AFRICAN DEVELOPMENT BANK GROUP

SCALING UP RENEWABLE ENERGY PROGRAM IN LOW INCOME COUNTRIES

LIBERIA RENEWABLE ENERGY PROJECT

COUNTRY: REPUBLIC OF LIBERIA

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LIST OF ACRONYMS

AfDB	African Development Bank
ADF	African Development Fund
CIF	Climate Investment Fund
CLSG	Cote d'Ivoire Liberia Sierra Leone Guinea Interconnexion
GHG	Greenhouse Gases
GoL	Government of Liberia
ECOWAS	Economic Community of West African States
EU	European Union
HPP	Hydropower Plant
IP	Investment Plan
IPP	Independent Power Producer
LEC	Liberian Electricity Corporation
MCC	Millennium Challenge Corporation
MDBs	Multilateral Development Banks
MoFDP	Ministry of Finance and Development Planning
MLME	Ministry of Lands, Mines and Energy
NDC	National Determined Contribution
PCU	Project Coordination Unit
PSC	Project Steering Committee
REFUND	Rural Energy Fund
RESMP	Rural Energy Strategy and Master Plan
RREA	Rural Renewable Energy Agency
SCF	Strategic Climate Fund
SREP	Scale-up Renewable Energy Program
WAPP	West African Power Pool

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1. INTRODUCTION

Background Information

1.1 Liberia has one of the lowest electricity access rates in the world presently, with less than 2% of households having access to electricity services nationwide. The population of Liberia is expected to grow approximately from 3.9 million currently to 4.5 million by 2020. According to the Least Cost Power Development Plan, the demand for electricity is expected to grow at an average rate of 8% until 2033, with slightly higher growth rates from 2015 to 2020[1]. The growth in electricity demand combined with insufficient investment in the electricity generation and network development in the past has led to considerable constraints on the electricity network, especially in densely populated urban and peri-urban areas of Liberia. In addition, rural energy access is virtually non-existent, increasing the impediments to doing business outside of Monrovia and also increasing sentiments of exclusion, which may lead to political instability.

1.2 Energy consumption in Liberia is dominated by biomass that accounts for more than 80% if the primary energy needs of the population. Most of Liberians still depend on firewood and charcoal for cooking and heating needs and palm oil for lighting. The most recent census data, shows that 70% of the urban population still use charcoal for cooking while 91% of the rural population uses firewood.

1.3 The total installed capacity of Liberia's public generation facilities is 191 MW. Around 98% of the country installed capacity is located in and around Monrovia and serves a total of 35,000 customers from a total population of 1 million inhabitants. These are served by the public network which is operated by the LEC. The public electricity network is supplemented with an installed capacity of 216 MW from private sources and an additional ten isolated mini-grids based on units powered by heavy fuel oil with a total installed capacity of 13 MW[2].

1.4 Electricity tariffs in Liberia are currently set by the Liberian Electricity Corporation (LEC) Board for the grid-connected system. A single tariff is applied for all types of consumers. Tariffs are calculated quarterly, taking into account the price of equipment, service schedule, maintenance, distribution costs and 20% of technical and non-technical losses. Liberia currently has one of the highest electricity tariffs in Sub-Saharan Africa (and among the highest in the world) at more than USD 0.56 /kWh due to high generation costs that are essentially based on fossil fuel production costs which range from USD 0.32-0.6/kWh.

1.5 Much of Liberia's infrastructure was greatly damaged, destroyed or looted during the civil war. This included the Mt. Coffee Hydro Power Plant (HPP), other generation facilities and electricity transmission and distribution networks. As a consequence, Liberia has a big deficit in electricity generation, transmission and distribution. It is noted that the Mt. Coffee HPP has been

[1] SREP Liberia Investment Plan

rehabilitated and is operational since December 2016. By July 2017, the power plant is expected to recover its full capacity of 80 MW.

1.6 The Ebola crisis that struck Liberia, Sierra Leone, and Guinea in mid-2014 had tremendous negative socio-economic impacts in the country. The country was able to manage the crisis with the assistance of the international community, and the number of cases have abated drastically since early 2015. Liberia is considered an Ebola-Free country by the World Health Organization since January 2016 and energy is considered a critical enabler for vital primary health care services, especially during the post Ebola period for maternal and childbirth emergencies in the remote areas.

Project Rationale

1.7 The preparation of the project has benefited from consultations amongst development partners active in the Liberia energy sector. More specifically, some interventions directly linked to renewable energy and capacity building are currently being implemented in Liberia. These include: (i) the World Bank is financing through the SREP, the Liberia Renewable Energy Access Project (LIRENAP) which supports the development of a mini-grid in the rural western side of the country and is strengthening RREA technical capacity and developing a number of regulations for the provision of decentralized electricity services, including support to scale-up the government's initiative to foster a market in Liberia for off-grid solar energy devices, (ii) the Government of Norway is financing capacity building and training programs for skilled technicians targeted at hydro technologies, (iii) the Government of the United States of America through USAID and Millennium Challenge Corporation (MCC) is focused on supporting the extension of the country's power generation capacity, in particular the rehabilitation of the Mt. Coffee Hydro Power Plant (HPP) as well as the construction of small-scale renewable energy pilot projects and in addition to build and improve the capacity of public and private actors, (iv) the EU is focused on improving energy access with the financing of the Cross Border Electricity Supply project that aims at providing access to modern energy services to 18 communities in the Maryland, Nimba, and Grand Gedeh Counties. The EU has in the past funded the Rural Energy Strategy and Master Plan (RESMP) which serves as a roadmap to guide the GOL's rural electrification programs for the period 2015-2030.

1.8 The proposed Liberia Renewable Energy Project is one of the projects included in Liberia's SREP Investment Plan (IP) prepared by the GoL in close cooperation with the Multilateral Development Banks (MDBs) and approved by the SREP Sub-Committee (SC) in October 2013. A USD 1.5 million project preparation grant was approved in the context of the project that served to finance the feasibility studies required on the sites that were considered in the concept note of the project included in the IP that was presented to the SREP SC for endorsement. Three feasibility studies for three mini hydro sites in Ya Creek, River Gee and Gbedin Falls were completed in May 2016 plus a feasibility study for a biomass site. The development of these four sites can greatly contribute to the targets set in the Rural Energy Strategy and Master Plan (RESMP) for Liberia.

1.9 Considering the limited funding available for Liberia, the GoL had to prioritize its investment based on the readiness of its projects and their sustainability. At the feasibility stage, the River Gee site shows numerous unknowns in particular with the geotechnical conditions at site

that require additional investigations. At the Ya Creek site, the proposed arrangement suggests the construction of a canal (~1km) in order to divert flow from its natural path to the HPP before returning it downstream. The diversion will severely reduce water flow in the bypassed section of the creek during dry season and cause significant impacts on the environment. However, the Gbedin Falls site shows less uncertainties and impacts on the environment while offering a higher energy generation (56.4 GWh). In addition, the cost per MW of the River Gee and Ya Creek sites (USD 7.11 million and USD 4.32 million per MW respectively) is higher than the Gbedin Falls HPP (USD 2.93 million per MW).

1.10 Following preliminary discussions and the availability of funding, the GoL opted for the development of the Gbedin Falls HPP given how promising the sire is in terms of envisaged installed capacity and the fact that the plant would be grid-connected. The project entails the development of a HPP (<10MW) to be located at Gbedin Falls on the Mani River, a tributary of the St John River, in Nimba County. The project will scale-up generation capacity in the Nimba County from renewable resources and provide, at low cost (USD 0.053/kWh), a sustainable and reliable source of electricity to the rural and urban population, businesses, institutions and industries in the North-East region of Liberia.

1.11 Following the GoL's choice to develop the Gbedin Falls site, the remaining amount (USD 700.000) available under the SREP Project Preparation Grant approved by the SREP SC in the context of this project will be used to finalize the Environmental and Social Impact Assessment of the Gbedin Falls project. In addition, the grant will also finance the design of the distribution grid to connect the rural population located along the existing cross-border line in the Nimba County to enhance access to electricity in these rural areas that are currently unserved despite the transmission line passing in their vicinity. The SREP Project Preparation Grant proposed the development of the feasibility studies to four project sites to develop

1.12 There are expectations that the project will also reduce dependency on electricity import (USD 0.14/kWh) and facilitate reliable supply of power to Ganta, Sanniquellie and possible expansion of the grid to Gbanga and beyond. This will allow and encourage the connection of a larger amount of households, businesses, institutions and industries (mining and commercial), to the national grid and significantly reduce the number of self-generation units and lead to a decrease in the use fossil-fuel for energy generation purposes. The presence of a reliable, sustainable and affordable source of electricity in the Eastern region of Liberia will lead to an increase in the electricity access rate to clean energy source among rural and urban centers, contribute to economic development and prosperity, and reduce poverty.

1.13 The proposed project will contribute to the country's transition to green growth and inclusive growth while enabling access to quality, reliable, cleaner and cheaper electricity services to a greater number of Liberians. In addition, the project will contribute to green and inclusive growth by reducing the use of highly polluting stand-alone diesel generators (currently being used by a majority of the Liberian population) with the provision of reliable power supply to the population and surrounding businesses as well as social facilities such as hospitals and schools.

The project activities will lead to a reduction in Greenhouse Gas (GHG) emissions and contribute to enhance climate resilience of the beneficiaries.

1.14 Liberia's Agenda for Transformation (2012-2017) sets precise goals and objectives for Liberia to become a more prosperous and inclusive society. Under pillar II entitled *"Infrastructure Development"*, the expansion of electricity services and the reduction of the cost of electricity are identified as essential conditions for achieving and sustaining economic transformation. This proposed project is in line with the development priorities of the country and the sector vision of a reliable and affordable supply of energy services for all sectors of the Liberian economy.

Justification of SREP Intervention

1.15 While some renewable energy investments occur sporadically, i.e. the rehabilitation of the Mt. Coffee HPP, the development of a training center for technicians in the electricity sector, and the creation of an independent energy sector regulator funded by Power Africa's engagement in Liberia through the MCC to name some of them, such approaches are insufficient to satisfy the GoL's electrification needs. SREP support will help demonstrate that renewable energy for electrification is indeed a readily scalable option. In the face of development priorities and political pressure to rapidly expand coverage, the GoL may be forced to choose second-best options, such as diesel generators. Not only are these options detrimental to the global environment, their adoption would make it more challenging to change the resulting status quo at a later stage. SREP resources will be used to catalyze the generation capacity of Liberia and build on synergies with various initiatives being implemented by other development partners.

1.16 Increases in energy access will stimulate access to electricity by households and businesses leading to increases in economic productivity. Women and children will particularly benefit through higher educational attainment, enhanced personal security and gains in productivity as a result of access to more productive and modern energy solutions.

1.17 Furthermore, the Gbedin Falls HPP is critical for meeting the national electrification goal of 30% rural access by 2030 and to support economic activities outside Monrovia. The project will also contribute to Liberia's international effort set in the Intended Nationally Determined Contributions of the Paris Climate Agreement to limit temperature increase to 2 ºC by 2020. Moreover the project contributes to reach the targets set in the SE4ALL Action Agenda that aims at achieving universal access to energy services and doubling the share of renewable energy in the global energy mix by 2030.

2. PROJECT DESCRIPTION

Project Description and Objectives

2.1 The Liberia Renewable Energy project aims at developing the run-of-river Gbedin Falls HPP with a total capacity of 9.34 MW. The power plant will be located in the Mani River in the Nimba County and connect to the existing 7.8 km /33 kV cross-border transmission line between Liberia and Côte d'Ivoire. The project is expected to become a source of reliable, sustainable and affordable power in the region, allow grid expansion to isolated localities and remote areas, and encourage the connection of a larger amount of households, businesses and industries to the national grid with the support of the EU financing for electricity supply in the Nimba region. This will significantly reduce the number of self-generation (fossil energy) units and increase the electrification rate in the Eastern part of Liberia.

2.2 **Location:** The Gbedin Falls site are located on the Mani River, a tributary of the St John River, in Nimba County (refer to map in Annex 1). The Falls are in a remote area of heavy forest 7 km from Gbedin village in the district of Sanniquellie Mahn. Access to the site from Monrovia is via the 260km paved road from Monrovia to Ganta, then the 19km unpaved road from Ganta to Gbedin village and 7km unpaved road from Gbedin village to the project site. The nearest seaports are the Freetown port of Monrovia and the port of Buchanan. The rail train from Port of Buchanan and going to Yekepa passes 7 km from the project site.

2.3 **Description of the Site:** The Gbedin Falls catchment area is located in a tropical climate with a unimodal rainfall distribution. Its surface is estimated to 1815 km² which provides an average annual flow of 39 m3/s at the Gbedin Falls. Upstream of the falls, the Mani River flows through a narrow passage with steep banks before reaching the top of the falls. The falls are made of a single step of about 20-25m height. The flow then falls into a wide natural basin (~170 m long) and stills before continuing its way downstream. The falls are located in a Precambrian gneiss geology and the bedrock is expected to be encountered at relatively shallow depths downstream the falls. This provides a relatively low geological risks for the development the power plant.

2.4 **Components of the project:** In accordance with the GoL's will to minimize social and environmental impacts, a run-of-river scheme is proposed. Other components include: (i) an access road of 17.3 km, (ii) a 5.40m height free overflow weir, (iii) a forebay and power intake structure, (iv) a 9.34 MW powerhouse equipped with turbines, and (v) a 7.8 km - 33kV transmission line and associated auxiliary infrastructure.

2.5 **Access road:** The site access road connects with the national road at Mr. Kona Town. To limit environmental and social impacts, the access road will follow the existing alignment from Mr. Kona Town through Gehwee village. The road will be rehabilitated on its first 9.5 km and the following 7.8 km will be built as new.

2.6 **Weir:** The weir traverses the river at the top of the Gbedin falls and includes a central free overflow spillway and a non-overflow gravity section on the right abutment. The free overflow weir creates a small storage to divert the flow into the forebay and provides head over the penstocks and flow regulation for the daily variations of power demand. The total length of the weir is 65m (including the forebay and power intake structure). The central free overflow spillway is a concrete gravity structure of 5.40m height with a crest length of 29.50m.

2.7 **Forebay and power intake structure:** The forebay and power intake structure is located on the left abutment and is composed of an offtake structure consisting of 4x bays (3m wide) equipped with coarse trash racks and stoplogs, a forebay 12.5m wide and 12.5m long, a sediment management system and a water intake equipped with a fine trash rack and connected to the penstocks.

2.8 **Powerhouse:** The powerhouse is 49.20m long, 34.1m wide and 22m high. Water flows from the intake structure to the powerhouse through two penstocks with a diameter of 2.60m and length of 92m. The powerhouse is located downstream the falls on the left bank and is equipped with two (2) upstream elbow S-type Kaplan units with an individual capacity of 26 m3/s. The Kaplan turbines are coupled to two (2) 6.6kV synchronous generators of 5.9 MVA for a total installed capacity of 9.34 MW. The intake gates are located at the power intake and the Emergency gates are located in the draft tube, downstream of the turbines. Stoplogs are located at the forebay intake (upstream of the coarse trash racks) and at the end of the draft tubes of each turbines to isolate waterways and turbines for maintenance purposes and adverse tailwater conditions.

2.9 **Transmission line and substations:** The Gbedin Falls HPP connects to the existing 33kV cross-border network through a 7.8 km transmission line. The 6.6/33kV step-up substation is near the powerhouse and the substation to connect the new 33 kV transmission line with the cross-border line is near Kitoma village. The cross-border network connects Logouato, Duoplay, Karnplay, Sanniquellie and Ganta, and Sanniquellie to Yekepa.

2.10 **Electricity generation:** The installed capacity at Gbebin Falls HPP is 9.34 MW and the total expected energy generation will amount to 56.5 GWh/year with average capacity factor of 0.71. The generation is however split between the wet season (May to November) where the average energy generation is 41.8 GWh with a capacity factor of 0.90, and the dry season (December to April) where the average energy generation is 14.7 GWh with a capacity factor of 0.45.

2.11 **Construction schedule:** The construction is expected to last for 36 months once procurement is completed.

Project Components

2.12 The project will be divided in three components as follows:

- **Component A - Gbedin Falls HPP and Transmission:** This component is composed of the hydro-electro-mechanical (HEM) equipment civil works, and transmission line with a corresponding substations. It includes the following sub-components:

    - **Sub-Component A1. Hydro-electro-mechanical equipment**. This component will finance the HEM equipment which include the design manufacturing, supply, installation

and commissioning of the hydro-mechanical equipment, electro-mechanical equipment and the steel penstock.

- **Sub-Component A2. Civil Works**. This component will finance the civil works which include excavation works, access road creation (7.8km) and rehabilitation of an existing road (9.5km Kona Town to Gehwee), mass and structure concrete works, river diversion works, site mobilization and demobilization.

- **Sub Component A3. Transmission Line**. This component will finance the electricity transmission works which include a 7.8km transmission line (33kV) to the existing cross border transmission network and two 33kV substations, one at the site and the other at the connection point of the cross border.

- **Component B - Project Management and Engineering supervision:** This component is composed of the design engineering and supervision services including project management and implementation support. It includes the following components:

  - **Sub-Component B1. Engineering and Supervision Services**. This component will finance detailed engineering design and detailed site investigations (topographic survey and geotechnical investigations), construction supervision, International tendering the HEM equipment which include the design manufacturing, supply, installation and commissioning of the hydro-mechanical equipment, electro-mechanical equipment and the steel penstock.

  - **Sub-Component B2. Project Implementation Support**. This component will finance The project management aspect will finance the establishment of a project implementation unit that will be staffed with a project coordinator, electrical engineer, mechanical and civil engineer, hydrologist, administrative support staff, environmentalist, gender expert, community outreach expert, project accountant and a procurement specialist.

- **Component C. Technical Assistance and Capacity Building**

  - **Sub-Component C1. Ganta-Gbarnga Access to the Grid Feasibility Study.** This component will finance studies that will assess the feasibility of the development of a distribution network that shall connect to the 33kV cross-border line from Ganta to Gbarnga.

  - **Sub-Component C2. Capacity Building.** This capacity building sub-component will target the enhancement of skills within RREA to undertake hydrology data collection and analysis, climate change mitigation and adaptions mechanisms, financial modeling and project monitoring and evaluation of hydro power plants and operational aspects of hydro power plants.

Brief Description of Expected Outcomes

2.13 The project is expected to add 9.34MW of installed capacity and provide an average 56.4 GWh/year to the Nimba County from hydropower. This will reduce by 60% the cost of electricity in the Nimba County which presently depends totally on electricity importations from Côte d'Ivoire at a rate of USD 0.14/kWh.

2.14 As a result, Liberia will reduce its costly electricity importations and the project will provide a more reliable, sustainable and affordable source of power to the County. This will encourage the rural and urban population, businesses, institutions and industries to connect to the national grid and reduce the use of self-generation and domestic wood. The EU projects aiming at developing the scale-up of electricity supply and number of households and businesses connections in the Nimba region are complementary to the Gbedin Fall HPP project.

2.15 The tariff reduction and the availability of power will also enable the expansion of the grid to isolated villages, localities and industries using captive power. It is expected that over 7,000 new customers (households and commercial and public consumers) will connect to the grid by 2021 and an additional 11,000 more by 2041. The residential, commercial and public energy demand will reach 11.94 GWh/year by 2021 and 56.11 GWh/year by 2041.

2.16 As suggested in the feasibility study of the Gbedin Falls HPP prepared by Tractebel in April 2016, the electrification rate is expected to increase from less than 2% to 30% in rural areas and from 8% to 50% in urban area until 2030. In order to reach these targets, the GoL will need to develop transmission and distribution networks in the Nimba County. The presence of a reliable, sustainable and affordable electricity generation in the Nimba County will definitely have a positive impact on the economic growth which is expected to lead to a 470% increase of the electricity demand between 2021 and 2041 as suggested by the same study.

3. FINANCING PLAN

Description of Project Costs

3.1 Liberia was hit by two large negative shocks in 2014, with significant implications on the economic outlook. The Ebola outbreak since mid-2014 has severely impacted the economy, with a particularly heavy toll on agriculture and services, and the impact is expected to linger over a longer period. Notwithstanding that, the sharp decline in the price of key export commodities, most notably the 60% drop of iron ore prices since early 2014, has affected exports and caused delays in investment in the sector. Taking this into consideration and recommendations made by the International Monetary Fund under an extended credit facility arrangement, the GoL contribution to fund this project is not feasible.

3.2 The total estimated project costs, including a 10% provision for price escalation and physical contingency but excluding customs and duties, is estimated at USD 29.23 million of which USD 23.50 is proposed to be financed from a grant from SREP, USD 4.82 million from

AfDB and USD 1.16 million from the Government of Liberia. The proposed project cost are defined in three components: (i) Gbedin Falls Hydro HPP and transmission infrastructure; (ii) Project Management and Engineering supervision and (iii) Technical Assistance and Capacity Building. A detailed breakdown of the financing of the respective project components is presented below.

3.3 The total Project cost is estimated at USD 29.52 million as per Table 1 below.

Table 1: Project cost estimates by component [amounts in million USD]

	Project Components	SREP	AfDB	GoL	Amount
A	**Gbedin Falls HPP and Transmission**	***US$ M***	***US$ M***	***US$ M***	***US$ M***
	A.1 Hydro-Electro-Mechanical (HEM) Equipment	12.64	-	-	12.64
	A.2 Civil Works	6.15	-	-	6.15
	A.3 Transmission Line	2.59	-	-	2.59
	Sub total Component A	***21.38***	***-***	***-***	***21.38***
B	**Project Management and Engineering Design Services**				
	B.1 Engineering and Supervision Services	-	2.79	-	2.79
	B.2 Project Implementation Support	-	0.69	-	0.69
	Sub total Component B		***3.48***	***-***	***3.48***
C	**Technical Assistance and Capacity Building**	-		-	-
	C.1 Ganta-Gbarnga Grid Access Feasibility Study	-	0.40	-	0.40
	C.2 Capacity Building		0.50	-	0.50
	Sub total Component C	***-***	***0.90***	***-***	***0.90***
	Base Cost	21.38	4.38	1.07	26.83
	Physical and Price Contigency	2.14	0.44	0.11	2.68
	Total Project Cost	**23.52**	**4.82**	**1.18**	**29.52**

3.4 Table 2 below shows the indicative sources of financing for the project whereas table 3 breaks down the total costs between works and services.

Table 2: Source of financing [amounts in million USD equivalent]

Sources of funding	Total	%
ADF	4.82	16%
SREP	23.52	80%
GoL	1.18	4%
Total project cost	29.52	100%

4. IMPLEMENTATION ARRANGEMENTS

Institutional and Implementation Arrangements

4.1 The National Energy Policy (NEP) was developed in 2009. Under the NEP, a plan was developed for the reconstruction of the electricity sector. The following aspects of the plan have already been undertaken:

i. Ratification of the Economic Community of West African States (ECOWAS) Energy Treaty, which made Liberia a full member of the West African Power Pool (WAPP) community in 2009.
ii. Creation of the Rural and Renewable Energy Agency (RREA) in 2010.
iii. Establishment of a Rural Energy Fund (REFUND) designed to manage all domestic and international funds for the electrification of rural areas.

4.2 The electricity subsector in Liberia currently comprises the Ministry of Lands, Mines and Energy (MLME), LEC and RREA. Roles and establishment dates of each institution is presented in the table below.

Table 4: Energy Sector Entities

Entities	Establishment Date	Roles
Ministry of Lands, Mines and Energy	1972	Administer all activities related to land, mineral, water and energy resource exploration, coordination and development
Liberia Electricity Corporation	1973	Generate, transmit and distribute electricity throughout Liberia
Rural Renewable Energy Agency	Established in 2010	Facilitate and accelerate the economic transformation of rural Liberia by promoting the commercial development and supply of modern energy products and services to rural areas through community initiatives and the private sector with an emphasis – though not exclusive reliance – on locally available renewable resources

4.3 The beneficiary of the proposed SREP grant will be the GoL represented by the Ministry of Finance and Development Planning (MoFDP). The project will be implemented by a Project Coordination Unit (PCU) that is already constituted within the Rural Renewable Energy Agency (RREA). The PCU has implemented projects funded by the World Bank, notably the Catalyzing New Renewable Energy project, the Lighting Lives in Liberia and the Liberia Renewable Energy Access Project funded by the SREP, and the Developing and Demonstrating a Rural Energy Strategy and Master Plan for Liberia funded by the European Union. Some key project personnel in the PCU include: (i) Project Coordinator (Power/electrical engineer), (ii) Procurement Specialist, (iii) Hydrologist, (iv) Project Accountant, (v) Mechanical/Civil engineer, (vi) M&E Specialist, (vii) Gender Expert, (viii) Community Outreach Officer, (ix) Environmental Specialist, and (x) 3 support staff.

4.4 A Project Steering Committee (PSC), chaired by the Minister of MLME with representatives from the MoFDP, RREA, LEC, Rural Energy Fund (REFUND), Environmental Protection Agency, Liberia Water and Sewer Co-operation, a Nimba County Representative, Non-Governmental Organizations and Civil Society Organizations, provides oversight governance and take strategic decisions including approving annual work plans, budgets and procurement plans. The PSC's role will be instrumental during the procurement phase of the project implementation.

4.5 The RREA was established as a permanent and autonomous agency in 2015. Until that day, RREA was operating under the guidance of MLME, with RREA's Executive Director appointed

and reporting to the minister. The GoL has appointed RREA's Board of Directors, which meets on a quarterly basis (current year first quarter meeting to be held before end of April 2017). The Board of Directors is in charge of providing strategic guidance and to undertake general oversight on the activities of the agency. Membership of the Board of Directors includes representatives of MLME, LEC, Ministry of Justice, the Executive Director of RREA, three persons selected to ensure equitable geographies and demographics, three persons selected on the basis of their qualifications and experience, and one representative of civil society. As part of its functions, the Board of Directors will facilitate inter-ministerial cooperation, which will be particularly useful for the proposed project during implementation.

4.6 The RREA is currently concluding the development of our Business Plan that will incorporate a methodology expected to have the Generation Plant operated by an Independent Power Producer (IPP). The first meeting with potential IPPs across the country has been held and it's expected that the Business Plan will be presented June 2017.

4.7 Consistent with the LEC and RREA Electrification Master Plans, the RREA and LEC will enter into an Memorandum of Understanding regarding the transmission of the Power, whereas, the distribution of power to end users will be implemented through Power Purchase Agreements, as is being done in Nimba County.

Procurement

4.8 The procurement of works and the acquisition of consulting services, financed by AfDB under the project, will be carried out in accordance with the *"Procurement Policy and Methodology for Bank Group Funded Operations"*, dated October 2015 and will align with any provision captured in the Funding Agreement.

4.9 The assessment of procurement risks at the country, sector, and project levels and of the procurement capacity of RREA to implement procurement actions will be undertaken before approval by AfDB's Board of Directors approval which outputs will serve as the basis to improve the final proposal and make final decisions on the allowed procurement methods to be used. Given the preliminary risks identified, some appropriate risk mitigation measures might include capacity building to train members of the PCU and the hiring of additional procurement experts to ensure a smooth implementation.

4.10 A draft Procurement Plan to capture the first 18 months of project implementation will be discussed with RREA during the final appraisal phase of the project. An assessment on the strength of these systems will also be undertaken during appraisal to ensure the company is well prepared to undertake this function.

Financial Management Arrangements and Audit

4.11 The financial management systems of the RREA and the executing agency (MLME) were assessed to determine their adequacy in fulfilling the fiduciary requirements of the proposed project. The RREA, will have direct responsibility for the day-to-day implementation of the proposed project. The Director of Finance has overall responsibility for the financial management system of the unit and shall be supported by a qualified project accountant and an accounts assistant. An accounting software - QuickBooks - will be used for project accounting and preparation of financial reports. The project will adopt International Public Sector Accounting Standards Cash Basis, in line with GoL accounting standards. The Project Accountant will produce quarterly interim financial reports for submission to AfDB, no later than 30 days at the end of each quarter. The project will be required to submit to AfDB, annual audited financial reports that will include audited financial statements and a management letter within six months of the end of each fiscal year. The annual audit will be performed by an independent external audit firm hired by RREA under the guidance of the auditor general, with audit terms of reference agreed with the AfDB.

4.12 The project will develop manuals for financial management and administrative procedures that will be drawn from existing manuals to streamline the financial management practices within the proposed project. A project implementation manual will be developed and operationalized by the project to guide implementation. AfDB recommended that the Internal Audit Agency deploys an internal auditor to the PCU, dedicated to the RREA projects to help strengthen the overall internal control environment.

4.13 **Disbursement**. Four disbursement methods (direct payments, payments through special account, reimbursement method and reimbursement guarantee) can be used in accordance with AfDB Disbursement Handbook in advancing resources to its projects. The most appropriate methods for this project include: (i) direct payment against large value contracts concluded by project management and duly approved by AfDB; (ii) payment through a Special Account for meeting small value contracts and recurrent expenses, and/or (iii) any other disbursement method allowed for by AfDB's rules. The beneficiary and the PCU shall comply with the procedures outlined in the Bank's Disbursement Handbook at all times.

4.14 A preparatory mission undertaken by AfDB during the first quarter of 2017, concluded that RREA has the adequate financial management arrangements in place to implement the proposed project, subject to the establishment of a PSC, the recruitment of key project staff (including a qualified project accounting), customization of financial management and administrative procedures, development of project implementation manuals, as well as deploying an internal auditor dedicated to RREA Projects.

Environmental & Social

4.15 A preliminary Environmental and Social assessment undertaken as part of the implementation of the SREP Project Preparation Grant identified the following potential impacts of the project: (i) loss of vegetation, (ii) alteration in river water flows, (iii) risk of degradation of water resources and aquatic resources, and (iii) impacts on Gbedin wetland located downstream. The following mitigation measures are being considered: (i) avoidance of vegetation clearing and densely vegetated areas during project construction by restricting clearing on construction areas and using the existing access roads as much as possible; (ii) choosing a site with high annual river flows and choosing a 'run-of-river' HPP design with a sediment management system; (iii) procure hydro technologies that cause little impacts on fisheries' resources, and (iv) ensuring that the economic, social and ecologic needs downstream of the power plant are taken into account during all phases of the project.

4.16 The project is expected to cause some negative impacts on the livelihoods of certain groups of people living in the surroundings of the project even though these are expected to be minimal due to the fact that the feasibility studies and visits to the site indicates that no involuntary physical displacement will be required but economic displacement, and subsequent income loss, resulting from losses in subsistence agricultural and fisheries. At Gbedin, rice irrigation is being attempted under a program funded by the GoL. A large sugar cane farm was also identified downstream of Gbedin Falls. The project design intends to avoid and minimize land acquisition where possible. Compensation will be paid for any loss of income. AfDB will ensure through the inclusion of conditions precedent for effectiveness of the funding agreement that project affected people is compensated in a fair manner. In addition, a water demand analysis downstream of the project site will be undertaken as part of the ESIA studies in order to ensure that water demands are sufficient to meet current economic activities.

4.17 The social risk of loss of traditional agricultural land and fishing areas has been determined as low. Stakeholder consultations will be carried out and a stakeholder engagement plan will be developed and shall include a grievance redress mechanism that will be designed taking into considerations these consultations. The transboundary nature of Mani River and the location of the right axis of the weir on the right bank of the river, which is located in Guinea might raise transboundary issues. The GoL indicated that it will be engaging with the Government of Guinea to discuss project. Currently, there are other hydropower projects that are benefiting from transboundary river resources. For these cases, regional agreements are in place and can be used during negotiations. The environmental laws in Liberia also provide for measures on dealing with transboundary impacts that also includes negotiation processes.

4.18 As per AfDB's Integrated Safeguards System, the Project will most likely be categorized as Category 1, which consider operations likely to cause significant environmental and social impacts. Project under this category may be very vulnerable to climate change and require a detailed evaluation of climate change risks and adaptation measures. Comprehensive, practical risk management and adaptation measures will be integrated into the project design and implementation plans. As per AfDB's rules, public consultations will be undertaken during the conclusion of the Environmental and Social Impact Assessment studies, the Environmental and

Social Management Plan and the Stakeholder Engagement plan to ensure that all risks are properly identified and managed.

Risks and Mitigation Measures

4.19 Given the maturity of the hydropower technology, and the results of the detailed feasibility studies and the, the overall project risk is considered moderate for project implementation. The key categories related to sector strategy, technical design of the project and institutional capacity are all rated moderate, given technical design of the project.

Table 5: Risk Ratings Summary

Risk Category	Rating	Mitigation Measures
1. Political and Governance	Moderate	Liberia has been devastated by the 14-years civil war but the Country is progressively healing. Democratic institutions with free elections have been restored. Increased dialogue with all players in the political arena will help ensuring that emerging security needs are properly managed. Governance improvements are still required to increase transparency and to reduce real and perceived corruption, and increase service delivery, including implementing regional security hubs. Infrastructure investments will be made in excluded areas to reduce exclusion as well as internal and regional tensions, and help diversify the economy.
2. Macroeconomic Stability	Substantial	Liberia's economy is shrinking since 2014. In 2016, the economy contracted by 0.5% mainly due to a sharp decline in commodity prices and the country struggle to address spill over effects caused by the Ebola disease. The GoL has reduced the public budget by almost 15% amid increased inflationary pressures and the relatively fast depreciation of the local currency in an attempt to correct its deficit. Coming from a decade long civil war that ended in 2003, Liberia democratic transition process is still in its infancy and still at a critical stage. Despite the above, the country has to overcome an additional number of fiscal challenges during the 2017 fiscal year, such as taking full responsibility for peace and security following the withdrawal of the United Nations peace mission in the country, funding the pending presidential elections, and allocate resources for investments required under the post-Ebola economic recovery plan. Over the medium term, economic growth is expected to increase from 2% in 2016 to 5.0% on average, due to a recovery in mining and improvements in infrastructure, particularly in energy and roads, and higher agricultural productivity. The authorities have managed to maintain macroeconomic stability in a difficult economic situation but substantial risks remain in terms of the macroeconomic stability of the country which can affect the implementation of the project.
3. Sector Strategies and Policies	Substantial	The GoL's efforts focused on reconstructing the electricity sector and developed the NEP in 2009, setting clear goals

		for the sector. The NEP called for universal, sustainable access to affordable, reliable energy to foster Liberia's economic, political, and social development. Despite approving a new Electricity Law in September 2015, the country lacks regulations for decentralized electrification. The SREP funded Liberia Renewable Energy Access Project being implemented by the World Bank aims at developing such regulations. Since the power of the Gbedin Falls HPP will be injected in the existing cross-border grid, this shall not represent an issue.
4. Technical Design of Project	Moderate	The Gbedin Falls HPP is a promising power plant due to its envisaged installed capacity and the fact that will be connected to the grid. The natural characteristics of the site allow for a run-of-river design which cause less environmental and social impacts than traditional HPP. At full operation, the Plant will deliver 56.4 GWh with 0.71 load factor in the wet season and 0.4 in the dry season.
5. Institutional Capacity for Implementation	Substantial	The energy sector is strengthening its capacity through training of local experts for the Mt. Coffee HPP. In addition, the existence of an activity to reinforce the capacity of RREA in the Liberia Energy Access Project being funded by the World Bank contributes to partially mitigate this risk. Since RREA will be responsible for implementing the two projects, benefits accruing from the complementarity between the two projects is strong. Nevertheless, AfDB will closely monitor the capacity of RREA to ensure the agency has the needed staff to deliver on the project's activities and objectives.
6. Fiduciary	Moderate	Several stakeholders are engaged with the development of this power plant in Liberia. The existing governance, monitoring & evaluation, as well as other capacities of the PCU represent good tools to mitigate the risks associated with the fiduciary aspect of the project. In addition, RREA operates as the implementing entity of the World Bank's SREP funded project (Liberia Renewable Energy Access Project) provide sufficient confidence that fiduciary risk in the context of the project will be moderate. AfDB will nevertheless continuously supervise the project throughout its life and ensure that this risk is properly monitored and mitigated.
7. Environment and Social	Moderate	The GoL has received several funds from AfDB to develop its energy, roads and water infrastructures and is already familiar with the Bank's Environment and Social requirements.

5. SREP INVESTMENT CRITERIA

Outline of SREP Investment Criteria

5.1 Detailed outline of the SREP investment criteria relevant to the Liberia Renewable Energy Project are presented below:

- **Increased installed capacity from renewable energy sources**. Gbedin Falls HPP will add 9.34 MW of installed capacity from hydro resources to generate 56.5 GWh/year with capacity factor of 0.71 in the wet season and 0.4 in the dry season.

- **Increased access to energy through renewable energy sources**. The proposed project aligns well with Liberia's Agenda for Transformation which calls on electricity services expansion and reduction of the cost of electricity as essential conditions to achieve economic transformation. At less than 2%[3], Liberia has one of the World's lowest rates of electrification and therefore, expand access to electricity is one of the country's topmost priorities. Success will not only help addressing the needs of critical social facilities (e.g. health, education centers, water treatment plants, and others) but will also support the economic and social recovery of the country following the Ebola crisis of 2014. The electricity to be generated by the Gbedin Falls HPP will be transmitted via the existing Liberia-Cote d'Ivoire cross-border transmission line. Based on average households' electricity consumption habits that currently stand at 510 kWh per year for an average family of 5.1 persons, it is estimated that the project could meet 13% of the current total electricity demand in the country and supply electricity to around 110,784 households and benefit a total of 564,998 people, of which around 50% would be women and children.

- **Low emission development.** The GHG emission savings potential of the proposed project was estimated by using the proxy-based method to estimate CO_2 emissions equivalent based on diesel generated electricity (793.7 tCO_2 equivalent per GWh). When applied to the proposed project, this method estimates a total emission savings of 44,804 tCO_2 equivalent on an annual basis. Over a lifetime of 30 years, the total savings would be approximately 1,344,120 tCO_2 equivalent. Additional savings could be expected due to a reduction in the consumptions of kerosene and wood fuel consumed by households which will also reduce indoor pollution and improves health.

- **Affordability and competitiveness of renewable sources:** Renewable Energy resources in Eastern Liberia have been identified and detailed feasibilities conducted on Gbedin Falls, Ya Creek and River Gee hydro generation sites and one biomass are available. Compared to other sources of energy developed in the country, the Gbedin Falls represents the least cost option. In fact, for comparison purpose, USAID is currently developing 1 MW HPP on the Mein River in Suakoko District, Bong County which has a total cost about USD 7.25 million. The toll of electricity prices on the monthly budget of Liberian families is especially important in a country where an estimated 76% of the population has an income of less than USD 1 a day and 52% less than USD 0.5 a day.

- **Productive use of energy:** The mini-grids will provide reliable and affordable electricity to the main towns of Nimba County which is a commercial, agricultural and economic hub in the region. Businesses and other productive uses have been already identified as potential customers of the electricity, such as cold storage, infrastructure machinery, sugar

[3] ESMAP, 2016.

crushers and palm oil processors. In addition, the project will power about 32,000 households, community services (such as hospitals, schools), and businesses.

- **Economic, social and environmental development impact:** The project will contribute to the expansion of electricity infrastructure for economic and social development using renewable energy. The proposed project will contribute to: (i) increase quantity and quality of electricity services in remote areas for households, public sector facilities, businesses and industrial loads; (ii) accrue educational benefits (e.g., through the provision of electricity to schools and households, lighting allows children to study at night); (iii) reduce GHG emissions from using renewable energy sources for power generation; (iv) increase income or productivity from promoting productive uses of electricity in agricultural, commercial, and industrial activities; (v) generate employment opportunities, mainly related to construction, operation, and maintenance of hybrid mini-grid systems; and (ix) increased public safety in service areas due to street lighting.

- **Financial and Economic viability:** The financial internal rate of return and the net present value of the project were calculated on the basis of the cost-benefit method for the implementation and operation of the project. The analysis covers a design life of 30 years and shows that the Gbedin Falls project is financially viable with a tariff of USD 0.13/kWh, which is sufficient to ensure sustainability of the system and at the same time is 70% below the current electricity tariff in Monrovia. Annex II provides the economic analysis undertaken in the context of the project and shows that the project would be economically viable with an economic internal return rate of 32.4% and an economic net present value of USD 124 million.

- **Leveraging of additional resources:** For each USD mobilized through the SREP, a total of USD 0.26 will be mobilized additionally. This figure is well-below the target defined in the SREP Liberia IP and is the result of a number of issues. These include: (i) insufficient ADF XIV allocation to Liberia, (ii) prioritization of highly concessional support being channeled to other priority sectors, namely health and education, in order to fast-track the economic recovery of the country post-Ebola, (iii) inability of the GoL to provide funding to the project due to limitations imposed by the International Monetary Fund on the country's capacity to borrow additional funds, and (iv) other priority projects in the energy sector by Development Partners.

- **Co-benefits of renewable energy scale-up:** The Project is expected to bring wider environmental, economic and social co-benefits both Nimba County and nationwide, including: (i) an amount of 1,344,120 tons of GHG emissions will be avoided over a 30 year lifetime. In addition, it will also lead to local pollution reduction from diesel generators, kerosene lamps, candles, and dry cell batteries that would have otherwise been kept for lighting or communication, (ii) employment opportunities will be generated, mainly from construction, operation, and maintenance of the project, (iii) build and sustain management and technical skills within rural communities, which will support income raise and decentralization, (iv) increased access to electricity that shall drive a raise in

income generating activities as well as enhancing communications over cell-phones and access to information, (vi) enhanced energy security and reduced dependence on imported fossil fuels, (vii) increased access to improved education and health services

iv. SREP RESULTS FRAMEWORK

6.1 SREP Core Indicators and targets expected to be achieved as a result of the implementation of the proposed project are presented in Table 6 below.

Table 6: SREP Results Framework

INDICATORS	TARGET
Annual Electricity Output in GWh	56.4
Increased Public and Private Investment (in USD million)	4.59
Number of people with improved access to electricity (men/women)	64,644 / 65,356
GHG emissions avoided in tons CO2 equivalent (annual/lifetime)	44,804 / 1,344,120

Monitoring & Evaluation

6.2 The project will be implemented over a period of 51 months from funding effectiveness, including 15 months of tendering process and 36 months for construction

6.3 The monitoring and evaluation of the project's implementation progress and impact will be the overall responsibility of RREA. The PCU will include a monitoring and evaluation expert to ensure proper monitoring of project. The project coordinator will be responsible for collecting and analysing indicators of the results framework and for preparing quarterly progress reports on the project.

6.4 The AfDB will monitor the project during implementation through regular supervision missions (at least twice a year) and review of annual audit reports. AfDB undertakes mid-term review of its projects approximately 18 months after approval by the Board of Directors. A Project Completion Report Shall be prepared 6 months after the completion of the project.

v. INDICATIVE TIMELINE

7.1 Table 7 presents an indicative timeline for the finalization of the project's appraisal, approval, effectiveness and disbursement.

Table 7: Indicative Timeline

ACTIVITY	DATE
SREP Sub-Committee approval	May 2017
Appraisal	June 2017
Approval by AfDB Board of Directors	September 2017
Effectiveness	December 2017
First Disbursement	January 2018

vi. CONCLUSION AND RECOMMENDATION

8.1 Lack of access to reliable, affordable and productive energy is is one of the key barriers in the social, economic and environmental development of Liberia. The development of Gbedin Falls Project in Nimba County can significantly contribute to partially address these barriers and allow to increase the electricity access rate in the targeted region, contributing to economic growth and poverty reduction in the Eastern region of Liberia.

8.2 It is recommended that SREP Sub-Committee approves a grant of USD 23.50 million to support the GoL in the implementation of the Liberia Renewable Energy Project.

Annex 1: Location of the Project Site

Annex 2: Economic Analysis

Methodology

1. The Economic Analyses of the project was undertaken on a macro-scale and considered the costs and benefits of the project at a regional or national level. Economic benefits may include irrigation water supply, flood mitigation, domestic water supply, inland fisheries and river navigation. Economic costs may include resettlement, inundation of agricultural land and environmental impacts.

2. The Gbedin Falls HPP is a run-of-river scheme with very low predicted environmental and social impacts. No economic costs have been identified in the context of these impacts. The economic benefits of the scheme are considered to be the following:

- The avoided costs of operating the HPP instead of the other generation sources

- The avoided costs of CO_2 emissions

- The economic benefit of energy independence (where the other generation sources are imported and subject to global price fluctuations).

3. Liberia has a great need to develop new electricity generation sources to supply the rapidly increasing demand. A study undertaken by Fitchner that assessed several electricity generation options as part of Liberia's least cost power development plan, concluded that reciprocating engines (such as the ones being adopted in the context of the project) are suitable as they can be installed very quickly on a unit by unit basis to meet increasing demands.

4. In addition to reciprocating engines, some energy is currently being imported from Côte d'Ivoire via the cross-border network. In the future it will also be possible to import energy via the 225 kV HV line interconnecting Côte d'Ivoire, Liberia, Sierra Leone and Guinea (CLSG).

Assumptions

5. Two least-cost alternatives are considered: (i) supply from heavy fuel oil units (selected as the most suitable technical alternative in Fichtner, April 2014), and (ii) imported electricity supply from CLSG.

6. The cost of the reciprocating engines is composed of a fixed levelized cost of electricity plus a variable cost which is a function of the production (fuel cost and CO_2 emission costs).

7. The unit costs of CO_2 emissions are a function of the 'carbon price' (assumed to be 30 USD/t) and the carbon intensity of the generation source. For fuel-based generation, the unit cost of CO_2 emissions was assumed to be USD 0.017 / kWh.

8. The unit cost of the plant then depends on the amount of energy produced during the lifetime of the scheme. Table 1 shows that the unit rate for two scenarios: to be conservative, the lowest unit rate has been adopted for the economic analysis.

Table 1: Unit rate of HFO units as a function of the production

Item	**Production**	**Unit cost (including CO_2 emission costs)**
HFO plant backup (with a design capacity of 9.34 MW) Producing only firm energy (90% of reliability)	73.62 GWh/year	23.2 USc/kWh
HFO plant backup (with a design capacity of 9.34 MW) Producing the same amount of energy as Gbedin Falls HPP	56.5 GWh/year	23.7 USc/kWh

9. The unit cost of imported supply via the CLSG is assumed to be USD 0.15/kWh.

Economic parameters

10. The following parameters were used for the economic analysis of the Gbedin Falls HPP: (i) net present value, benefit-cost ratio and internal rate of return.

11. The spreadsheets used for the calculation of these parameters are provided in Appendix E. The financial parameters are summarized in Table 40.

Table 2: Economic parameters for Gbedin Falls HPP

Economic parameter	**HPP substitution for HFO generation**	**HPP substitution for imported generation**
Economic value of the energy	USD 160.5 million	USD 103.8 million
ENPV	USD 124 million	USD 67 million
EBCR	4.4	2.8
EIRR	32.4%	22.9%

Sensitivity analyses

12. Sensitivity analyses was performed for each of the other generation sources by varying the avoided economic costs (in this case the unit generation cost) and the discount rate. The results of the sensitivity analyses are presented in Table 3 and 4 for the unit generation cost and 6 for the discount rate. The absolute change and percentage changes from the base case are also shown.

Table 3: Economic parameters – sensitivity analysis for substitution of HFO generation (unit generation cost)

Economic parameter	**Unit generation cost -20%**		**Unit generation cost +20%**	
	Result	**Variation**	**Result**	**Variation**
Economic value of the energy	USD 128.4 million	USD -32.09 million / -20%	USD 192.6 million	USD +32.12 million / +20%
ENPV	USD 92 million	USD -32.09 million / -25.9%	USD 156 million	USD +32.12 million / +26%
EBCR	3.5	-0.87 / -20%	5.2	+0.87 / +20%
EIRR	27.2%	-5.21% / -16%	37.2%	+4.78% / +14.7%

Table 1: Economic parameters – sensitivity analysis for substitution of imported generation (unit generation cost)

Economic parameter	**Unit generation cost -20%**		**Unit generation cost +20%**	
	Result	**Variation**	**Result**	**Variation**
Economic value of the energy	USD 83 million	USD -20.76 million / -20%	USD 124.5 million	USD +20.76 million / +20%
ENPV	USD 46 million	USD -20.76 million / -31%	USD 88 million	USD +20.76 million / +31%
EBCR	2.3	-0.56 / -20%	3.4	+0.56 / +20%
EIRR	18.9%	-4% / -17.5%	26.6%	+3.7% / +16.2%

Table 5: Economic parameters – sensitivity analysis for substitution of HFO generation (discount rate)

Economic parameter	Discount rate 6%		Discount rate 10%	
	Result	**Variation**	**Result**	**Variation**
Economic value of the energy	USD 193.4 million	USD +32.85 million / +20.5%	USD 136.6 million	USD -23.96 million / -14.9%
ENPV	USD 157 million	USD +33.1 million / +26.7%	USD 99 million	USD -24.6 million / -19.9%
EBCR	5.3	+0.93 / +21.3%	3.7	-0.72 / -16.4%
EIRR	N/A	N/A	N/A	N/A

Table 6: Economic parameters – sensitivity analysis for substitution of imported generation (discount rate)

Economic parameter	Discount rate 6%		Discount rate 10%	
	Result	**Variation**	**Result**	**Variation**
Economic value of the energy	USD 125 million	USD +21.23 million / +20.5%	USD 88.3 million	USD -15.5 million / -14.9%
ENPV	USD 89 million	USD +21.48 million / +32%	USD 51 million	USD -16.14 million / -24.1%
EBCR	3.4	+0.6 / +21.3%	2.4	-0.46 / -16.4%
EIRR	N/A	N/A	N/A	N/A