved in rental or retail/supply of solar portable lamps, energy efficiency or cooking gas related equipment. The Rural Services Unit(s) will act as importer. Buyer and wholesaler of Solar Portable Lamps and efficient cook stoves. On City Gas, Petrol retailers will be required to distribute and make available cooking gas in different sizes down to at least 6 kg per bottle. LPRC will support also LPG imports and storage.

Contract		Generation	Transmission	Distribution	Mixed	Total	Investment (BUSD)
PPP	BOO	63	0	0	0	63	11.60
	BOT	24	1	0	2	27	4.00
	BLT	2	0	0	0	2	0.10
	BROT	2	0	1	3	6	1.70
	ROT	4	0	0	4	8	0.52
	RLT	1	0	1	1	3	0.12
<b>Management contract</b>		1	0	1	11	13	-
<b>Privatization</b>		6	0	0	1	7	1.70
<b>Lease</b>		0	0	2	0	2	0.00
<b>Rental</b>		25	0	0	0	25	-
<b>Total</b>		<b>128</b>	<b>1</b>	<b>5</b>	<b>22</b>	<b>156</b>	<b>19.74</b>

Table 6.1 - Private investment in Sub-Saharan Africa (1900-2013)

# 6.4 RENEWABLE INDEPENDENT POWER PRODUCERS

**Growing the Grid Renewable IPP initiative.** The Growing the Grid Program includes the “On-Grid Renewable IPP” initiative with 100 MW planned. The IPP model has been selected given the larger size of investments, the ease of integration with the grid – both national and international – and the expected free cash flow that can be generated on the national grid – allowing to obtain funding from Development Finance Institutions and Private sector investors.

**Renewable development in decentralized grids.** In Decentralized Grids renewable development under a pure IPP model would be challenging in the short / medium term as system size imply smaller projects and potential issues on electricity off-taking due to technical restrictions. Also, the need to balance renewables with more expensive diesel based generation limits free cash flow and the capacity to pay for such investments. Solar/Diesel transitional mini-grids and Hydro generation in Decentralized Grids are expected to be funded by Grants and therefore should remain property of REFUND to be leased to private operators.

**Smaller scale IPPs to replace diesel.** Smaller scale investments such as biomass gasifiers to replace diesel could be successfully developed and operated by local entities under a pure IPP model – as long as such operators accept similar dispatch rules as diesel generators.

**Renewable IPP contractual schemes.** Renewable IPPs are normally supported on a Concession/License agreement and a Power Purchase Agreement. The Concession/License agreement establishes the relationship between the producer and the State, normally authorizing construction, providing fiscal incentives or different types of guarantees and potentially clarifying the transfer of assets to the State after a certain period. The Power Purchase Agreement establishes the relationship between the producer and the off-taker, normally establishing the tariffs by which electricity is sold to the off-taker and the rights and duties regarding dispatch of power plants.

**Renewable procurement program.** Many options exist regarding the structure of a renewable procurement program. Further studies are proposed to clarify the Legislative, Regulatory and Administrative framework of renewable procurement in Liberia building on best practices and on a correct assessment of Liberia’s renewable potential. Such study shall develop and detail also the License and Power Purchase Agreements.

# 6.5 REGIONAL DISTRIBUTION COMPANIES

**Creation of Regional Distribution Companies.** The creation of Regional Distribution Companies is a key element of the Rural Energy Master Plan and a major change to the current institutional framework requiring further and more detailed studies. The Master Plan and present chapter outline some of the key elements to be considered.

**Initial setup.** The initial setup of Regional Distribution Companies can be complex. In Senegal, where the country was divided into several concessions, the setup took many years and still today the model faces significant challenges. The existing cross border grids represent short term concrete opportunities to start developing and testing the contractual structure. Additionally, the need to combine grants with private sector and to have REFUND as an asset ownership platform allows the investment process – supported in owners engineering services - to advance in parallel with the creation of the Regional Distribution Companies.

**Local presence and transition from “Community Current”.** Selection process should give preference to partnerships between Liberian Companies – coming from other sectors – with size and financial capacity together with experienced utilities operating already in other countries. The process should also try to include “Community Current” entrepreneurs as preferred employees of the Distribution Companies as hundreds of such entrepreneurs may risk becoming unemployed and may constitute an obstacle to the new Distribution Companies.

**Affermage contracts.** The need to have grant funded assets separated makes the use of Affermage or Lease Contracts a preferred option for Distribution activities in Liberia. In Leases and Affermages the operator does not receive a fixed fee but charges a tariff to consumers. In the case of affermage – the preferred model - the operator has its remuneration guaranteed (assuming that the receipts are sufficient to cover costs) and it is REFUND that takes the risk on the rest of the receipts collected from customers.

**Hybrid License/Affermage model.** Normally in pure Affermage contracts it is the asset owner that remains responsible for financing and managing investment in the assets based on a rental payment. In the water sector in recent years in West Africa, a hybrid affermage/concession arrangement has been adopted successfully – for example in Cote d’Ivoire - where it is the Private Company that assumes the management of the investment process in articulation with the asset owner. The Master Plan proposes a similar hybrid solution to be developed based on REFUND and LERC regulation that allows Licensees to lease grant funded assets, to own and invest in network expansion assets, while limiting demand risk and potentially reducing tariff differentiation among regions.

**Demand risk.** Rural electricity demand faces still significant uncertainties with impact on private operators. If revenues are significantly below expectations than fixed costs or high running costs such as diesel may be hard to support in a sustainable way – limiting the level of service provided and population’s acceptance and adherence. The Affermage contract with lease fees to REFUND dependent on results can mitigate significantly demand risk impact on Distribution Companies economics.

**Tariff and service differentiation.** Significant tariff and service differentiation between Regional Distribution Companies may not be well understood by population limiting acceptance and adherence. REFUND, through differentiated lease fees, can act as a balancing mechanism between Distribution Companies – avoiding significant differences in tariffs. The Rural Services Unit(s) in charge of managing the pre-paid meter and billing infra-structure and software can also mitigate differences between Regional Distribution Companies in terms of service delivery and promote synergies.

**Regional structure.** The map in **Figure 6.2** represents a possible division of the country in 5 Regional Distribution areas based on the existing Region structure and taking into consideration the existing and planned cross border infra-structures. Region 2 because of its size was divided in two different distribution areas: Lofa on one side and Bong/Nimba on the other. Region 3 would be managed by LEC Distribution Unit.

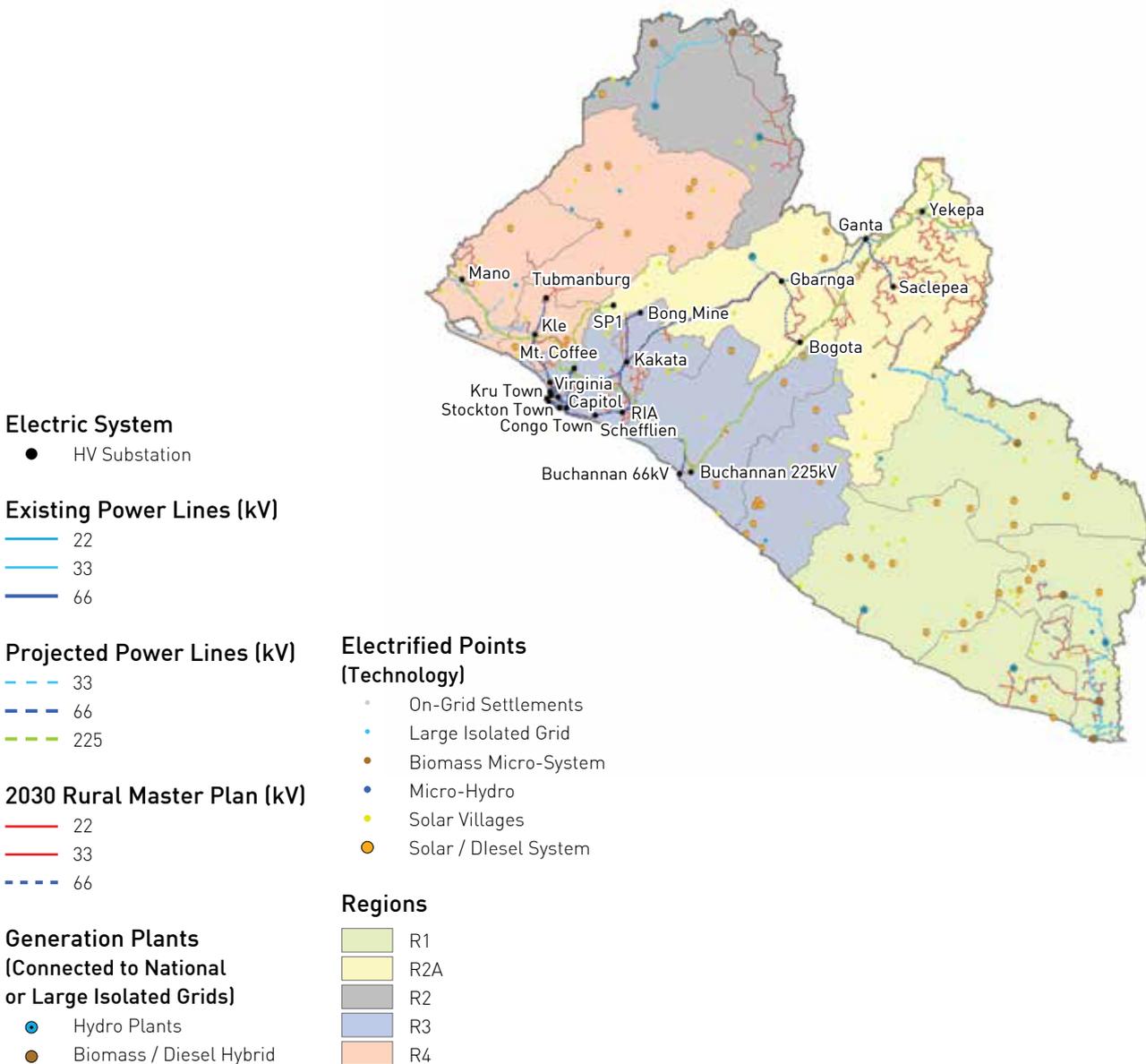
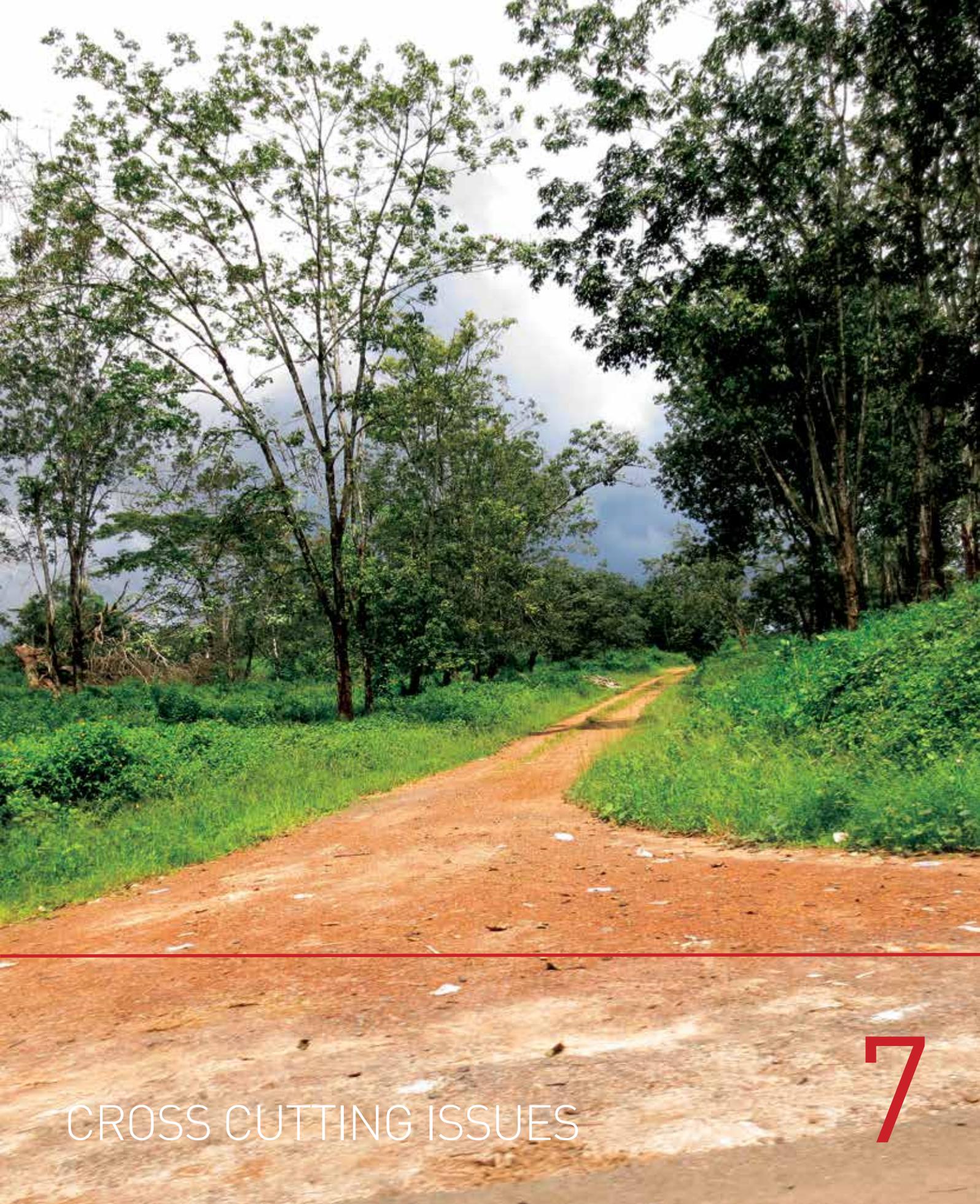


Figure 6.2 - Proposed areas for Regional Distribution Companies



CROSS CUTTING ISSUES

7

# 7.1 GENDER EQUALITY

Electrification has many benefits to women and to promote gender equality. This chapter will have a focus on the specific measures included in the Rural Energy Master Plan which will benefit gender equality.

**Biomass as fuel affects primarily women.** According to the International Energy Agency (IEA), World Energy Outlook 2015, in Liberia the percentage of population relying on traditional use of biomass for cooking was 98% in 2013. Moreover, this percentage is higher in Liberia than in Sub-Saharan Africa (80%), and indeed Liberia is among the countries with highest percentage of the population relying on traditional use of biomass for cooking in the world. The burden of gathering wood and other types of fuel falls beneath the women's responsibilities which imposes a setback on their education and economic involvement. Moreover, the use of biomass indoors contributes to respiratory illnesses which affect more women than men. With electricity, cooking gas and promotion of efficient cook stoves the amount of wood used for cooking can be seriously diminished, thus decreasing the burden set on women to gather it and also promoting efficiency, meaning that the time consumed in these activities is reduced.

**Electric appliances allow women to save time and reduce effort.** Other than promoting more efficient cooking fuels and options, by providing electricity to households women are also able to have other appliances which are extremely helpful in their daily activities, such as refrigerators and freezers to conserve food, and in a later phase washing machines for clothes and dishes and electric irons. Allowing women to cook food more efficiently and preserve it for the next day using a refrigerator and powering households with options where they can obtain several appliances enables women to complete their usual tasks in less time and with less physical effort and some of the manual tasks that may be substituted with the use of electric appliances. Hence, by reducing the time women spend on these household activities they are able to employ more time in education and in their economic activity.

**Additional ways to promote gender equality.** Another way to promote gender equality is to involve women in the decision making process regarding rural electrification, as well as educate women with regards to electrification so that they are able to be part of the construction and maintenance of the electricity grid. A scholarship program to facilitate women's access to the training opportunities of the Master Plan is planned.

Hence, there is a clear promotion for gender equality and to increase the livelihood of women.

# 7.2 HEALTH

**Health is one of the main priorities.** Health facilities are, among key Liberian decision makers, the top priority in terms of electrification. Given this, the electrification target for health centers is of 100% by 2025. Furthermore, there is a clear program in the Rural Master Plan focused in the health sector in order to provide affordable and reliable energy for health clinics and health centers.

**Electricity provides access to better health care services.** With electricity, health centers are able to have better light and hence provide medical services at night but it also enables health facilities to have vaccine refrigeration and ice pack freezing, better communication, more medical appliances, sterilization of equipment and water supply and treatment. These are indeed basic needs for any health facility and hence reliable electricity can have significant implications for providing health care, especially for reproductive and child health.

**Using less biomass contributes to increased public health.** More than providing better health care services, electricity also helps to increase public health in other areas. Indeed, as demonstrated above, a great part of the population in Liberia still relying on traditional use of biomass for cooking and the usage of lighting fuel is heavily reliant on kerosene lamps and other polluting alternatives. This use of biomass indoors contributes to household air pollution which emit large proportions of health-harming pollutants in their smoke, further damaging the health of the population. Indeed, in 2013 the percentage of deaths due to household air pollution from solid fuels in Liberia was 7.11% (a rate of 54.23 deaths per 100 000), which is higher than the percentage of total death due to HIV/AIDS (6.59%). Hence, by promoting efficient cook stoves and electricity to several households the health of the population is also improved.

# 7.3 ENVIRONMENT

**Context.** Sustainable development depends largely on successfully integrating the environment into economic planning and decision making. This makes environment a part of the fifth pillar – Cross-Cutting Issues. Agenda for Transformation has as strategic objectives for this pillar the development and implementation of clear environmental policies and quality standards, in order to guide environmental management, and those include a National Plan for Low Carbon and Climate Resilient Economy. This all goes in line with the Millennium Development Goals, as one of the main messages is the environmental sustainability of energy supply and consumption.

**Rural Energy Master Plan.** The present Rural Energy Master Plan plays a role on these Liberian strategic objectives, since the energy sector has major influence on the environment. A strong commitment to the environment was considered in aggressive targets for renewable generation until 2030 of more than 75%, influencing the penetration of renewable and sustainable energy sources, such as hydropower plants, solar photovoltaic panels and biomass generation units. For example, off-grid solutions contain PV systems, which provide green electricity, not polluting the environment and not needing any fuel.

**Diesel and Biomass.** Additionally, diesel and biomass generation units for mini-grids were analyzed. Using biomass instead of diesel represents a strong decrease in the emissions of carbon and other pollutants, reducing the environmental impact of electricity generation and also its impact on human health. Moreover, using biomass resources for electricity generation may contribute to the reduction of residues that could damage the environment, especially when considering waste and urban resources. Despite this, a sustainable use of biomass resources is vital, as deforestation remains an issue in Liberia.

**Cook stoves.** Finally, by using efficient cook stoves and other devices, Liberians can substantially decrease the amount of resources spent in cooking activities, as well as lighting and heating, which contributes positively to the environment.

# 7.4 RESEARCH AND INNOVATION

**Context.** Innovation drives growth and enables change. It is of the utmost importance for a country to be innovative, as it allows the country to discover new and better solutions for existing problems. Even though the results matter, the process of innovation allows people to learn, and enabling learning is the start of the road for development.

**Biomass gasifiers.** Concerning the energy sector, Liberia's innovative process can be observed in universities such as Booker Washington Institute, in Kakata. There, the use of small biomass gasifiers for power generation has improved access to power. These gasifiers represent small-scale projects, for demonstration purposes, as the technology itself is not mature yet. In this way, Liberia is contributing to the testing and improvement of gasifiers, while benefiting from the power generation. Furthermore, Liberian people are learning about the technology used, building capacity and acquiring practice with the power generation units and also with the use of natural resources. This is particularly important for the sustainable development and use of resources, raising awareness of these issues.

**Off-grid and decentralized solutions.** Current innovative processes are focused on off-grid or decentralized generation. The Rural Energy Master Plan encourages innovation in the energy sector, with the use of different and mostly sustainable technologies that represent a step forward compared to the already known diesel generation units.

**Gender equality.** Concerning learning and innovation, it is imperative to take into account gender equality issues, so as to allow both men and women to learn and to handle the devices and technologies used.





COORDINATION, MONITORING  
AND COMMUNICATION

# 8.1 COORDINATION STRUCTURE

**Overall coordination.** RREA will be in charge of coordinating, supervising and reporting progress of the implementation of the rural Energy Master Plan, as seen in **Figure 8.1** below. The Ministry of Land, Mines and Energy will provide policy oversight and monitoring of the Master Plan.

**High Level Rural Energy Committee.** A High Level Committee with all relevant Ministries and Superintendents will meet at least once every year to guarantee the involvement of all key entities in the Rural Energy Master Plan and also an adequate articulation between MLME and those entities. RREA will act as Secretariat of the Committee.

**RREA and the Rural Services Unit(s).** RREA will be the acting agency in charge of the Rural Energy Master Plan and overall coordination, monitoring and communication activities under delegation from Ministry of Lands, Mines and Energy. Additionally, RREA will act as Program Coordinator and, in some cases, as Responsible Entity. The Rural Services Unit(s) will host and manage the Management Information System and will support RREA in all reporting activities.

**Program/Initiative coordinators.** Each Program or Initiative will have a Program/Initiative Coordinator in charge of coordinating and monitoring the implementation of all the projects under that program or initiative. The Program Coordinator will support the implementation but will not have a hierarchical role towards the Responsible Entities for each project. Program/initiative Coordinators will be appointed by the following institutions:

- GTG Program and OTP Program / Efficient Lights & Appliances and Prepaid meters initiatives: LERC
- DG, BTG, BC Programs and OTP Program / Efficient cooking biomass initiative: RREA
- OTP Program / City cooking gas initiative: LPRC

**Responsible entities.** Each Project will be assigned a Responsible Entity. The Responsible Entity has to guarantee the implementation of the Project. The Responsible Entities will directly respond to MLME on the results of their Projects. They will provide information to the Rural Energy Management Information System and will articulate and require the support, if needed, of the Program/Initiative Coordinator.

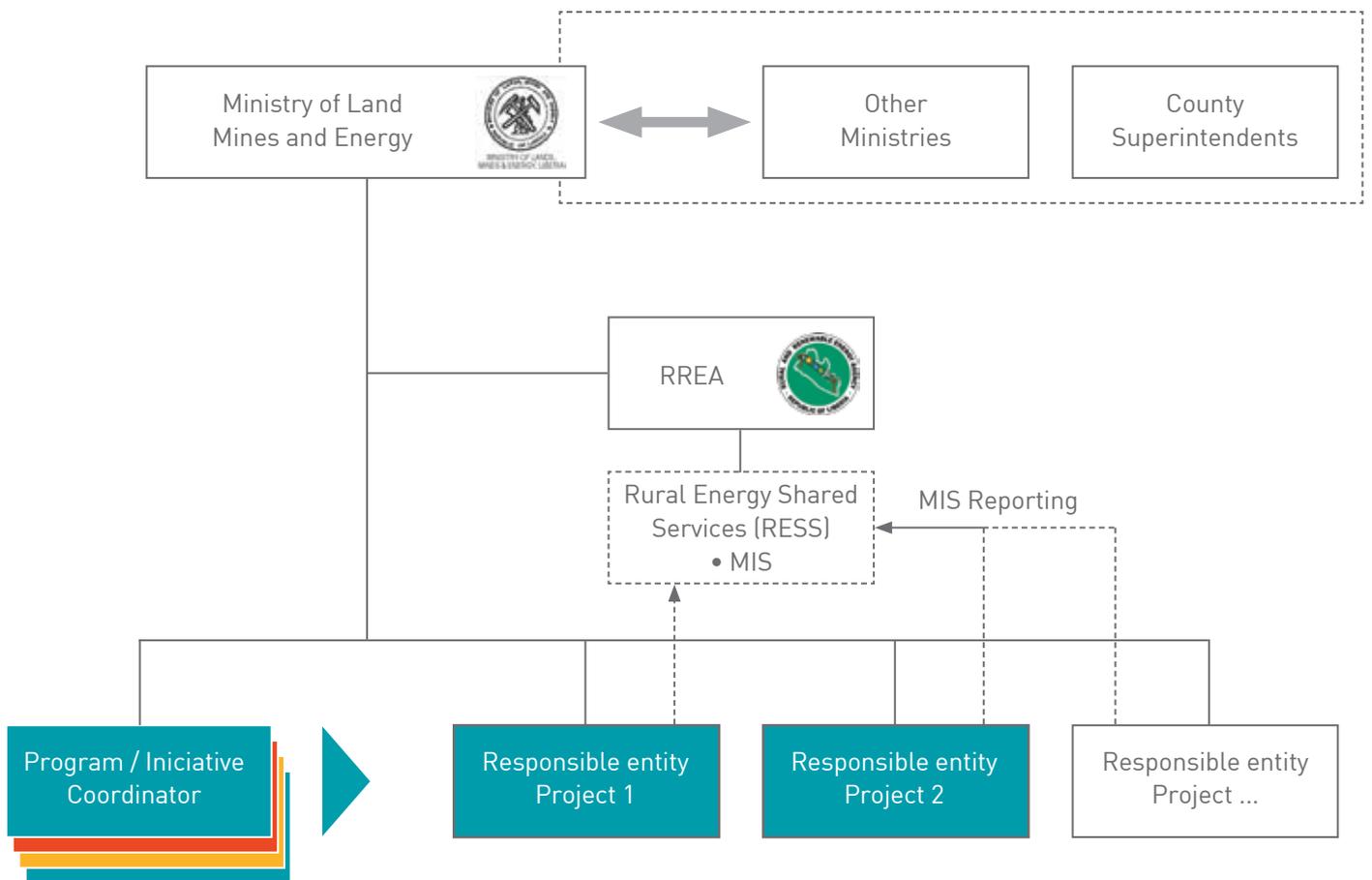


Figure 8.1 – Coordination structure.

# 8.2 MONITORING AND CONTROL

**Multiple layers of control.** Monitoring and control will be developed at all levels, from bottom to top. The Responsible Entity will be the first entity in charge of monitoring and controlling on a day-to-day basis the implementation of the Project and of updating the MIS. The Program/Initiative coordinator also has to control the status of the project, but is only required to do it on a quarterly basis. Finally, RREA will prepare a bi-annual monitoring report to be presented to MLME and to the Rural Energy Master Plan Council.

**Information flows.** Information will be collected at Project Level under a Management Information System. The information will go directly from Project Applications, Project team or Project Responsible Entity to the MIS.

**Rural Energy Master Plan Council.** A Council with all Responsible Entities will be chaired by MLME under the secretariat of RREA and will meet twice every year. The Council will review the bi-annual monitoring report with each Program/Initiative Coordinator presenting the status of his Program or Initiative.

**Annual High Level Rural Energy Committee and Stakeholder Meeting.** An annual report will be prepared by RREA and presented at the Annual Rural Energy Stakeholder Meeting. The annual report will also constitute the basis for the High Level Rural Energy Committee which will meet once every year.

# 8.3 MANAGEMENT INFORMATION SYSTEM

**Rural Energy Management Information System.** A comprehensive information system will be developed, hosted and managed by the Rural Services Unit(s). The information system will be composed at least of the following key databases:

- **Prepaid meter and Client Connections database.** The MIS will be interconnected with the pre-paid meter database and will have updated information on the number of electricity clients, their consumption and installed capacity, per County, District and Settlement.
- **Funding database.** Information on committed or secured funding in order to identify the remaining gaps.
- **Project database.** Information on the current status of each Project, budget and incurred costs as well as the level of completion and funding sources.
- **Geo-referenced asset database.** Georeferenced information on the existing infra-structure.
- **Procurement database.** Information on all ongoing tenders and status.
- **Generation database.** Information on installed generation.

**Information update.** In order to minimize extra costs and resources on data collection and processing, the MIS will try to interconnect with existing operational databases and, in some cases, develop useful applications that can support operations and, at the same time, collect the key information.

**Transparency.** The MIS will not only serve for monitoring and control of implementation, but it will also be a key tool to maintain transparency and promote information exchange with all key stakeholders.

# 8.4 COMMUNICATION STRATEGY

**Communication target audience and objectives.** Communication is a key element of the Rural Energy Master Plan implementation with the following key objectives for different target audiences:

## **For Liberian Population:**

- Maximize acceptance by population of electricity services and providers and promote adherence to such services;
- Change habits of consumers on cooking (introduction of city gas and efficient cook stoves);
- Create awareness of available products, services and job opportunities (e.g. Solar Portable Lamps, Credit lines, training centers, ...);
- Reduce gender inequality and encourage stronger participation of women on rural energy sector activities and jobs.

## **For entities directly involved in the implementation of the Master Plan:**

- Maximize coordination and information sharing between the implementing entities, namely the Program/initiative coordinators and the Responsible entities;
- Engage public sector institutions and public companies to secure their support and commitment to the implementation of the Master Plan and of the future institutional framework;
- Procure participation of private sector companies in the implementation of the Master Plan;
- For donors and other stakeholders;
- Procure and secure the commitment of donors, financial institutions and other international stakeholders to fund the Rural Energy Master Plan projects and investments;
- Engage stakeholders to secure their support and commitment to the implementation of the Master Plan through a clear and transparent communication on progress and involvement/ consultation on key elements of implementation.

**Communication mix.** Different methods and tools will be applied to communicate the right message to the different target audiences.

**Liberian population.** RREA communication shall convey the benefits of electricity, efficient cooking and appliances. It will be mostly based on “above the line” media such as billboards, social media, SMS campaigns and radio, but will also include “below the line” communication with press releases and organization of events. Regional Distribution Companies communication will also have a key role in consumer acceptance through its image and of its employees and through the availability of a clear web-site, of local outlets and of a call center where people can ask their questions and present their concerns. All Regional Distribution Companies will be required to approve a Communication Plan and be present at the more populated locations.

**Entities directly involved in the implementation of the Master Plan.** Communication to this target will start by creating a “Rural Energy” brand and identity. Stationary such as caps or t-shirts will be distributed in key implementation events. Coordination and information sharing will be facilitated by a monthly Newsletter to be released by e-mail to all intervenient. The mailing list will be shared and used also to distribute Progress reports and other key information. The bi-annual Rural Energy Master Plan Council and the meetings of the Rural Energy High Level Committee will further reinforce communication and engagement.

**Donors and other stakeholders.** A prospectus on the Rural Energy Master Plan will be distributed to key donors and stakeholders. A web-site will be developed by RREA to communicate the results of the Master Plan, the Rural Electrification database and statistics, share the key reports and documents as well as job/procurement opportunities. An international mailing and roadshow to key potential donors will be implemented. A stakeholder annual meeting will be organized by RREA through the implementation of the Master Plan.

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