Economic Community
Of West African States

Communauté Economique
Des Etas de l'Afrique de l'Ouest

WEST AFRICAN POWER POOL
SYSTEME D'ECHANGES D'ENERGIE ELECTRIQUE OUEST AFRICAIN
General Secrétariat / Secrétariat Général

REGIONAL SOLAR PARK PROJECT IN GAMBIA

TERMS OF REFERENCE FEASABILITY STUDY

September 2019

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LIST of ABBREVIATIONS

ECOWAS	Economic Community of West African States
IPP	Independent Power Producers
NAWEC	National Water & Electricity Company LTD
PPA	Power Purchase Agreement
RES	Renewable Energy Source
ToR	Term of Reference
WAPP	West African Power Pool
OMVG	Organisation de Mise en Valeur du fleuve Gambie
PPP	Public-Private Partnership
TFP	Technical and financial partner
GIS	Geographic information system
PIU	Project Implementation Unit
2iE	Institut International de l'Eau et de l'Environnement
RES	Renewable Energy Source

1. INTRODUCTION

1.1 West African Power Pool

The West African Power Pool ("WAPP") was created in 1999 at the Conference of Heads of State and Government of the Economic Community of West African States ("ECOWAS"). There was a realization that the immense energy resources available to the region, even if not equitably distributed geographically, could be exploited for the mutual benefit of all Members to increase access to reliable and affordable electricity for the socio-economic development of countries. In 2006, the ECOWAS Conference of Heads of State and Government invested the WAPP with the mission of promoting and developing electricity generation and transmission infrastructure as well as coordinating exchanges of electrical energy between ECOWAS Member States.

The Strategy of WAPP is based on the implementation of infrastructure programs with various regional projects of generation and transmission of electric power, which are mutually complementary and reinforcing the regional network. Ultimately, the completion of these infrastructure projects will allow the integration of all power grids in West Africa. The WAPP Infrastructure Program is based on the results of the ECOWAS Master Plan for the Production and Transmission of Electrical Energy Resources approved by the Heads of State and Government in December 2018.

1.2 WAPP Master Plan

Since its establishment, the WAPP Secretariat has taken a leading role in the development of the regional infrastructure and in the implementation of the priority projects defined in the Master Plan of the means of production of transport of electric energy of ECOWAS.

The ECOWAS Master Plan forms the basis for the development of regional projects in the region. The actual Master Plan was approved by Heads of States in December 2018 through Supplementary Act A/SA.4/12/18. This Master Plan identified 75 (#) regional projects deemed priority for the period 2019-2033 among which there are 47 (#) generation projects with a total capacity of approximately 15.49 GW and 28 (#) transmission line projects of approximately 22,932 km of high-voltage transmission lines.

The generation projects comprise:

- 31.1% thermal projects operating mainly with natural gas and
- 68.9% renewable energy projects (10.67 GW) of which 29.5% involve Variable Renewable Energy (VRE) projects (3.15 GW solar, wind)

WAPP supports national companies in their implementation and the completion of the feasibility studies and environmental studies necessary for their financing.

The Master Plan has shown the interest of the massive development of hydropower in West Africa and the construction of a reliable transmission network allowing the sharing of resources throughout the region.

Nevertheless, it was pointed out that in a regional context where macroeconomic parameters could strongly influence the discounted cost, it is important to maintain a balanced energy mix between the different resources in order to guarantee a reasonable development cost under all circumstances and ensure the technical and financial viability of the development plan.

The Master Plan also showed interest in the development of renewable energy throughout West Africa given that the cost of solar photovoltaic installations ("PV") has been greatly reduced. This is why some large renewable projects have been proposed among the priority regional projects. A solar power plants of 150 MW have been considered and planned by The Gambia. It was also recommended that countries with large solar or wind or biomass resources develop these resources nationally.

1.3 Solar Park Concept “Plug & Play”

It is proposed that one regional solar project with an indicative capacity of 150 MW will be developed in The Gambia under the concept of Solar Park "Plug & Play". The concept of Solar Park "Plug & Play" has already been developed in many countries (e.g.: India), since it is easier to be controlled and less expensive to develop (Fig.1. refers).

The government identifies a site based on the following criteria: (i) the capacity of a given substation and the network to absorb the electricity generated by the solar park ; (ii) the solar radiation; (iii) the availability of land to allow the development of a large-scale project to achieve economies of scale; and (iv) the road access .

The government ensures the availability of land, obtains certain permits necessary to sign the Power Purchase Agreement ("PPA") and prepares the transmission lines between the Solar Park and the utility connection substation.

The reduction of regulatory barriers and the development of an auction system organized with a bankable PPP would allow a significant reduction in the cost of repurchasing electricity and will permit the independent power producers ("IPP") to have a direct access to the grounds and infrastructure of the Solar Park.

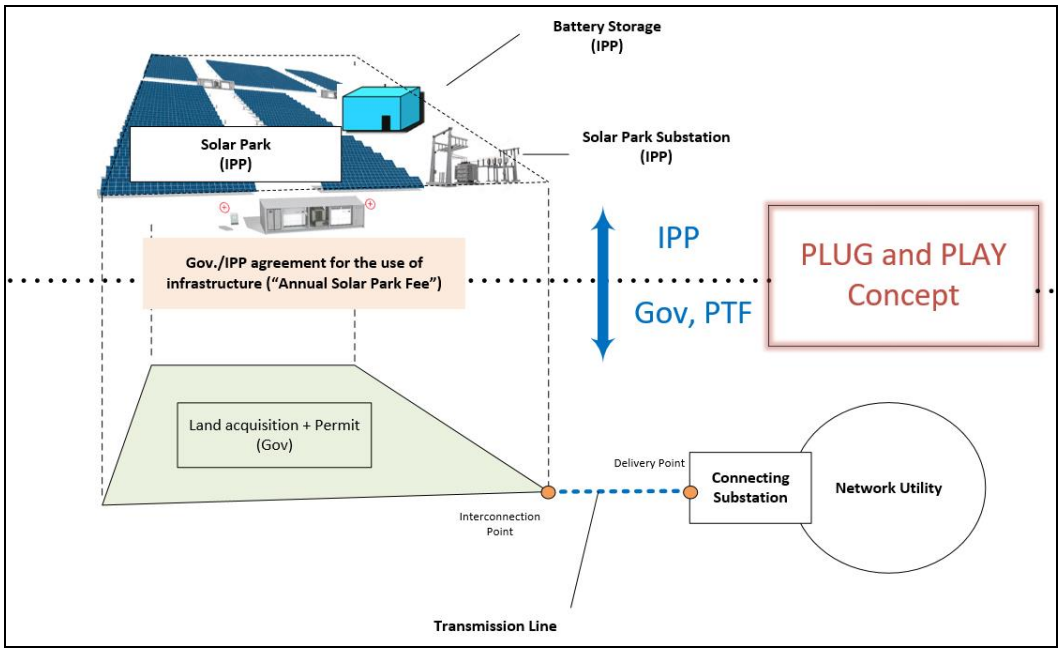

Fig. 1: Solar pack's Plug and Play concept

1.4 Objectives of the Terms of Reference

The WAPP with Governments of The Gambia (the "Client") seeks consultants or a consortium of consultants (the "Consultant") to produce technical and financial feasibility studies following the concept of Solar Park "Plug & Play" in The Gambia.

Preliminary screening indicates approximately 172 km^2 suitable for solar PV in a 20km radius around Soma where a 225/30 kV OMVG substation is under construction (Fig.2. refers).

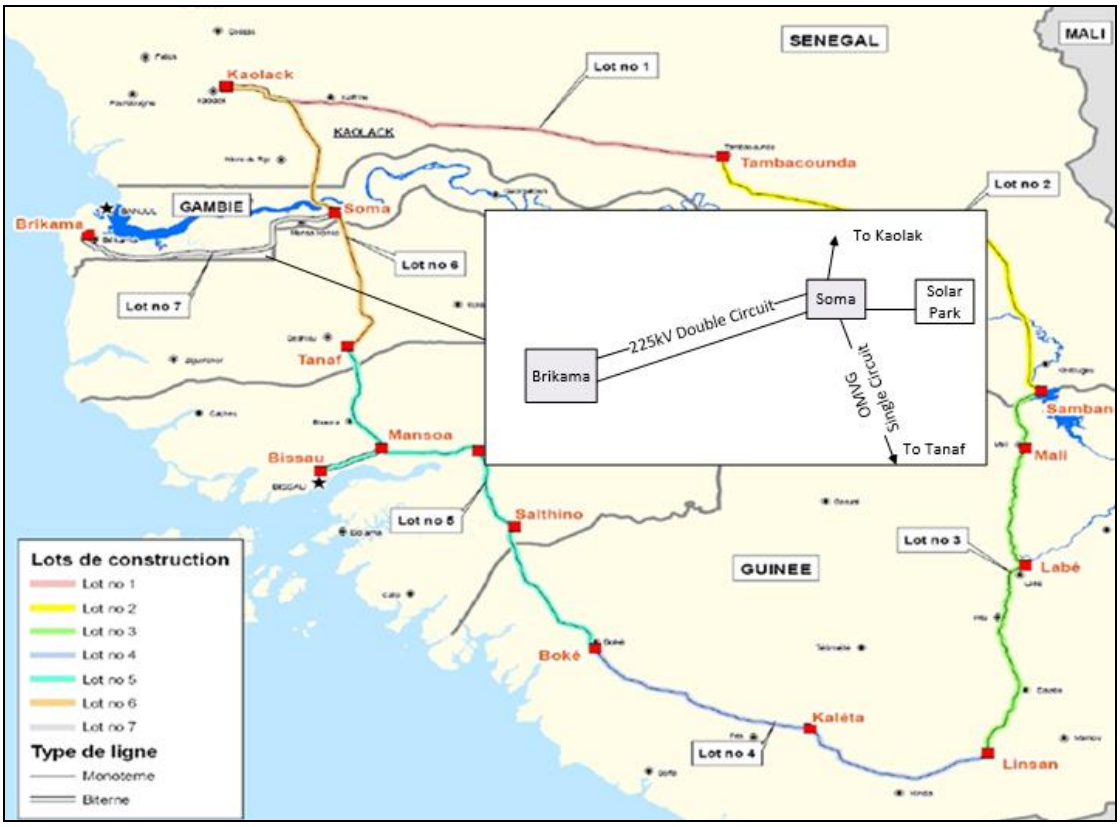

Fig.2: Soma's 225/30 kV OMVG substation

This study will make a "land banking" exercise to secure sites for future solar development and also define the optimal strategy for the phasing of the construction of this solar park with the consideration of storage battery and connection to the transmission network.

Moreover, this study will perform a diagnosis and an evaluation of the investments required for the creation of the Dispatching Center with the view to integrate the solar electricity generation.

2. SOLAR PARK IN THE GAMBIA: FEASIBILITY STUDY

2.1 Introduction

2.1.1 Electricity Sector in The Gambia

Aligned with the long-term vision to build an efficient, reliable, and sustainable energy infrastructure to support socio-economic development, the National Energy Policy of The Gambia serves as the overarching policy framework for the strategic development of the sector. The electricity sub-sector is governed by the Electricity Act of 2005, which promotes the development of the electricity sub-sector in The Gambia, with a view of attracting private investments to stimulate competition and growth. The Electricity sub-sector roadmap, developed and approved by government of The Gambia in 2017 sets the direction for the development of the sector in the short-to-medium term (2017-2025) with a vision to modernize the sector and expand electricity generation and access in the country.

The Gambia electricity sub-sector is characterized by heavy dependence on fuel (HFO/LFO) imports for electricity generation, which is costly and exposes the country to the volatile fuel market prices, which negatively affects the cost of service and delivery. Electricity services are provided by the National Water and Electricity Company (NAWEC), which is a state-owned vertically integrated utility that handles generation, transmission, distribution, and retail of electricity.

NAWEC operates two main power plants in Kotu and Brikama serving the Greater Banjul Area (GBA). In the rural areas, NAWEC provides electricity through two independent grids, covering the north and south bank of the river. NAWEC plans to connect the different grids creating a national transmission backbone covering the whole country. As of January 2019, the total installed capacity in the country was around 139 MW. Keeping with the targets in the electricity roadmap, The Gambia seeks to scale up its generation capacity to 300 MW by 2025.

Up until 2006, NAWEC was the sole producer of electricity in The Gambia, but reforms in the sector, such as the establishment of a regulator and the liberalization of electricity generation, saw the emergence of private sector participation in the electricity market. The first Independent Power Producer (IPP) project was commissioned in 2006 for a capacity of 25.4 MW HFO power plant in Brikama, owned and operated by a private company. In 2018, NAWEC contracted a short-term power rental Independent Power Producer (IPP) for a capacity of 30 MW, serving the Greater Banjul Area.

The Gambia aims to transition to competitively tendered IPPs as the main source of financing new domestic generation. The target is to have domestic generation capacity able to generate at least 50 percent of electricity needs, but with a willingness and readiness to import/export electricity within the context of the regional electricity market, being developed by WAPP. The Gambia also intends to upgrade its electricity transmission and distribution infrastructure in line with the OMVG interconnection network.

2.1.2 The development of solar energy in The Gambia

By virtue of its geographical location, The Gambia enjoys very good solar insolation throughout the year with slight seasonal variations. The average daily solar radiation ranges from 4.4 to 6.7 kWh/m^2— making solar energy the most prominent renewable energy resource of the country. Other available renewable energy resources include wind and biomass. Since the early 1980s, solar energy, particularly photovoltaic (PV) technologies, has had the most successful application of renewable energy in The Gambia. Early uses included rural water supply and remote power for telecommunication facilities. To date, the use of solar PV technology in The Gambia remains largely limited to distributed and off-grid applications.

In an effort to promote the development and use of renewable energy in The Gambia, the Renewable Energy Act was enacted in December 2013 to stimulate the deployment of both on- and off-grid renewables in the country's electricity mix in order to achieve greater energy self-reliance and reduce The Gambia's dependence on fuel imports for electricity generation. In the electricity roadmap, solar PV is recognized as a low-cost game-changer for he Gambia electricity sector.

A number of utility scale solar PV projects have been committed and in the pipeline for implementation in the Gambia. This includes a 20 MW solar PV power plant financed by the World Bank and the European Union as part of the Gambia Electricity Restoration and Modernization Project (GERMP). Also, NAWEC has signed a power purchase agreement (IPP) with an IPP for a 10 MW solar PV project. These solar PV projects and upcoming projects will contribute significantly to increase the share of renewables in the Gambia's electricity and diversification of energy resources.

2.2 Study context

2.2.1 Preliminary study

As part of the development of a Regional Solar Park in The Gambia, a preliminary planning calculation concluded that there will be a benefit to The Gambia for a solar park connected on OMVG Soma's substation. The imports from WAPP OMVG and a solar park with storage (150 MW additional solar in two phases with 20 MWH storage to manage grid integration) will be the lowest cost option to scale up generation and represent an excellent opportunity for The Gambia.

GIS analysis was also conducted around Soma and Brikama. According the discussion with the authorities, the Soma site could be developed according the land availability near the OMVG Soma's substation and a feasible technical integration in the NAWEC's network with the future 225 kV Soma-Brikama.

2.2.2 Selection of Sites and Connection Stations

As the preliminary GIS did not provide judgment on the prioritization of sites, there was a need to deepen the selection criteria to select the optimal sites for the feasibility study. The selection criteria for the best site (s) are:

(i) Excellent solar irradiation;
(ii)A significant availability of land in a vicinity of 20 km from the substation;
(iii) Low agricultural land use;
(iv) Easy transmission line interconnection to Soma's Substation.
(v)Easy Access

The map below in Fig 3 shows the results on the preliminary GIS near Soma's substation.

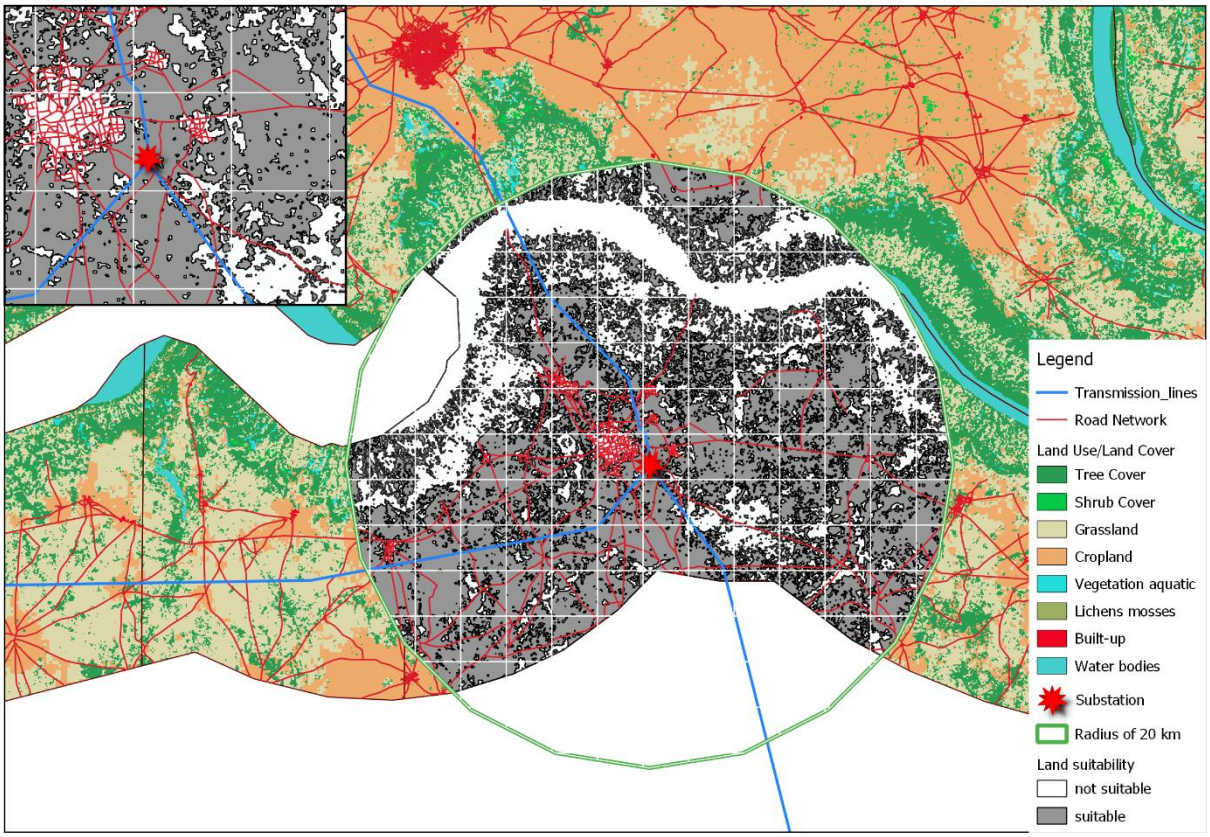

Fig. 3: Preliminary GIS map near Soma in The Gambia

2.2.3 Integration in the Network and Storage

The preliminary power planning model developed for the energy sector roadmap concluded that the feasibility study should include 150 MWp solar in two phases (80MW in 2021 followed by 70MW in 2025), with storage.

The integration study should consider that the 150 MW could be planned for the national demand and export via OMVG network. The detailed simulations need to estimate the required spinning reserve, the risk of lack of reactive power and the installation of battery storage. The consultants of the solar park feasibility study will therefore have to confirm the capacity of solar park, phasing, layout, connection and maintenance and integration into the NAWEC network as well as the potential need for network support through storage.

According to preliminary estimates, the 150 MWp Gambia Solar Park will be combined with between 100 and 150 MWh of battery.

In addition, the Consultant will carry out a diagnosis and an assessment of investment needs for the creation of the National Dispatching Center for the operationalization of the solar park.

2.3 Objectives of the study

The feasibility study has three main objectives:

- ✓ **Select the land of the Solar Park**

Consultant will identify land parcels and size of about 225 hectares within a perimeter of 20 km from Soma substation through a review of the cadastral and environmentally sensitive areas, residential areas (hamlets / villages etc.), geotechnical peculiarities of the area, access and solar irradiation and this in partnership with the Client and the local government.

Network stability study will analyze the potential constraint to connect the 150 MW solar park to the 225/30 kV Soma substation in two phases (80MW in 2021 followed by 70MW in 2025), with storage. The analyses will also determine the capacity of the required battery storage.

The Consultant will need to highlight the potential risks of each parcel of land and will work closely with the World Bank's legal and environmental / social teams for all land safeguarding and verification. An environmental and social impact study following IFC's Equator Principles and World Bank Safeguards (" ESIA ") will be developed separately under another contract.

According to these preliminary results of the integration study and field identification, the Consultant with the Client will select the optimal site for the solar park and the line routing from the transmission line to Soma’s substation.

- ✓ **Finalize the technical aspects of the solar power station**

The Consultant will have to finalize the technical characteristics of the Solar Park with storage to allow a shift in time of the solar production for two to three hours towards the peak of the evening as well as to control the generation during the day.

These points will have to be done in partnership with the team in charge of the network study, as well as through discussions with solar panel and battery equipment manufacturers and the World Bank's financial and technical teams.

Through the detailed integration study, the Consultant shall confirm and optimize the phasing for the solar park construction and identify the prioritization and required investments for the Gambian network reinforcement and especially for the Transmission Lines Soma-Brikama and Brikama’s substation.

The Consultant will have to submit all the calculations and to draw up all the drawings relating to the preliminary technical design of the Solar Park with the connection to Soma’s substation and the other potential reinforcements in the Gambian network.

- ✓ **Diagnosis and investment evaluation for the creation of the National Dispatch Center**

The Consultant shall undertake a diagnosis for the creation of Dispatching Center and rules of operation in order to establish an evaluation of required investments in capacity building (research, training) and modernization (hardware equipment, software, smart grid technology, etc.) of the network and Dispatch Center to ensure the integration of solar generation.

The Consultant has to review / establish the grid defense planning: (simulation with and without solar park)

2.4 Scope of Services

The Consultant shall provide services in accordance with internationally recognized practices. The Consultant will also provide its services independently, in accordance with acceptable international standards and the laws and regulations in force in The Gambia and other countries involved in the project.

The detailed ESIA will be provided by another consultant under a separate contract. The Consultant shall work closely with the ESIA team to ensure completion of the Feasibility Study in a timely manner.

The deliverables that should be submitted by the consultant will cover the scope below but not limited to:

- Ensure the collection of data on all elements to be considered for the development, construction and operation of regional renewable energy source in The Gambia;
- Develop a map with the different selection criteria represented - cadastre, environmental sensitive areas, residential areas (hamlets / villages etc.), geotechnical peculiarities of the area, and solar irradiation - within a radius of 20 km from the Soma connection substation;
- Organize discussions with the Governments and NAWEC on the choice of Sola Park close to Soma's substation;
- Identify parcels of land that could be used for the Solar Park and confirm with the ESIA Consultant, and local and national governments, the feasibility and availability of the selected parcels of land;
- Validate with OMVG PIU and NAWEC the configuration of Soma's substation for the connection of 150 MW solar park with battery;
- Perform a load flow study and voltage stability in order to analyse the impacts of solar park generation on the stability of the national grid (NAWEC) and on OMVG countries. This study will be carried out on a static and dynamic model of the network and will make it possible to ensure the feasibility of the evacuation and the connection to the network as well as an evaluation of the investments necessary for the connection (line and substation) and the possible reinforcement of the network;
- Finalize the selection of land for 150 MWp and line routing/right of way for transmission line;
- Perform a thorough analysis of the solar potential of the site (after selection of the land), with a Solar GIS data analysis;

- Determine the technical feasibility of the Solar Park and technical design of a level of detail corresponding to the feasibility stage;
- Confirm the technological solution and the recommended Solar Park configuration and phasing with a storage system, with a greater focus on storage size. The Consultant will have to confirm or suggest the optimal phasing with the different steps to reach 150 MWp;
- Organize discussions with solar panel manufacturers and battery manufacturers;
- Finalize the optimization for battery storage with Solar Park and its phasing;
- Finalize the transient stability study with the technical solution selected to ensure Solar Park integration into the network;
- Develop a simulation of the complete solar and battery system using the PVSyst software after selecting the technology. The PVSyst shall be added as an appendix to the Final Report;
- Determine the viability of the Solar Park by developing a financial analysis and an economic analysis and a risk analysis;
- Determine the potential of solar export to neighboring countries via OMVG network;
- Prepare and submit Final Report that will include the following points
  i) Overview of the Solar Park: description, local and national government support, solar potential of the site, environmental and social benefits;
  ii) Site evaluation: location of the site, its current use, its acquisition status, technical evaluation (topographical, geological, climatological and hydrological, flood risk), social assessment (demographic, economic and social regional development)
  iii) Network Integration Study: Description of installed capacity, current and future energy demand, power grid and integration study of solar park in the grid.
  iv) Description of the technical solution: description of the system and its configuration, description of its production with the use of batteries and phasing
  v) Economic and financial analysis: Levelized Cost of Energy (LCOE), net present value (NPV) and internal rate of return (IRR) according to different technical and financial setup scenarios.
  vi) Risk analysis
- Define required capacity building of staff of the Ministry of Energy, Secretary General of WAPP, NAWEC and other operators concerned through a program of assistance for the preparation of the Solar Park including all technical, economic and financial;
- Conduct a diagnosis of the National Dispatch Center and evaluate the required investments for its creation.
- Review the electric grid defense planning
- Specify application for forecasting the PV power plant generation a day (D+1) ahead and three hours (h+3) ahead.

2.5 Details of the scope

2.5.1 Task No.1: Data Collection and Review

The main purpose of the data collection is to determine (i) the physical and socio-environmental data of the Soma areas, (ii) the connection conditions with the future planned Soma OMVG

substation, (iii) international data relevant for the analysis of options technical characteristics of the regional power plant, their sizing and costs and (iv) collect from NAWEC the characteristics of the existing and planned network with future investments in the areas.

In this context, the Consultant will collect, review and compile all relevant technical, economic and cost data on Gambia's transport networks as well as existing and planned exchanges with neighboring countries, which are essential for the conduct of the study.

Regarding the physical and socio-environmental aspect, the Consultant will collect among other data:

- Site characteristics: location and contact information, area, shape of the terrain, topography, geotechnical and seismic data, close elevations may create shadows (such as hills, trees and houses), cadastre, environmental sensitive ones, and zones of houses
- Information concerning the vicinity of the sites: presence of nearby water (surface water and groundwater, available flow), roads and access roads, flood areas, means of telecommunication (coverage by mobile telephone network), housing and economic activities, land close to an existing HT / MT substation or that can be realized at short notice
- Geotechnical particularities of the area (topographical, geological, flood risk)
- Solar irradiation
- Weather Conditions such as sunlight, temperature, humidity, wind speed, the level of air pollution, etc. These data must be used to determine the daily, monthly or seasonal variations of these parameters and establish the corresponding typical curves, as well as potential outliers. The existence of a nearby weather station will be verified to validate this data
- Specific meteorological phenomena and their impact (for example, the harmattan). The Consultant will have to estimate the deposit of dust or sand on the installations for both sites and analyze the corresponding impact on the performance and estimate the maintenance cost for the optimal performance.

These data will be completed during visits to these sites. In the event that some data is not available, the Consultant will use common sense, based on international practice, to provide replacement data. However, the Consultant will provide a rationale for the selection of data in the data report.

The Consultant will create a map with the different selection criteria within a radius of 20 km of Soma area.

WAPP network data in a GIS format will be made available to the Consultant. The characteristics of all the potential sites will be included in the data report. These characteristics will also be provided in a GIS format approved by the WAPP.

The interconnection analyzes will define the rules for connection and operation of the Solar Park, the design of the solar park substation, the capacity of the interconnection transmission line to Soma’s substation and the extension of the Soma’s substation in order to specify its main technical characteristics and optimize its operation. The data will cover, but not be limited to:

- Expansion plans for the production and transport system;
- Current network operating conditions;

- Single-line diagrams, site plans, installation diagrams, protection plans, types of circuit-breakers and their ratings (nominal values) of substations in the interconnected network near preferential sites
- The conditions and connection requirements including all the technical limits applicable to the connections of solar power plants connected to the Medium and High Voltage NAWEC networks.

Task No.2: Determination of the site (s)

- **Preliminary Study of Network Integration**

A preliminary study of integration into the network will support the finalization of the selection of the site. A complete stability study will be developed in Task No. 4.

The integration study (load flow and voltage plan study) in the network will be done for a 150 MWp Solar Park in two (2) phases with between 100 and 150 MWh of battery.

The analysis of the impacts of the production of the solar parks on the stability of the network will be carried out on a static and dynamic modeling of the network. This modeling of the national network includes existing generators, lines and substations. It allows traffic technical analysis point of view of power flow, voltage profile, short-circuit currents and protection, harmonic and transient stability.

Phase 1: Modeling

This phase focuses on the modeling of the network for the stability studies. The studies will consider the commissioning of the different phases of the solar park ((90MW in 2021 followed by 70MW in 2025), with storage. This model will detail the transmission network with the OMVG interconnection. The distribution networks will be detailed in the candidate area near Soma to accommodate the solar parks.

The consultant will collect information from NAWEC and local stakeholders to take into account the existing generation and network as well as the planned new infrastructure projects. The following minimum data will be collected:

- Data on the evolution of the load of the network and in particular on the distribution networks near the targeted sites;
- Data on the evolution of the export-import contract via OMVG interconnection with neighboring countries;
- Characteristics of the generation fleet (existing and planned) and also the NAWEC substations.

On this basis, the Consultant will prepare:

- Preparation of collection sheet on generation, transmission data, demand evolution;
- Planned power plants and transmission lines;
- Assumption work for missing data;
- Synthesis of input data in a study report;
- Modeling of the perimeter network described above, integrating the planned solar park and others PV generation and future NAWEC projects and interconnections;

- Description of models and their validation based on calculations of current baseline scenario.

Phase 2: Load flow study and voltage stability

This fundamental calculation will define the load flow by determining the active and reactive powers passing through each structure, the voltage plan in all the nodes of the network for seasonal or annual peak load or during dip load.

These load flow calculations will be performed both in the normal state of network operation and in the disturbed state following an incident, rule "n-1". The load flow study for static operation will address the following questions:

- The study of the coupling / decoupling of plants;
- Load flow calculations of the entire network with and without solar generation;
- Consideration of network incidents (n-1);

These calculations will be made without solar power station (reference) and with the phased addition of solar parks. Absorption capacities are verified by the following criteria:

- Absence of thermal constraints (mainly on transmission lines or transformers rating in substations) and definition of possible reinforcements to be provided for the connection;
- Failure to exceed the voltage criteria. In the case of the distribution network and the connection within a loop in particular, it is necessary to control the voltage rise along the transmission lines during maximum solar generation and for low local consumption;

In the case of the transport network, the influence of solar parks of significant power on the flows in the transmission lines and OMVG interconnections with neighboring countries (Senegal and Guinea Bissau-Guinea) will be studied to define the principles of voltage adjustment (regulated reactive power).

This phase includes the following tasks:

- Definition of the configurations and extreme scenarios of the load flow / voltage plan depending on the number of generating sets in service, the state of the OMVG interconnections, the state of the load, etc;
- Simulations of N-1 approach scenarios with the objective of validating the load flow and voltage plan for extreme cases considering:
    - the conformity requirements imposed by NAWEC or to be defined (voltage level, line load, etc.);
    - the need of reactive power for the operation of the inverters;
    - The wheeling capacity of MAWEC's network.
- Specific analysis of the constructive capacities to require from the point of view of reactive power generation;
- Calculation of losses in different situations.

The expected results of this study are:

i) The technical feasibility of the interconnection of the solar park on Soma substation and integration to NAWEC's network;

ii) The necessary investments for the interconnection (solar park substation, transmission lines and extension to the interconnection substation) and the possible reinforcement / extension of the NAWEC network;

iii) the most appropriate phasing for solar park with the associated storage;

- **Identification of Potential Land**

The Consultant will have to identify several parcels of land larger than 225 hectares around SOMA's substation according to a review of the cadaster (land ownership), environmental sensitive areas, residential areas, geotechnical peculiarities of the area, and solar irradiation.

The parcels selected must meet the following criteria:

(i) Be located within a 20 km radius of the SOMA's substation;

(ii) Have an overall area of at least 225 hectares that can be divided into three (a minimum of 75 hectares each);

(iii) Not be in a sensitive environmental zone or in an area with geotechnical and geological properties that are not compatible with the development of a solar park;

(iv) Minimize the local population to relocate for the implementation of the solar park and the transmission line interconnection to SOMA's substation; and

(v) Have excellent solar irradiation.

The analysis will include the environmental sustainability of the sites in collaboration with the consultant in charge of the environmental study, the possibilities of connection to the interconnected network NAWEC-OMVG in SOMA's substation, the location of the loads and the capacity of transit of the network, the possibilities to export to the countries of the sub region with OMVG interconnection.

Discussions with local governments should be held to ensure the availability of land and their potential allocation for a Solar Park.

- **Selection of the Final Site (s)**

The Consultant will present the results of the preliminary study of integration and the identification of the parcels of land and will develop an analysis of the potential sites near Soma presenting their potential to develop the Solar Park.

When the final land final will be selected on one approved site, the consultant will also propose the routing of the transmission line for the interconnection to SOMA's substation

The Consultant should highlight the potential risks of each site and will work closely with the legal teams of the various stakeholders and the consultant in charge of the ESIA concerning safeguard clauses and verification of the land.

- **Campaign to measure solar radiation**

In order to complete and validate the data already available on solar radiation in The Gambia, a solar radiation measurement campaign will be carried out on the selected sites.

This measurement campaign will be initiated by WAPP separately as soon as possible. Measurements should make it possible to supplement the data available from satellite surveys or measurements made at existing weather stations, in order to specify the most appropriate technology and the selection of recommended sites.

The data of measurements will be available for the Consultant who can use them to optimize the dimensioning of installations and refine the technical-economic analysis and the design of solar park generation.

The necessary readings and parameter records will be taken for a minimum period of one year after commissioning.

2.5.2 Task No.3: Preliminary Technical Design

The services to be provided by the Consultant in the context of this study must cover all the preliminary technical studies that will confirm the technical feasibility and establish the operational specifications for the installations, equipment and works of the solar park. The preliminary design will:

- Define the operational specifications and the main design criteria for the plant and the associated substation of the solar park;
- Define the specifications and the main design criteria of the interconnection transmission line, the extension of the Soma's substation and the reinforcement / extension of the NAWEC network;
- Analyze alternatives in terms of energy storage
- Propose optimization for the phasing of the realization of the solar park
- Examine the operation and maintenance requirements and evaluate the consequences of the design on NAWEC systems

The Consultant will identify the key issues that the study should consider in order to ensure that the project is economically viable (based on its total discounted cost over the minimum life cycle).

The Consultant will define:

(i) Delimitation of the proposed area for the installation of the PV panels and the solar park;

(ii) Technical conditions including among others:

- Engineering conditions taking into account the relevant international, national and electricity company standards
- Ambient conditions taking into account climatic and environmental data such as: air quality (density, aerosols), wind speed and direction (at a height of 3 m) , temperature, hygrometry, pollution level, geotechnical data, seismic data, surface and groundwater, taking into account the seasonal variations of these conditions and their medium and long-term

(iii) Technical requirements including among others:

- The dimensioning of panel control and DC / AC conversion facilities
- The optimal phasing for solar park development to reach 150 MWp with 2 phases on PV technology
- The sizing of the storage system
- The SCADA system

The choice of technologies proposed should take care to minimize the problems of operation, maintenance or repair of equipment. The technologies should be already proven from an industrial point of view, having been continuously exploited for a minimum of 5 years (with the exception of storage where the main criterion will be linked to its relevance for the specified use) .

The Consultant will propose a limited number of operating options to be examined (maximum 3) with the agreement of the Client. The analysis of the alternatives and operating options to be examined will be based on a limited number of realistic scenarios for the development of national networks, international interconnections and the means of generation planned in The Gambia and in the region.

These scenarios should be based on the development plans proposed by the WAPP and the Gambia Government and be validated by all stakeholders in the study.

2.5.3 Task No.4: Transient Stability Study of the Network for Finalized Technology

The consultant should develop a transient stability study to confirm the results of the preliminary network study developed in Task No.2. This study will cover the solar park with the interconnection to Soma's substation and the rest of the NAWEC's network in order to the network improvements: substations, SCADA systems, dispatching and possibly required communications.

This study will analyze the impact and phasing of the solar park on the dynamic stability of its entire network in order, among other things, to verify the impact of intermittent high-power solar generation in relation to the total power of the generating leading to low inertia and higher sensitivity on frequency fluctuation during an incident.

The study will define the solar limit penetration rate for which any exceedance can lead to excessive frequency variations. The following points will be refined:

- Define the level of spinning reserves, national or regional via the OMVG interconnections to maximize the share of solar generation and evaluate the minimum share that must be guaranteed on these interconnections.
- Calculate the risk of curtailment, load shedding, and the behavior of the network during frequency fluctuation in case of an incident.

The proposed dynamic study will aim to analyze the transient behavior of the electrical system studied during disturbances of high amplitude (loss of generation due to solar intermittency, but also interconnection or thermal power plants) during peak load or other penalizing conditions.

The initial state of the network is the one determined by the static study in peak load situation or in penalizing configurations such as non-interconnected and low-load network situations where solar power plants account for a larger share of total output (strong penetration rate).

This involves verifying that the solar park does not lead to destabilizing the frequency and the voltage in a minimal configuration with the risk of activation of the protections and load shedding. The most interesting cases being among others:

- the passage of clouds with reduced production on the solar parks (80% in a few tens of seconds) and the rise of power that can follow.
- The loss of a plant or a significant group (not solar) and the reaction given the new rotating reserve.
- Loss of loaded line (especially interconnection).

From this approach the results are analyzed for (i) the determination of limits, special specifications on plant equipment or reinforcement to be provided (ii) suggestions for an optimal dispatching that define the activation rules as merit order/pro rata of the sources and thermal / hydraulic reserve to be planned and the management of spinning reserves (availability, operational procedures and settings).

The tools and methods put in place will be detailed in a study report.

Dynamic analysis involves a dynamic modeling of existing generators, this modeling is conducted on the basis of collected data supplemented by typical penalizing assumptions where appropriate.

The Consultant will work in coordination with the NAWEC planning team in charge of the Gambian network development to analyze the impacts of solar park integration into the network.

- **Integration study**

The Consultant will perform the necessary simulations to analyze the integration modalities in the network and the constraints generated. This study will confirm the maximum level of solar production penetration and the corresponding implementation constraints (maximum size of plants, means of compensation to implement, phasing, storage size ...).

This integration study should determine the impacts of solar generation, the installed capacity limits induced and the investments needed to ensure the stability and operation of the NAWEC and OMVG networks within the WAPP.

The Consultant will carry out all the simulations necessary for the examination of the impact of the regional solar park on the operation of the system and the dimensioning of the equipment of the plant. The analyzes will include at a minimum:

- Power transits calculations in order to establish the potential HV network reinforcement needs related to the presence of the regional solar park, including the possible needs in reactive compensation;
- Calculation of network losses for different technological alternatives and operating options;

- Calculation of the level of storage necessary to limit the impact of the regional power plant on the national reserve and to limit variations in generation. The storage should be analyzed with the 2 main services for the systems: frequency regulation and electric energy time-shift to peak load;
- Voltage regulation → Reactive compensation needs;
- Frequency regulation → Impact on the required spinning reserve (national or regional) or battery storage;
- Specific protections associated of the solar park operationalization;
- Control and supervision → Required information to be sent to the yet to be created national and regional dispatch center;

The Consultant will ensure compliance with the technical limits applicable to the connection of solar park to the Soma's substation. The technical limits mean the limits and technical constraints that a photovoltaic power station must meet in order to be able to access the NAWEC and OMVG network. The consultant will check the requirements (non-exhaustive list) in terms of:

- Power Quality System Control in normal an abnormal range
- Frequency control and operating reserve
- Voltage Control (Voltage and Quality)
- Reactive Power / Active Power
- Behavior during abnormal voltage conditions (Harmonics, Flicker, Imbalance)
- Protection System
- Information exchange (Communication and Control)
- Black Start (Specific requirements)
- Voltage level to be maintained at different input conditions
- Frequency and Voltage range (LVRT, HVRT) / Fault-ride through capability
- Contribution to the system inertia (fast frequency reserve)
- Provide particular reserve margin for Load Frequency Control (ramp reserve).
- Flexible contribution to reactive power control modes (voltage control mode, reactive power control mode and power factor control mode)
- Services that address the quality of the supply (damping actions)
- Active and Reactive Power (Characteristics and specifications of the controllers)
- Characteristics, power ratings, and operational requirements of the converter stations
- Timing requirements for the decision-making and taking the necessary actions
- Protection system for variable operating conditions
- Forecasting

- **Solar Park Interconnection design**

The Consultant will carry out the engineering studies related to solar parks interconnection that include the following infrastructures: power substation of the solar park, interconnection transmission line to Soma's substation, extension/reinforcement of Soma's substation and reinforcement of NAWEC's substation. Engineering studies will specify the preliminary design and give all the required inputs to verify the technical and economic feasibility. The studies will cover the components below at least:

- The study of the line routing for the interconnection line;
- Engineering design of transmission lines and substations and the associated equipment (battery, compensation, etc)
- Preparation of single line and auxiliary diagrams and all the required drawings for transmission lines and substations
- Summary estimates of projects for works and installation

The engineering design of the transmission lines and substations will be done according to the Standards in Gambia. The Consultant will approach NAWEC to ensure that these requirements are taken into account. The following conditions and requirements must be respected.

(i) Technical conditions including among others:

- Technical conditions taking into account relevant international and national standards and those applicable in NAWEC;
- Site Conditions taking into account the climatic and environmental data such as air quality (density, aerosols), speed and wind direction, temperature, humidity, pollution levels, geotechnical, seismic, surface water and groundwater, etc., taking into account seasonal variations of these conditions
- Network conditions taking into account the stability of frequency and voltage, eligible disturbances (harmonics, flicker, etc), The short-circuit power, the risk of congestion, the protection plan, keeping the levels short-circuiting of equipment, breaking capacity of circuit breakers, grounding networks and communication systems including optical fiber, SCADA system and their compatibilities etc.

(ii) Technical requirements including, among others:

- Wheeling capacity under given conditions (in normal or degraded system conditions) taking into account the voltage regulation, the reactive power production;
- Coupling capacity taking into account the adjustment voltage, reactive losses;
- Operational reliability taking into account the availability and the maintenance;
- Environmental aspects from electrical noise, visual impact, acoustic noise, the influence of electric and magnetic field,
- Safety Constraints during the implementation phases and operation;

➢ **Control-command and SCADA**

The Consultant shall review existing and planned control and communication systems including Tele-Protection, Supervisory Control and Data Acquisition (" SCADA").

The Consultant will propose, where appropriate, the extension of these systems to take into account the solar power station. If they are unsuitable, the Consultant will make an appropriate proposal.

Any new extension proposed will be of the digital type. The Consultant will also need to take into account, as appropriate, the ongoing developments of the WAPP Information and Coordination Center (" ICC").

The Consultant will ensure that any proposed communication and SCADA systems are compatible with existing and planned systems in the short and medium term. The use of an optical fiber link as the main communication channel will have to be considered. A back-up system will also be provided, as appropriate via a PLC link.

The Consultant will recommend the equipment and tools needed for the estimation of the solar generation in real time and the forecasting in the short and medium term. The data collected by the meteorological equipment installed at the site (including solar radiation measurements) should be able to be transmitted to the national control center and the ICC.

2.5.4 Task No.5: Generation and Economic Viability Studies

- **Generation study**

The Consultant will carry out a thorough analysis of the solar potential of the site after selection of the land, with a SolarGIS data analysis reviewed according to the ground data of the 2IE which will be shared with the Consultant.

With the selection of the technical design, the Consultant will produce a generation simulation on a software such as PVsyst to allow the use of this generation simulation data in the financial analysis.

- **Study of the export to the neighboring Countries**

Electricity from the Solar Park will be sold by the IPP to NAWEC. As the Solar Park is a regional project under the WAPP, part of the electricity generated by the Solar Park could be exported to neighboring countries.

In the framework of the formulation of tariff proposals, the Consultant will also have to carry out consultations with the ECOWAS Regional Electricity Regulatory Authority (" ERERA"), as well as with the authority in charge of the regulation of electricity sector in Gambia and its neighboring countries.

The Consultant will have to work with the members of the WAPP to assess their interest in the Solar Park, their potential use of this electricity (ie daytime need, for their evening peak etc.) and the optimum price for the Solar Park that they would have identified.

- **Economic and Financial Studies**

The objectives are to determine the economic and financial viability of the Solar Park, and provide relevant and sufficient justifications for its realization.

The Consultant will also have to carry out the analyzes and justify in detail a development plan for the implementation and operation of the Solar Park after its completion.

The consultant will need to evaluate and compare project costs and benefits against alternative scenarios (local and / or imported thermal generation and other renewable options) to determine the economic viability of the project.

The benefits from the Solar Park will be measured using the concept of comparing the best scenarios "with the project" and "without the project". The consultant will calculate the cost of avoiding the ton of CO2. The economic benefits of reducing CO_2 emissions compared to an "equivalent" thermal power plant will be quantified in terms of volume and value based on reasonable assumptions and acceptable to stakeholders. Non-quantifiable benefits such as reducing local pollution will be examined

The Consultant will calculate among other indices the Net Present Value ("NPV"), the Financial Rate of Return and the Internal Economic Rate of Return ("IERR") of the project and explain in detail the results.

The main basis for the calculation of cost benefits will be based on the electricity capacity. This calculation must be carried out with the P90 values (PVsyst) and must consider all the losses of the installation as well as the efficiency of the different technical parts of solar field, inverters, electrical storage if necessary, etc. for the solar park.

The consultant will propose the optimum financial model and simulate its bankability using the usual financial ratios. The financial analysis should propose and evaluate different project tariffs and institutional structures, as well as financial arrangements that would make the project financially viable and guarantee an acceptable return on investment for project completion. The inputs used will be discussed upstream with the Gambian Authorities.

Tariff proposals will be based on a regional market analysis and will also need to propose additional measures to ensure the financial viability and sustainability of the project. To this end, the consultant will determine the financing gap of the project taking into account the difference between the average price of electricity and the cost of the Solar Park over the life of the facilities.

The economic and financial studies will include an sensitivity analysis on parameters affecting the viability of the project, among others, load forecasting, generation costs, plans for expansion of generation and transmission, investment costs, the mode of development and operation envisaged, delays in the implementation of the project, and economic parameters.

- **Risk studies**

The Consultant will identify and assess the different potential risks (Political and Governance, Macroeconomic, Sector Strategies and Policies, Technical Design and Construction, Institutional, Implementation, Fiduciary, Environment and Social, and others perceived Risk to Project Sustainability). For each risk, the Consultant will recommend appropriate measures to prevent failure or at least decrease the profitability of the project, or justify the main objectives of the project, as regards delays, costs and technical contingencies; this during the implementation and implementation phase, as well as during the operational phase.

This study will cover the following services:

(i) Identification of potential risks and classification of these risks according to:

- Relationship with the project: internal or external

- Nature: political, economic, institutional, legal, technical, organizational, financial risks, etc
- Origin: Subcontractors, Public authorities, Donors¸ Consumers¸ etc ...
- Impact: cost overruns, non-compliance with deadlines and technical specifications, operational underperformance.

(ii) Quantitative risk assessment to assess the direct and indirect impacts on project objectives and the likelihood of their occurrence. This evaluation can be supplemented by a qualitative analysis.

(iii) Proposal for measures to prevent risks and reduce their impacts, any contingency plan scenarios, and a definition of the duties and responsibilities of risk management.

The Consultant will propose an appropriate strategy for the implementation of the Solar Park which mitigates the identified risks and foresees contingency scenarios that consider the complete execution of the project.

2.5.6 Task No.6: Evaluation of Investments required for the creation of the National Dispatch Center

It is important for The Gambia to have a high-performance National Dispatch Center to control the intermittency of various solar power plants by ensuring the stability of the network and the quality of the electrical service. The planned development of solar production must therefore be accompanied by the creation of a dispatching center with a view to:

- Increase the RES penetration while considering the integration capabilities on the grid without jeopardizing its overall stability;
- Operation and management of the network with the management of the intermittency of solar generation;
- Reduce the technical and commercial loss;

In order to meet these objectives, in addition to the usual network rehabilitation and reinforcement work, the implementation of "smart" smart grid systems (real-time operation, automation of the primary reserve and frequency adjustment, forecasting in solar output, etc) in addition to traditional SCADA must be seen as a development priority.

The Consultant will have to undertake besides the technical requirement (hardware equipment, software, etc), an evaluation of the investment required for the creation of the National Dispatch Center and the operational rules to establish an evaluation of capacity building investments (research, training) to ensure the integration and forecasting of solar generation.

The Consultant will conduct field visits to ascertain the current state of the electrical system to gather all the data required for his mission.

These visits will enable him to analyze all available documents in order to understand and analyze the following points:

- Description of the current and future electrical system on the operating conditions of the plant and the operational process;

- Evaluation of the impact of solar power plants on operational constraints for the tele-control of the network;
- Analysis and proposal for improvement of the new operation rules to be adopted;
- Proposal of methods for analyzing events and making good decisions for the integration of solar power plants;
- Proposal for the creation of the dispatch center including the implementation of (i) WAMS (Wide Area Measurement System) to measure in real time the level of stability of the network (ii) of an operating station dedicated to the management of renewable energies (ii) curtailment system for solar generation taking into account the financial implications of the obligation in the PPA of IPP (iv) Integration of remote management systems for solar power plants (v) implementation tools (software to study the integration of VRE on networks) and procedures (vi) telecom interface / integration of all data between dispatch center and PV plants;
- Establishment of empowerment of RES forecasting and reduction of deviations from generation programs. The Consultant will have to make sure that this forecasting system, as well as the information exchanges with the renewable energy production parks, will allow the operators the optimal control of the electrical system;
- Identification of gaps and suggestions for improvement in terms of studies, investments and training;
- Evaluation and definition of the capacity building for the dispatchers to ensure the operations and ideal dispatching of the RES power plants;
- Suggest the optimal configuration (creation of dispatching with a post dedicated to renewable energy or creating a dedicated dispatching renewable energy) to operate in real-time renewable energy source ("RES") in The Gambia, considering the other projects currently planned. The Consultant will recommend hardware, software and tools needed for real-time operation based on Smart Grid technology.

The Consultant will submit in his offer a detailed methodology of his approach to this task.

Following these visits and the critical examination of the situation thus established, he will establish the technical possibilities of installing modern systems equipped with the tools required to increase the safety and reliability of the supply of electricity. These analyzes will enable it to define the financing required in terms of investment, study and training for the creation of the dispatch center to ensure the integration of solar generation. The Consultant will establish a financial estimate for these 3 components by prioritizing the investments for a realistic upgrade of the solutions to be implemented.

The report on this task will include two parts:

- A diagnosis of the operation and management of the transport network (source substations, automation, control-command, dispatching, information system) to evaluate "smart grid projects that will allow a rapid improvement of the quality of service and facilitate the integration of renewable energies into existing and future network;

- An assessment of the investment needs on the transmission network for conventional works or equipment (transmission line reinforcement / extension, installation of HV substations, GIS, etc.) as well as on intelligent systems to improve its performance. reduce technical and commercial losses, facilitate its management and allow the integration of a large proportion of intermittent renewable energies.

2.5.7 Task No.7: Training

The Consultant's services will include knowledge transfer and training at the Consultant's premises in the areas covered by the study. The transfer of knowledge will be done in the field.

To this end, the Consultant will have to integrate the counterparts designated by the respective beneficiaries in his teams and work closely with them during the different phases of the study.

Training in the Consultant's premises will be provided after receipt of the Feasibility Study Report by the WAPP General Secretariat and the Ministry of Energy. In addition to capacity building in the areas covered by the study, this training should allow local experts to better understand the content of the report and give their initial response. It will also be an opportunity for the Consultant to obtain clarifications or clarifications on the expectations of the beneficiaries.

This training will be in English. The Consultant's proposal must include the details of the training program. The Consultant will support all client costs associated with the organization of the training of experts in the Consultant’s premises. The training should be at last about one week. The Consultant's proposal should also contain the approach and methodology that he intends to use to achieve real knowledge transfer to the counterparts. The training program will focus on, among other things:

- The choice of design criteria, the organization of the measurement campaign, the site survey and the design of the plant, including the choice of equipment, the specifications, as well as the software / models used;
- The model and methodology used for the technical analysis of the plant and networks and the software / models used. Project studies will be explained in detail during the training program;
- The model and methodology used to conduct economic and financial studies. Studies on the project should be explained in detail during the training program;

Therefore, the proposal should also include the costs associated with the full assignment to the WAPP General Secretariat and to each of the project beneficiaries, the hardware and the various software / models used in the technical, economic and financial studies.

At the end of the training, the Consultant will have to submit a detailed report on the training provided.

2.6 Deliverables

The services to be provided by the Consultant include the preparation and submission, within the deadlines, of all documents and reports. All documents and reports must be prepared in English and must be submitted by the Consultant in paper and electronic versions simultaneously to the WAPP General Secretariat and the Gambian Authority (NAWEC and Ministry of Energy) in accordance with the specifications below.

The reports will be sent with an official letter from the WAPP General Secretariat to the Gambian Authority. All maps will be provided in computerized form in a Geographic Information System (GIS) format that has been developed by stakeholders.

Printed copies will be provided in the specified number of copies to each recipient.

The electronic versions will be provided on a USB key and will include:

- complete PDF version of the printed report, possibly in the form of a portfolio so as to limit the size of the individual files. This PDF version will be produced from the source files so that it can be indexed; a scan of the printed report is not acceptable;
- the original source files of the documents in a format approved by the stakeholders (for example, word file for texts or Excel for tables). The maps will be provided in a GIS format approved by stakeholders. Other schematics will be provided in Autocad format.

In its offer, the Consultant should schedule a kick-off meeting and workshops to present all draft versions of the reports to facilitate the preparation of comments. All these meetings and workshops will be held in Banjul, namely:

(i) The initial meeting of the feasibility study presenting the Initial Report;

(ii) Presentation of preliminary results on the identification and selection of sites;

(iii) Presentation of the preliminary results of the technological choice and the configuration of the solar park, and the integration network study;

(iv) The examination of the preliminary report of the feasibility study;

(v) The review of the interim report of feasibility study;

(vi) Examination of the draft report of the " Diagnosis and Evaluation of the National Dispatch Center ";

(viii) Training with the Client;

The Consultant will support on behalf of the Client all costs related to the organization of meetings and seminars, in accordance with the practices of the WAPP General Secretariat.

All reports and presentations must also be available on a website dedicated to the project to be set up by the Consultant.

2.6.1 Initial Report

The Consultant will have to submit an initial report within two weeks, starting from the start of the service, which will contain, among other things, (i) the work plan and the methodology, (ii) the work schedule, the annotated comments of each report which will be presented and provided to the WAPP General Secretariat and Gambian Authority.

The number of copies of reports to submit will be as follows:

- ✓ Initial Report:
- Three printed copies and three electronic copies to Gambian Authorities;
- Three printed copies and one electronic copy to the WAPP General Secretariat.

2.6.2 Data Collection Report (Task No.1)

Based on the results of the preliminary study, the Consultant will have to prepare a data report after the completion of the data collection and analysis task. The report will include all technical and economic data on the national transport networks, including the single-line diagram of HV network and the transformer substations.

It will also indicate the physical and environmental data collected on the sites identified for the installation of the regional solar park power station. These data will be represented on a map within a radius of 20 km with the following selection criteria:

- Cadastre (land register)
- Environmental sensitive areas
- Housing areas
- Site Access
- Grid distance
- Geotechnical features of the area
- Solar irradiation

The data collection report should also indicate the assumptions and input data for conducting the feasibility study. In addition, the report must specify the design criteria that will be used in the technical study of the solar park, the substation and the HV network connection line.

The number of copies of the reports to be submitted will be as follows:

- ✓ **Preliminary Data Collection Report**
- Five printed copies and five electronic copies to Gambian Authorities;
- Five printed copies and one electronic copy to the General Secretariat of the WAPP;

- ✓ **Final Data Collection Report**
- Ten printed copies and ten electronic copies to Gambian Authorities;
- Ten printed copies and one electronic copy to the General Secretariat of the WAPP;

2.6.3 Site Selection Report (Task No.2)

The report will include all the data collected for the selection of the site (s) for the Solar Park. The following elements should be part of the report, among others:

- Mapping with the various selection criteria represented - land register, environmental sensitive areas, residential areas (villages etc.), geotechnical characteristics of the area, and solar irradiation - within a 20km radius of the selected connection station (Soma);
- Summary of discussions with local governments;
- Technical, Legal, Environmental & Social arguments for the selected site (s);
- Features of the interconnection to NAWEC network and preliminary integration study;
- Detailed analysis of the solar potential of the selected site with a SolarGIS data analysis review based on the 2IE ground data that will be shared with the team of consultants;

The number of copies of the reports to be submitted will be as follows:

✓ **Preliminary Report**

- Five printed copies and five electronic copies to Gambian Authorities;
- Five printed copies and one electronic copy to the General Secretariat of the WAPP;

✓ **Final report**

- Ten printed copies and ten electronic copies to Gambian Authorities;
- Ten printed copies and one electronic copy to the General Secretariat of the WAPP;

2.6.4 Report on the Technical Design of the Solar Park (Tasks No. 3 and 4)

The report on the configuration of the solar park and its connection to the NAWEC/OMVG networks will include the recommendations of the consultant regarding (i) the technology to be implemented in the selected site (solar panel, battery suppliers, etc), (ii) configurations for the implementation phasing (iii) the study of integration and (iv) required infrastructure and equipment (SCADA, etc) for the connection and operationalization.

In addition, the report will include the results of the stability study. The report on the technological choice, the configuration of the phasing of the plant and the connection to the NAWEC/OMVG networks will be based on this integration study.

The number of copies of the reports to be submitted will be as follows:

✓ **Preliminary Report**

- Five printed copies and five electronic copies to Gambian Authorities;
- Five printed copies and one electronic copy to the General Secretariat of the WAPP;

✓ **Final report**

- Ten printed copies and ten electronic copies to Gambian Authorities;
- Ten printed copies and one electronic copy to the General Secretariat of the WAPP;

2.6.5 Memorandum on the Interest of the neighboring Countries (Task No. 5)

The Consultant will produce a memorandum on the interest of neighboring countries in the purchase of electricity from the Solar Park by organizing meetings with WAPP countries.

The number of copies of the reports to be submitted will be as follows:

- ✓ **Preliminary Memorandum:**
- Five printed copies and five electronic copies to Gambian Authorities;
- Five printed copies and one electronic copy to the General Secretariat of the WAPP;

- ✓ **Final Memorandum**
- Ten printed copies and ten electronic copies to Gambian Authorities;
- Ten printed copies and one electronic copy to the General Secretariat of the WAPP;

2.6.6 Feasibility Study Report (Tasks No. 1 - 5)

The report should include a synthesis report and a main report. The Consultant will submit a preliminary report for the Client's comments, and a draft Feasibility Study Report incorporating all required comments and a final report incorporating the comments of the Client and Donors.

The Final Report will include:

(i) Overview of the project: description, local government support, solar potential of the site, environmental and social benefits;

(ii) Site evaluation: site location, current use, acquisition status, technical assessment (topographic, geological, climatological and hydrological, flood risk), social assessment (demographic, economic and social regional development);

(iii) Network Integration: Description of Installed Capacity, Current and Future Energy Demand, Power System and Network Analysis of the Park Solar;

(iv) Description of the chosen technical solution: description of the system and its configuration, description of generation profiles (if batteries are used);

(v) Economic and financial analysis: evaluation of the economic impact and financial viability of the project under different scenarios and financial packages;

(vi) Risk Analysis;

The number of copies of the reports to be submitted will be as follows:

- ✓ **Preliminary report of the feasibility study**
- Five printed copies and five electronic copies to Gambian Authorities;
- Five printed copies and one electronic copy to the General Secretariat of the WAPP;

- ✓ **Provisional report of the feasibility study**
- Five printed copies and five electronic copies to Gambian Authorities;
- Five printed copies and one electronic copy to the General Secretariat of the WAPP;

- ✓ **Final report of the feasibility study**
- Ten printed copies and ten electronic copies to Gambian Authorities;
- Ten printed copies and one electronic copy to the General Secretariat of the WAPP;

The final report of the feasibility study must be delivered in an appropriate form (with a cover page and formatting in particular) in accordance with the good practices acceptable to the Client and the International Financing Agencies.

2.6.7 Needs Assessment for the creation of the National Dispatch Center (Task No.6)

The Consultant will produce (i) a diagnosis of the operation and dispatching of the NAWEC network (source substations, automation, control-command, dispatching, information system) to evaluate the "smart grid" projects that will allow an improvement of service quality and facilitate the integration of renewable energies into existing and future network ; as well as (ii) an evaluation of the needs for investments in the transmission network for conventional works or equipment (line reinforcement / extension, installation of HV substations, GIS in particular, etc.) as well as on intelligent systems to improve its performance, reduce technical and commercial losses, facilitate its management and allow the integration of a large proportion of intermittent renewable energies.

The number of copies of the reports to be submitted will be as follows:

- ✓ **Preliminary report**
- Five printed copies and five electronic copies to Gambian Authorities;
- Five printed copies and one electronic copy to the General Secretariat of the WAPP;

- ✓ **Final report**
- Ten printed copies and ten electronic copies to Gambian Authorities;
- Ten printed copies and one electronic copy to the General Secretariat of the WAPP;

2.6.8 Training (Task 7)

The Consultant's services will include knowledge transfer and training at the Consultant's premises in the areas covered by the study. This training will take place at least one week and the Consultant must submit a detailed report on the training provided.

The number of copies of the detailed report to be submitted will be as follows:

- ✓ **Detailed Report**
- Ten printed copies and ten electronic copies to Gambian Authorities;
- Ten printed copies and one electronic copy to the General Secretariat of the WAPP;

2.6 Duration of the Study and Schedule

The duration of the feasibility study does not must exceed 8 months (32 weeks). The Consultant will propose in his offer, a detailed schedule of execution of the consultation. For this purpose, the following schedule is proposed as an indication:

Key Phases	Date
Kick Off Meeting (2 weeks after signing the contract)	So
Initial Report	So + 1 week
Data Collection Report (Task No.1)	
Preliminary Report	So + 10 weeks
Approval Meeting	So + 12 weeks
Final Report	So + 13 weeks
Site Selection Report (Task No.2)	
Preliminary report and discussions with local authorities	So + 16 weeks
Approval Meeting	So + 18 weeks
Final Report with final selection of the site	So + 19 weeks
Solar Park Conception Design Report (Tasks No. 3 and 4)	
Preliminary Report	So + 21 weeks
Approval Meeting	So + 23 weeks
Final Report	So + 24 weeks
Feasibility Report (Tasks No.1 to 5)	
Preliminary Report	So +28 weeks
Approval Meeting	So +30 weeks
Final Report	So + 32 weeks
Diagnostic of the National Dispatch Center Report (Task No.6)	
Preliminary Report	So + 19 weeks
Approval Meeting	So + 21 weeks
Final Report	So + 22 weeks
Training (Task No.7)	
Training	So + 26 weeks
Final Report	So + 27 weeks

3. PAYMENT SCHEDULE

The payment schedule is the following:

Rapport	Schedule	Payment
Initial Report	So + 1 week	10%
Report on site selection	So + 18 weeks	20%
Solar Park Conception Design Report (Tasks No. 3 and 4)	So + 23 weeks	20%
Diagnosis and Evaluation of Dispatching Center	So + 21 weeks	10%
Training Report	So + 27 weeks	20%
Final Report Feasibility Study	So + 30 weeks	20%

4. KEY STAFF

The Consultant must organize himself to meet the constraints in terms of timing and content of the service. The required staff should at least include the following profiles:

- ✓ **Project Manager:** expert in solar projects with a minimum of 15 years of experience;
- ✓ **Power Engineering Expert:** electrical engineer in transmission line and substation design with knowledge of the planning and connection of solar power plants on HV networks with a minimum of 15 years;
- ✓ **Network Expert**: specialized engineer in charge of modeling and simulations for stability studies with at least 10 years' experience in connection studies, integration of renewable energy;
- ✓ **Expert in Solar Energy**: electrical engineer or Master specializing in renewable energies with at least 10 years' experience in the implementation of solar photovoltaic plants of more than 10 MWp minimum;

- ✓ **Expert in Hybrid Projects:** engineer specialized in hybrid systems (diesel / batteries / solar) and having a minimum of 10 years of experience;

- ✓ **Land, Social and Environmental Expert**: expert in land issues in Africa and having a minimum of 10 years of experience. Experience in The Gambia appreciated;

- ✓ **Expert Economist and Financial Energy**: expert in the study financial and economic projects energy s with a minimum of 10 years' experience. Experience in Africa appreciated;

- ✓ **Expert Scada / Dispatching**: electrical/electronics engineer, with experience in the design, installation and commissioning of SCADA and Dispatching systems with a minimum of 15 years of experience. Experience in Africa appreciated;

The staff must be fluent in English. The minimum required experience of key personnel is as follows:

Project Manager	
Year of Professional Experience	15
Specific Experience	Management or planning of at least two (2) projects of renewable energy power plants, including Feasibility Studies, and preparation of the Bidding Documents and Contracts (see above). One or more of the projects should have a value of at least US $ 1, 000, 000 and should be in Africa. An experience in photovoltaic power plants or solar thermal systems will be particularly appreciated
Power Engineer Expert	
Year of Professional Experience	15
Specific Experience	Involved in the design and implementation of at least three (3) solar power connection studies including Network Simulations and Analyzes, Preliminary Designs, Transmission Line / Substation/Scada Feasibility Studies, and the preparation of Tender. The studies should have a value of at least US $ 1,000,000 each and one should ideally concern a project in Africa or in similar conditions.

Network Expert	
Year of Professional Experience	10
Specific Experience	Engineer specialized in electrical engineering modeling and calculation network with at least 10 years of experience in simulations on studies stability and connection and involved in integration study of at least three (3) solar power generation projects of more than 10 MWp minimum, including Feasibility Studies, Preliminary Designs and preparation of Tender Documents. At least one of the projects should have a value of at least US $ 1,000,000 and one should ideally be located in Africa or in similar conditions.
Expert in Solar Energy	
Year of Professional Experience	10
Specific Experience	Involved in the design and implementation of at least three (3) projects of solar power plants of more than 10 MWp minimum, including Feasibility Studies, Preliminary Designs and the preparation of the Call File. Offers. At least one of the projects should have a value of at least US $ 100,000 and one should ideally be located in Africa or in similar conditions.
Expert in Hybrid Projects	
Year of Professional Experience	10
Specific Experience	Involved in the design and implementation of at least three (3) projects of solar power generation plants with hybrid systems (diesel / batteries / solar) including Feasibility Studies, Preliminary Designs and the preparation of the Tender File. At least one of the project should to have a value of at least US $ 100,000 and should be ideally located in Africa or in conditions similar.
Land, Social and Environmental Expert	
Year of Professional Experience	10
Specific Experience	Involves in the assessment of land and social and environmental impacts of at least three (3) projects of solar power plants of more than 10MWp minimum with connection infrastructure, as well as in the implementation of Plans Environmental and Social Management (ESMP) and the implementation of the RAP.

Expert Economist and Financial Energy:	
Year of Professional Experience	10
Specific Experience	Ten 10 years of experience in conducting economic and financial analyses for investment projects energy in Africa, especially for projects generating solar power plants connected to the network .
Expert Scada/Dispatching	
Year of Professional Experience	15
Specific Experience	15 years of experience in the design, installation and commissioning of SCADA and Dispatching systems. Involves in at least two (2) projects of rehabilitation and strengthening of Conduct Center including 1 project with the installation of Smart Grid technology.

5. OTHER INFORMATION

5.1 Information / Data to be provided by the Client

The Customer will provide the following:

- Data on existing and planned network and generation fleet;
- All relevant documents available that could facilitate the completion of studies;

5.2 Reporting Requirements

The Consultant will report to the WAPP General Secretariat.

However, the Ministry of Energy of Gambia and NAWEX will appoint counterparts during the studies.

All correspondence from the Consultant addressed to either party should be copied to the other party for information.

5.3 Conduct of Activities

Close coordination between the WAPP General Secretariat, Gambian Authorities and the Consultant will be required.

The Consultant will be responsible for the overall management of all aspects of studies and services. The Consultant will appoint a Project Manager and a Deputy Project Manager (whenever the Project Manager will be unavailable) to liaise with the client, the WAPP General Secretariat and Gambian Authorities.

WAPP will designate a project coordinator to manage the project and coordinate with the various stakeholders.

Focal points will be identified at the level of the Ministry of Energy of Gambia and NAWEC will coordinate the activities of the Consultant during his stays in The Gambia.

The Consultant will attend meetings with the above organizations:

The Consultant will apply its internal control and quality assurance procedures during the performance of the contract, and will demonstrate that they are effectively implemented.

All data, reports, card spreadsheets and measurements taken will be placed on a dedicated website after approval by the WAPP General Secretariat.

The configuration and design of the site must be approved by the WAPP General Secretariat. The site will be set up no later than one month after the implementation of the project and must remain accessible after the project is finalized, for a minimum of three years.

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