REQUEST FOR EXPRESSIONS OF INTEREST
(CONSULTING SERVICES-FIRMS SELECTION)

FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA (FDRE)

CONSULTANCY SERVICE FOR FEASIBILITY STUDIES FOR UTILITY-SCALE WERANSO SOLAR PV PROJECT

Sector: Energy/Power

Financing Agreement reference: Grant No: 2100155041053

Project ID No.: P-Z1-FA0-179

The Federal Democratic Republic of Ethiopia (FDRE) has received financing from the African Development Bank toward the cost of the **Ethiopia Djibouti Second Power Interconnection Project**, and intends to apply part of the agreed amount for this grant to payments under the contract for Consultancy Service for Feasibility Studies for Utility-Scale Weranso Solar PV Project.

The services included under this project are:

- Preparation of feasibility study, including hydrology study, geotechnical investigation and seismic study, characteristics, assessment of climate conditions (meteorological) and solar resources and energy yield assessment, financial and economic analysis and modeling, grid integration impact study, etc.
- Preparation of Environmental and Social Impact Assessment,
- Preparation of Resettlement Action Plan,
- Preparation of design reports and drawings.
- Preparation of bidding documents
- Providing capacity building which includes trainings and Application tools

It is expected that the consultancy service assignment will take **10 months**.

The detailed Terms of Reference (TOR) for the assignment can be obtained refer to the following website: www.eep.com.et or can be obtained at the address given below.

The Ethiopian Electric Power (EEP) now invites eligible consultants to indicate their interest in providing these services. Interested consultants must provide information indicating that they are qualified to perform the services (brochures, description of similar assignments, experience in similar conditions, availability of appropriate skills among staff, etc.). Consultants may constitute joint-ventures to enhance their chances of qualification.
The shortlisting criteria are: (i) Core business and years in business; (ii) Relevant Experience in the field of assignment; and (iii) technical and managerial capability of the firm. Individual experts' bio data/CV is not required and Key Experts will not be evaluated at the shortlisting stage.

Eligibility criteria, establishment of the short-list and the selection procedure shall be in accordance with the African Development Bank's ***"Operations Procurement Manual"*** dated October 2015, which is available on the Bank's website at http://www.afdb.org. The Client is under no obligation to shortlist any consultant who expresses interest.

A Consultant will be selected in accordance with the QCBS method set out in the Consultant Guidelines.

Interested consultants may obtain further information at the address below during office hours Monday to Friday, 8:00 AM to 5:00 PM local time.

Expressions of interest must be delivered to the address below in person or by Email on or before **10 July 2024, 4:00 PM** local time (Addis Ababa, Ethiopia), and mention as "**Expression of Interest for Consultancy Service for Feasibility Studies for Utility-Scale Weranso Solar PV Project**"

The address referred to above is (are):

Ethiopian Electric Power (EEP), Procurement Office
Attn: Mr. Kefyalew Mergiya, Procurement Director
Yeka Sub-city, Woreda 09, (Former Kotebe 02)
Infront of Kotebe Metal Tools Factory,
Ethiopian Electric Power Compound, Block Number 09, First Floor, Office Number 203
Addis Ababa, Ethiopia
E-mail: kmergiya@yahoo.com
Tel: +251115580597
Copy to: Mr. Hussen Adem, Manager, Project Procurement
Yeka Sub City, Worda 09, (Former Kotebe 02)
In front of Kotebe Metal Tools Factory,
Ethiopian Electric Power Compound, Block Number 09, First Floor, Office Number 205
E-mail: Hussen.Adem@eep.com.et or hussenadem377@gmail.com
Tel: +251115580781
For EOI Submission;
Mr. Kalayou Haddis, Technical Support, Project Procurement
Email: kalayou.haddis@gmail.com
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TERMS OF REFERENCE

FOR

FEASIBILITY STUDIES

FOR

UTILITY-SCALE WERANSO SOLAR PV PLANT PROJECT

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1. OVERVIEW OF ETHIOPIA's ELECTRICITY SECTOR

The steep growth in the electricity sector introduced significant constraints in the former Ethiopian Electric Power Corporation (EEPCo), which was a vertically integrated utility, both in terms of infrastructure development and management. In 2013, EEPCo was restructured and divided into two companies: Ethiopian Electric Power (EEP) and Ethiopian Electric Utility (EEU). generation and transmission responsibilities are now managed by the Ethiopian Electric Power (EEP), while distribution service is provided by the Ethiopian Electric Utility (EEU). A two-year external management contract for EEU was signed in 2013 and concluded in August 2015.

The Ethiopian Electric Power (EEP) is 100% state-owned enterprise, established by regulation No. 302 in December 2013 (as amended by regulation No. 381 in March 2016), is responsible for construction and operation of electricity generation, transmission and sub-transmission (above 66 kV levels). The main functions of EEP are: undertake feasibility and design studies for generation, transmission and substations; undertake electricity generation, transmission and substation expansion as required; operate and maintain generation, transmission and substation facilities; sell bulk power to EEU and large industrial off-takers and lease transmission lines as needed. Section-13 presents the organogram of EEP.

In 2023, the installed generation capacity from the national interconnected grid (ICS) and isolated grids reached (SCS) 5,247 MW (91.5% hydro, 6.9% wind, 0.9% thermal, 0.50% waste-to-energy, and 0.2% solar). In the same year, the total energy generated was about 17,7230 GWh from both national interconnected and isolated grids, of which hydropower contributed 96.63%, wind 3.25%, thermal-diesel 0.06%, and waste-to-energy 0.04%. The peak demand on the interconnected system was 3,550 MW, that includes the supply to Djibouti, Kenya and Sudan.

Currently, the Ethiopian Electric Power is managing 21 power generating stations. Among them, fifteen are from hydro, these are Gibe III (1870 MW), Beles (460 MW), Gilgel Gibe II (420 MW), Tekeze (300 MW), Gilgel Gibe I (184 MW), Melka Wakena (153 MW), Fincha (134 MW), Amarti Neshe (95 MW), Tis Abay II (73 MW), Koka (43.2 MW), Awash II (32 MW), Awash III (32 MW), Tis Abay I (11.4 MW); Genale Dawa III (254 MW) and the Grand Ethiopian Renaissance Dam (with the two early generation units of 750 MW already operational) generate a total of 4,802 MW from hydro. There are also four wind power plants: Adama II (153 MW), Ashgoda (120 MW), Adama I (51 MW), Ayisha II which is partially completed and started operation with the capacity of 40 MW.

In addition to the above existing generation capacity, there are a number of generation projects under construction by Ethiopian Electric Power, including the Grand Ethiopian Renaissance Dam (5,250 MW), Koysha hydro power (1,800 MW), Aysha-II wind power (120 MW) which is at 80 MW of its 120 MW installed capacity is already connected with the system and the remaining wind-turbines are under completion phase. A number of Power Purchase Agreements (PPA) have also been entered between EEP and private developers (IPPs), which include the Tulu Moye-I and II geothermal power project (200 MW), Corbetti-I and II geothermal power project (150 MW), and two solar power projects Dicheto and Gad (each 125 MW). However, the implementation has not started on these private sector projects (geothermal and Solar projects) as they have not reached to a financial close.

The total length of the high voltage transmission lines has reached more than 17,838 km

across the country ranging from 45 kV to 500 kV voltage levels, composed of the 433.7 km of 500 kV HVDC, 1,234 km of 500 kV AC, 2,157 km of 400 kV AC, 6,512 km of 230 kV, 5,559 km of 132 kV, 1,731 km of 66 kV and 212 km of 45 kV transmission lines. The number of substations has reached 186 substations ranging from 132 kV to 500 kV.

The Ethiopia national grid is interconnected with Djibouti, Kenya and Sudan. The interconnection with Djibouti is through a double circuit 230 kV transmission line of 296 km length commissioned in 2011, with Sudan also with a 230 kV double circuit transmission lines of 194 km commissioned in 2013; and with Kenya through a 500 kV HVDC bipolar transmission line with a 2,000 MW power transfer capacity of 1,066.5 km length commissioned in 2022. Additionally, there exist a small 33 kV distribution lines supplying border towns in Kenya.

The upcoming generation facilities will increase the installed generation capacity up to 10,000 MW in 2025, which will be expose Ethiopia to overreliance on one type of energy source (hydro) in the generation mix and this will have implications for energy security, especially in the context of uncertainties surrounding future climate change impacts (hydrology) on the country's water resources.

2. PROJECT BACKGROUND

The government of Ethiopia is committed to diversify the sources of electricity to address the imbalance of the existing generation mix and reduce overreliance on hydropower. In this regard, the GoE has planned to engage private renewable energy developers via PPP scheme in addition to development partner and self-investments to meet such energy development. The generation expansion has also focused on diversifying its energy mix with wind, solar, and geothermal sources to complement the hydropower dominated grid for reliable power supply.

In line with the above, the power utility (EEP) is taking the planning to develop a Weranso Solar PV Site with a capacity of 150 MW and integrate with the national grid. The ultimate goal of the project is to increase the share of other renewables into the energy mix and reduce the overreliance on hydropower.

Implementation Strategy: The project will be designed to be implemented in two stages each with a installed capacity of 75 MW solar PVs. The first 75 MW including the substations and the transmission line to connect the 150 MW to the national grid will be implemented through public sector financing, whereas the second 75 MW will be implemented by private sector or public sector financing. Therefore, the consultancy service assignment is to prepare the feasibility studies for the 150 MW, but the cost estimate and the financial analysis and model have to be prepared separately for each phase.

3. PROJECT LOCATION

The proposed Weranso Solar PV Project site is located in Adear Woreda and Administrative Zone 1 of Afar National Regional State as shown in the figure below (Figure 1). The Solar PV project site is situated in a close proximity to Eli-Wuha town. The average elevation is approximately 656.923 m above mean sea level. The Geographic location coordinates of the boundaries of the project site are given in

Table 1 below.

Table 1 Location Coordinates taken During Site Investigation

Boundary Point	Latitude	Longitude
Point 1	11 16 40° N	40 27 24°E
Point 2	11 16 41° N	40 25 38°E
Point 3	11 16 25° N	40 25 39°E
Point 4	11 15 50° N	40 26 17°E
Point 5	11 15 50° N	40 26 25°E
Point 6	11 16 21° N	40 26 26°E
Point 7	11 16 22° N	40 27 24°E

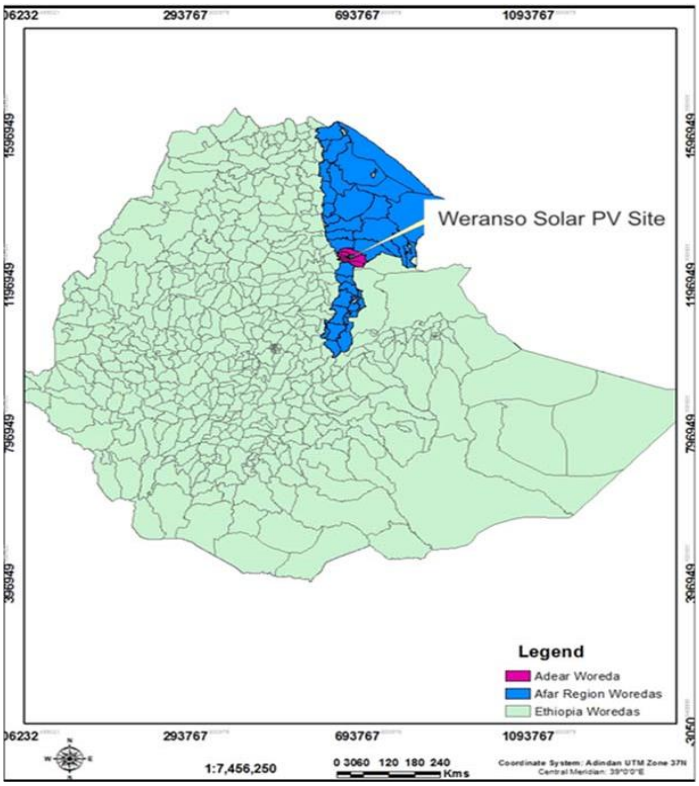

Figure 1 Afar Regional State Administrative Map (Ethio-GIS)

The project site is mainly small bush covered significantly flat area as shown in the figure below.

Figure 2: Weranso site

4. OBJECTIVE OF THE ASSIGNMENT

The overall objective of the Assignment is to establish the technical and economic feasibility of the ***Weranso Solar PV for two phase implementation (each phase of 75 MW) Project***, develop the Project's design reports, prepare the Environmental and Social Impact Assessment (ESIA), Resettlement Action Plan (RAP), and Bidding Document(s) for timely and effective implementation of the Project for engagement of an EPC contractor.

The feasibility studies shall help the African Development Bank (AfDB) and the Ethiopian Electric Power ("EEP" or "Client") with the project development , deeper assessment of project site and different technical options. It shall also cover permitting needs, cost/benefit analysis, the technical and financial evaluation of preferred options.

By engaging a Consultant, the Client should get access to international best practice in the field of solar power and project management.

5. SCOPE OF WORKS

5.1. GENERAL

The Consultant shall be responsible for carrying out all the necessary deskwork, fieldwork and investigations to compile information and data required for the Assignment. All of these services should be fully included in the Financial Proposal of the Consultant. The scope of work for the Assignment includes all the items detailed below in this section.

In the course of the Assignment and where necessary, the Consultant shall with authorization and consent from the client undertake on-site missions visiting the Project site and any other relevant infrastructure as necessary to inspect and review the condition of the site, liaise with

the Client in the preparation of documents, and perform any other activities required for the Consultant to successfully fulfil the requirements of this Terms of Reference (ToR).

The Consultant shall base its design on data and information provided by the Client and from the following site investigations and studies to be conducted by the consultant:

i. Geotechnical investigation and seismic study
ii. Area characteristics (topographical survey, orography, usage, etc.)
iii. Hydrology study report
iv. Assessment of climate conditions (meteorological)
v. Solar energy resources assessment
vi. Transport Study

The Client will also provide to the consultant the following preliminary report, conceptual designs, assessment reports produced previously:

- Drone Survey Footage
- Environmental and Social Scoping Report
- Grid and Infrastructure Report
- Geotechnical Investigation Report
- Grid Integration Study Report
- Hydrological Study Report
- Installation report for Solar Resource Measurement Campaign (may not the exact this site location)
- One-year Solar measurement report
- Site coordinates
- Indicative site layout
- Topographical Survey Report

However, the Consultant should not consider the conceptual design/prefeasibility study report produced previously as definitive in any respects, and the Consultant shall independently reevaluate the Project study documents and undertake its own comprehensive site assessment, site adaptation with satellite data for irradiation values, detailed feasibility study, etc. according to its professional judgement, experience and methodologies and requirements of this ToR. The Consultant shall bear in mind that the list of tasks and activities can by no means be considered as a definitive or exhaustive description of the Consultant's full duties. It is the Consultant's responsibility to verify critically the scope of services indicated and to extend, reduce or amend it with the consent of the client, wherever it deems necessary according to its own professional judgement and the knowledge during the preparation of its proposal. It is understood that the Consultant carries out all work as necessary to fulfil the objectives and deliver the scope of the Assignment.

5.2. Review of Current Power System Status and Data Collection for the Grid Connection

a) Data collection and review:
   - Existing grid data
   - Power system network model,

- annual generation capacity data, forecast electricity demand data and any other relevant energy generation information, national grid development and planning assumptions.
- Data on load flows on the network and dynamic studies
- Compilation of data on the planned location of the Solar PV plant and resource characteristics.

b) Evaluate alternative connection points considered according to the geographical location of the PV plant.

c) Review current operating practices, including generating unit engagement and allocation, allocation of primary and secondary operating reserves, and electricity market practices to assess their relevance to the reliable and cost-effective integration of the solar PV plant.

d) Review planned transmission network extensions and upgrading.

e) Review transmission grid codes, integration standards and technical requirements (frequency control, voltage control, reactive power supply, low voltage ride through, ramp speed, real-time remote measurement, and power management) for the connection of the solar PV plant and their suitability.

5.3. FEASIBILITY STUDY

5.3.1. Project Planning and Performance

The consultant shall, but not limited to:

- Develop and describe basic plant design and site layout.
- Develop basic electrical cabling, grid connections and single line diagrams.
- Determine key power/energy parameters.
- Determine energy yield estimates.
- Calculate estimated self-consumption.
- Optimize Battey Energy Storage System (BEES) sizing
- Calculate CO_2 savings compared to the conventional thermal alternative.
- Develop the O&M Concept
- Develop time Schedule for project Implementation.
- Establish site specific recommendations for deployment of solar plants in terms of technology and systems. The impact on ground construction and modules shall be considered.
- Identify the risk of flooding by rainfall.

5.3.2. Site Specific Study

The Consultant shall conduct a detailed feasibility study of the solar PV power plant. As a minimum, the feasibility study should include:

a) The project site and boundary area and approximated site plan and layout. This will include topographic mapping of the site. Available geophysical, soil, climate, solar and weather data will have to be included.

b) A conceptual design of the project, including estimation of installed capacity depending on the type of best available technology.

c) Cost-benefit analysis for different technological options for solar PV, depending on module type, mounting options, inverter type and use of electric storage. Availability, inter-operability, reliability, scalability, and maintenance aspects; defining communication, command and control systems, load consumption, system architecture definition and roadmap (including layout, modules, inverters, transformers, meters, etc.), relationship between the features, system output and performance should be considered.

d) Estimated energy yields for each technology option (see item (c) above), that are most suitable for the site. The energy yield should include:

- An assessment of the inter-annual variation and yield confidence levels.
- Consideration of site-specific factors, including soiling or rain, and the cleaning regime
- Shading analysis including near and far shading
- Electrical losses Influence of temperature variances on the efficiency of the plant.

e) The cost estimates for development, construction and operation of the project and predicted revenue, based on the available resource data, as well as indicative quotes or comparison with similar projects.

f) The land ownership and/or land use status, based on information received from the client (EEP) and relevant Regional/local Administrations.

g) Site plan and concept plant layout

h) Assess and determine battery (BESS) sizing

i) Transmission line and grid connection, including cost of grid connection.

j) The status of access roads and water supply, and other facilities for the project site.

k) Permitting requirements and expected timeline and estimated costs for achieving these
issues, based on information received from the client (EEP) and relevant Local Administrations.

l) Geotechnical investigation should include:-

- Assessment of the General Geology and Seismicity of the project area and its surroundings.
- Description of soil type and outcrops of the solar project area and its vicinity supported by colour photographs including description of potential geo-hazards.
- Excavation of eight test pits (TPs) and sampling to maximum depth of 3m or until hard
- Soil sampling for laboratory testing
- Electrical Resistivity tests using Wenner four-point electrode method for earthing design purposes.

m) The topographic study Should include:-

- Conduct Detail topographic survey for the proposed area by Total Station (TS) and GPS at a grid of 25m x 25 m with reference to nearby established BM (3-D pillar) Pillar of Survey; the topographic survey will cover X,Y, Z (RL) values of each and every Ground Control Point (GCP), structures and any other significant physical features exists above the surface, banklines of water bodies etc.
- Collect cadastral Mouza Maps (RS Maps) from Land office and to convert them into GIS database by superimposing those with proper geo-spatial reference
- Prepare Digital Terrain Model (DTM) and Digital Elevation Model (DEM) for the proposed project site including contour line generation at an interval of 1.0 m and 5.0 m
- conduct detail cartographical mapping (on GIS platform) of surveyed data, elevation models (DTM and DEM) with existing land uses, water bodies, cadastral mouza data, aiming to demarcate area with geo-reference to cadastral land documents.

n) Hydrology Study should Include:-

- Investigation of any areas at risk of flooding
- Investigation of potential sources of water for construction and operation
- Map, showing relevant geographical features and hydraulic components relevant to flood risk
- Recommendation for surface water management on the site
- Recommendation for mitigation measures

o) Transport Study should Include:-

- Assessment of most suitable transport for oversea goods from port to site
- Site Access Road study and assessment

5.3.3. Solar Resource and Energy Yield Assessment

The Consultant shall review any available study or reports and conduct detailed solar resource and energy yield assessment to optimize the Plant design. The consultant shall take into consideration the following:

- Local meteorological and irradiance conditions and projections.
- Assess the seasonal and inter-annual variation in irradiation data at the Project sites.
- The technical characteristics and performance of the technology applied.
- System power losses, including shading effect, soiling, component efficiency effects, mismatch effects, cable losses, availability effects and other technical losses.
- Possible losses due to electricity network constraints.
- Expected degradation of production capacity over time; and
- Uncertainties and deviations (considering irradiation data, fluctuation and modelling);

The energy yield shall be calculated by the Consultant, based on the most representative irradiation data sets from:

(i) site measurement, and

(ii) existing databases such as Meteonorm, PV-GIS (classic and Climate SAF), NASA (classic and SSE+HC1), Satel light, Meteotest or similar.

The Consultant shall produce probability-based forecasts for the expected power production in MWh (including P50, P75, P90 and P99 estimates based on the available data) for 1-year, 5 year, 10-year, 15-year and 20-year periods. As a result, the Consultant shall provide a full, detailed, bankable energy yield report detailing the methodology, assumptions, inputs and results of the resource and yield assessment as an appendix to the Feasibility study and design Report.

5.3.4. Assessment of the Network Integration - GRID IMPACT STUDY

It is intended that the solar PV System will increase the electricity supply to the national grid. The consultant needs to carry out a grid impact assessment to determine available options for adding capacity to the electricity grid from solar PV. The Grid integration and impact study shall consider the Ethiopian National Electricity Transmission Grid code.

I. Grid Integration

- Identification of the nearest transmission line.
- Identification of a Point of Interconnection with alternative options. Technical and Financial analyses shall be carried out for all options.
- Analysis of the transmission grid downstream of the identified line including detailed analysis of the existing demand and supply situation in the area near the Point of Interconnection.

II. Grid Impact Assessment.

This evaluation will consist, but is not limited to:

a) the identification of bottlenecks that may prevent the injection and transmission of the energy generated by the solar PV plant during periods of high solar availability.

b) assess the connection of the Project to the electrical grid confirming that all power generated by the Project can be evacuated into the grid without limitations.

c) Develop the design criteria for the Project, analyze and recommend the optimum on-grid design configuration including but not limited to required power plant controllers, voltage-frequency regulation, dynamic support methods to ensure both static and dynamic network stability for the integration of the solar plant instrumentation, electrical design, including design of a supervisory, control and data acquisition (SCADA) system.

d) to carry out studies on the load flow of the electrical system, contingency and dynamic (Elecro-mechanical) stability to confirm the adequacy of the grid in steady and dynamic state and to determine whether the power system developed, and the solar power plant technologies adopted will be sufficiently powerful to cope with temporary disturbances (unscheduled shutdown of one or more plants) and major system failures (loss of transmission lines, etc.)

- Load flow scenarios should include critical situations regarding solar energy (day-

peak, day-off-peak and off-peak conditions and situations of high production of the unconventional) for each considered connection options,

- Contingency analysis shall consider N-1 and N-2 contingencies, PV and QV analysis
- Switching analysis for energization of the power plant
- Power Quality analysis shall include Harmonics analysis and filter optimization if necessary
- Dynamic stability analysis should include, but are not limited to, transient stability (i.e. fast cloud event and tripping events), frequency stability, voltage stability, grid islanding, source tripping, critical fault clearing time and response for load shading, reactive support during abnormal conditions.

e) to perform a short-circuit level analysis at the proposed solar plant interconnection point, in critical solar energy situations, and recommend the solar plant capacity limits at the proposed injection points to ensure satisfactory quality of power supply or otherwise, the required technical solutions. The short-circuit analysis shall consider all Symmetrical and Asymmetrical faults, different operation conditions of the plant and verification of capability of the switch gear.

f) to perform Electro-Magnetic Stability analysis which includes at least Insulation coordination (internal and external) and Single-phase auto-reclosure

g) to carry out Protection and Relay Coordination study for the most suitable and selected interconnection scheme

h) Determine the capacity of connection point and describe upgrade works (if any) required to receive Output from solar PV plant. Required upgrade work should include electrical protection devices required to be installed at existing grid facilities which the solar PV plant to be interfaced.

The consultant will make full use of all appropriate resources to carry out the network simulations for transmission lines, substations, and power generation units. The consultant shall use DIgSILENT Power Factory for analysis and simulation. The objective of these simulations is to justify the optimal configuration choices of the transmission networks based on the need for static and dynamic stability of the target networks.

The electrical characteristics of transmission networks, substations and power generation units will be determined using the above-mentioned software.

Network simulations should justify the voltage levels chosen or lead to an optimal choice of the appropriate voltage level for the interconnection line of the solar plant and existing transmission network.

All hypotheses, technical data, and all choices to be used for electrical calculations must be decided by mutual agreement between the consultant, the African Development Bank, and the Client (EEP).

5.3.5. Battery Energy Storage (BESS) for the Solar Plant

The Consultant shall conduct the assessment of BESS within the feasibility study. In case the

assessment/study recommends a BESS, the consultant shall consider the following:

Optimal Battery Energy Storage System (BESS) capacity: The Consultant shall define an optimal capacity for a Battery Energy Storage System to be installed and the most adequate use cases. This definition will take into consideration a techno-economic analysis to minimize electricity cost while maximizing the adaptation to the site or country profile. A sensitivity analysis of energy storage needs with a daily demand profile would be required in order to assess the different sizes.

BESS Technology: The consultant will estimate the size in energy and power a number of BESS technologies. The analysis will consider:

- An assessment of the inter-annual operation of the system.
- Consideration of site-specific factors, including ambient temperature.
- Operation cycles and use cases.
- Electrical losses due to auxiliary and others
- Optimal dispatching strategy.

Financial Assessment: The consultant will assess the economic feasibility of incorporating the energy battery storage system to the solar plant by also considering the technical results and reliability indices for a more realistic assessment. This financial assessment would take into consideration the planning aspects of generation and power system of the studies being evaluated in here above.

5.3.6. Financial and Economic Analysis and Modeling

The Consultant will present his model of financial simulations in an Open Excel that allows to carry out analysis leading to the proposal of the Optimal Solar Plant Investment for the integration of the solar production on the National electricity networks of Ethiopia. This model will be made available to the Client (EEP) for future use in similar projects.

The Consultant shall provide detailed budget estimates of capital costs (CAPEX) for each component of the Project, including inter alia costs of civil and structural works, supply and installation of panels and its support structures, inverters, electrical equipment, other related equipment, cabling, transmission line and auxiliary equipment, logistics, taxes, licenses, land fees, and engineering and project management fees. The Consultant shall base its estimates on collated information on unit costs of materials and equipment, cost of civil works, electro-mechanical works, electrical works, transportation, labor costs etc. based on recent projects of similar scale and quality both internationally and in Easter Africa region.

The Consultant shall also provide a detailed estimate of operating costs (OPEX) and any interim capital expenditure associated with repairs to / replacement of equipment that would typically be expected during the useful life including estimates of, inter alia, expected labor costs including overheads, variable operating costs for consumables and spare parts, fixed operating costs for O&M management, administration, and overheads.

- Identify applicable local taxes and duties.
- Prepare overall Project budget estimates, separating foreign exchange and local currencies, including physical and price contingencies.

Financial/Economic Analysis

- Conduct the economic assessment of the Project.
- Highlight the key financial and economic assumptions.
- Propose alternative concepts for module, inverter, and mounting frame types including pros and cons for each concept. Concepts should include without limitation: south oriented fixed, east-west tracking; east-west oriented fixed Installation.
- Complete economic and financial analysis of each System concept, considering all relevant factors. The optimization for each concept is to achieve maximum benefit with regards to LCOE, amount of energy, fit of demand pattern of consumers and production, best use of available land.
- The financial modelling shall detail financial assumptions, energy yield, and evaluation of
  results depending on available primary and secondary data. The financial models must be in an open Excel tool, and must clearly set out all assumptions, sensitivity analyses carried out, and model outputs. The financial models must be sufficiently adaptable for use by others at later stages.
- Conduct the financial and economic evaluation for the selected technology for the solar power plant taking into account economic costs and benefits (including avoided carbon emissions, as applicable), including least cost analysis and comparison of alternative solar technologies/configurations, specifying the investment cost ($/kW), levelized cost of energy ($/kWh) versus the tariff/price mechanism for electricity that THE CLIENT pays under the present arrangements (if any), impact of any subsidies and incentives (e.g., applied to the equipment's costs, etc.), costs and benefits, life-cycle costs of plant, etc.
- Carry out a Cost-Benefit analysis and assess the project economic indicators, such as the Net Present Value (NPV) and the Economic Internal Rate of Return (EIRR);
- Identify all risks to Project costs and revenue and conduct relevant extensive sensitivity analyses of Project profitability against changes in all critical Project parameters to be identified by the Consultant including inter alia the irradiation scenarios (including P50, P75, P90 & P99), electricity demand, electricity market price/tariff levels, construction costs, operation & maintenance and repair/replacement costs and construction delays.
- Analysis of value to the power sector, demand and market sizing, customer profiling, return on investment, costs and revenues trajectory, running and recovery costs, risks, profitability and performance analysis and Value for Money analysis.
- CO_2 mitigation cost. The estimated local and global environmental benefits including climate, annual Greenhouse Gas (GHG) reduction benefits attributable to the renewable energy generation for the site.
- Financial cash flow forecasts with and without Clean Development Mechanism (CDM).

Anticipated Benefits

Anticipated benefits shall be calculated in terms of, but not limited to:

- Production from the solar plant in GWh per year
- The amount of Yearly recurring savings in terms of liters of equivalent diesel plants,

Greenhous Gas Emission, contribution to water storage in the hydro dams, and improvement of energy mix.

- Permanent jobs creation for operation and maintenance of the plant, during operations
- Creation of jobs during construction of the plant,
- etc.

5.3.7. Operational Recommendations

a. Identify, meet, analyze and give recommendations on O&M players for the PV plant and National Control Center.

b. Based on the technical and financial analysis the Consultant shall develop a business model (including Operation and Maintenance concept) for the operation phase, which allows for the supply of electricity to the national grid under the coordination of the National Control Center.

5.4. PREPARATION OF DESIGNS

The Consultant will use the results of the data provided by the client and the data and analysis conducted by the consultant to determine the design parameters for the solar plant and associated substations and transmission networks for possible integration and upgrading. The Consultant shall carry out a comprehensive tender design of the project for the construction and integration of the solar plant for the purpose of preparing bill of quantities, detailed technical specifications, the required drawings and bidding documents.

The tender design reports shall also be submitted in electronic copies; including editable format; in English language, and shall contain the description of structures; plans, maps, and diagrams; details on the standards used; technical specifications of the equipment, required technical parameters (employer's requirements), bill of quantities and the terms of reference for the project supervision and management consultant.

The Consultant shall consider the impact of climate change in the development of the layouts, designs, proposals and specifications for proposed equipment in order to ensure that the Project will be resilient to the impacts of future changes in precipitation and ambient temperatures and capable of maintaining reliable operation and performance.

The Consultant shall analyze, and consider the following factors in its assessment of each PV technology:

- Basic topography of the proposed site
- Geotechnical analysis for the proposed site
- Site environmental considerations and climate.
- Interconnection with the transmission grid.
- Equipment required for construction and maintenance.
- Performance, availability, and equipment warranties.
- Operations and maintenance schedule and costs; and
- Auxiliary power requirements during construction and operation.

The Consultant shall prepare the design and technical specifications for the Project that include the following items:

- Site plans and layouts for both Solar PV and associated substation.
- Electrical single line diagrams (SLDs).
- Survey/topography map to allow the contractor(s) to design the civil works.
- Instrumentation, protection and control systems for both Solar PV and associated substation.
- Major equipment list with sizing.
- Major equipment specifications.
- Plant substation including HV switchgear, transformers, protection and relays, etc.
- Power plant and substation monitoring and controlling system (SCADA) scheme
- Transmission lines Tower types, including fittings and accessories.
- Earthing and Lightning for Power plant, substation and transmission line
- Using the transmission line survey data provided by the Client, prepare the transmission line profile, tower spotting, bill of quantities, etc.

The design should be:

- robust and technically sound and based on well-established technology.
- compliant with internationally respected guidance and standards and good engineering practice.
- compliant with all relevant regulatory requirements and requirements of the Client.
- capable of performing as required in all anticipated operating modes and achieving the required level of performance (efficiency, degradation, operational life, etc.).
- sufficient quality to perform and operate satisfactorily for the expected operational life of the Project.

The consultant shall also prepare civil design that includes:

- Site layout, temporary and permanent installations
- General design layout
- Module cleaning water supply system
- Foundations and civil design
- Substation(s)
- Security systems
- Transmission line foundation types to be used.
- Solar PV and substation access road.

Security Vulnerability Assessment: The Consultant shall assess and include in the design of the project the physical security and cyber security needs to prevent unauthorized access to secure areas and SCADA. The assessment and design will include observations and considerations for the following areas, where applicable:

- Lighting.
- Security fencing.
- CCTV cameras.
- Other sensors (e.g. photoelectric beams, trip wires, passive infrared, microwave,

motion, interlinked digital signal processing).

- Warning devices (e.g. signage, alarms, klaxons);
- Security personnel.
- Cyber security; and
- Other security measures

The assessment shall consider local standards and regulations (if any), as well as industry best practices.

5.5. PREPARATION OF BIDDING DOCUMENTS

Following the completion of designs, drawings, detailed specifications, bill of quantities, Employer's Requirements section (scope of works, technical requirements, technical specifications and functional specifications, drawings, E&S requirements as provided by the employer, etc.), and requirement of construction works the consultant shall prepare the bidding documents using the relevant and latest versions of AfDB's Standard Bidding Documents (SBDs) for each contract package in particular the SBD entitled "Procurement for Plant, Design, Supply and Installation". The bidding documents will be produced based on the results of this feasibility study and the further site-specific studies and will include the feedback / requirements received from the relevant permitting authorities. The consultant shall design and include in each bidding document stringent qualification and evaluation criteria to select reputable and experienced bidders/contractors. During the preparation of Bidding documents, the consultant shall be responsible to consider the Environmental, Social, Health and Safety issues to be adequately captured, as well as the final project ESMP is annexed in the Bidding document, as deemed necessary.

The Consultant shall develop the technical requirements, technical specifications, functional specifications and drawings for the Project tender documents according to IEC /IEEE/ EN standards.

6. ENVIRONMENTAL AND SOCIAL SAFEGUARD

6.1. Environmental and social impact assessment

The specific objectives of the Environmental and Social Impact assessment are:

- To characterize the project area using scientific methods of environmental and social analysis and undertake baseline studies on the environmental, social, economic and cultural conditions in the project area.
- To identify, analyze and evaluate the type and extent of likely potential environmental and social risk & impacts of the proposed project throughout the project life cycle with emphasis on duration, significance, magnitude and distribution of beneficial/adverse effects of the planned project on the existing biophysical, socio-economic and cultural components, and assess the capacity of the institutions responsible for management of these impacts.
- To assess, in an integrated way, all relevant direct, indirect and cumulative environmental and social risks and impacts throughout the project life cycle, including those specifically identified in OSs 2 to 10, as well as contextual issues, such as the prevailing political economy, which may affect how risks and impacts manifest themselves.

- To provide mitigation measures for the identified environmental and social risk & impacts and where residual impacts are predicted, a plan for their management including but not restricted to offsets, action plans etc. should be included.
- Evaluate the social and socio-economic aspects of proposed project, identify stakeholders, carry out public consultations, including potentially project affected persons (PAPs), religious & clan leaders (if applicable), and vulnerable groups, other key stakeholders in relation to potential project benefits and negative E&S impacts, analyze their views regarding the environmental and social impacts, design social provisions and measures, formulate strategies for participatory implementation, and recommend the incorporation of the findings into the project design.
- To assess the best alternative project option with most benefits and least costs in terms of financial, social, and environmental considerations.
- Carryout alternative analysis and compare various Subproject planning and design options in terms of their environmental and social consequences.
- To develop the Environmental and Social Management Plans (ESMP). The ESMP shall outline the mitigation/enhancement, monitoring, consultative and institutional strengthening measures to prevent, minimize, mitigate or compensate for adverse environmental and social impacts and to enhance beneficial impacts, costs of the measures and monitoring requirements.
- To prepare the following relevant standalone management plans to support the ESIA implementation based on both the national and Updated Integrated Safeguards System of AfDB requirements.
    - Labor Management Plan,
    - Stakeholders Engagement Plan,
    - Occupational and Community Health and Safety plan
    - Biodiversity Management Plan
    - Security management Plan

The ESIA study will enhance Environmental and Social Impacts that the project will have as well as determine measures to prevent, minimize, mitigate or compensate for adverse impacts and for an environmental enhancement; to be integrated in the planning and design of the project. The ESIA will at the same time generate an environmental and social management plan (ESMP) that describes in detail the mitigation measures to be carried out, the costing, scheduling and responsibility of such measures, a detailed monitoring process and schedule.

(i) Statutory Legal and Administrative Framework

The statutory frameworks within which the consultancy activities shall be executed are provided in the following regulations, guidelines, and standards (Note that the list is not exhaustive):

- African Development Bank Integrated Safeguards System
- Laws, regulations, guidelines, and standards of the Government of Ethiopia.
- All international Conventions and Treaties on Environmental and Social Protection to which Ethiopia is party to
- Regulation and guidelines regarding power generation, transmission, and distribution activities in Ethiopia

- Regulations and guidelines of the various Ministries of environmental and social welfare as well as Region where the project is located (the affected local region).

The ESIA will include the following key activities:

- Review of project details by interaction with Client, the Bank, and Ethiopian Environmental Protection Authority for a good understanding of the assignment.
- Define Project Area of Influence on the basis of the project scope and extent.
- Provide information on location and general layout of project related development sites (include maps to illustrate project areas), pre-construction activities, construction activities, operational and maintenance activities, decommissioning activities, schedules, staffing and support and life cycle for major project components.
- Review the policy, legal, and administrative framework within which the ESIA is carried out (these should include pertinent laws, regulations and standards governing environmental quality, health and safety, labor laws, protection of sensitive areas and endangered species, land ownership, land use control, gender etc.,). Review the national environmental and social requirements and the financier (AfDB's ISS and the respective OS). Also review international treaties and conventions that Ethiopia subscribes to.
- Collection of data from secondary publicly available sources for the macro-environmental setting like climate (temperature, rainfall, humidity, and wind speed), physiographic, geology etc. and social baseline
- Conduct site visits to subproject locations including formal and informal discussion with local communities, government entities and other key stakeholders to assess baseline environmental quality or social issues, as appropriate, and socio-economic, etc.
- Provide the existing physical, biological, socio-economic and cultural environment of the project area, including any changes anticipated before the project commences, based on the findings/results from the previously conducted screening phase.
- On physical environment provide information on geology (general description of study area), topography, soils and erosion patterns, climate, including rainfall patterns and characteristics, surface and ground water hydrology, identity of streams, rivers, lakes, marine ecosystem etc.
- Biological environment – Flora, fauna, rare or endangered species within or adjacent to the project area, sensitive habitats including wetlands, parks, protected areas, species of commercial importance that would be affected by the project.
- Socio-economic and cultural environment - population and demography, land use, planned development activities, economic activities, employment and labor market, distribution of income, public health, education and literacy level, sources of energy, water and sanitation, waste management, cultural properties (archeological sites), land ownership and custom, gender and vulnerable groups.
- The consultant shall undertake social survey which will include identifying any community households that would need to be resettled from implementation of the project, identify vulnerable groups such as people with disabilities, women and elderly who might need special assistance, organize gender disaggregated stakeholder consultation to capture specific concerns raised by women, document land tenure systems in the project area highlighting land acquisition and land use. The outcome of

this survey shall guide if there will be need to prepare a Resettlement Action Plan and any other mitigation measures for the social impacts. The outcomes shall also be integrated into the ESMP.

- ***Analyze project design alternatives***: Systematically compare feasible alternatives to the proposed project site, technology, design, and operation - including the "without project" situation. The consultant shall outline reasons for selecting the proposed project alternative over other alternatives.
- Identify and describe all the potential environmental and social impacts that the project is likely to generate during the 4 phases (pre-construction, construction, operation and decommissioning phase) (including expired battery storage and disposal risk management provisions as well as induced impacts from the project.)
- Assess the significance of these impacts.
- Follow mitigation hierarchy while designing mitigation measures to make it prudent.
- Prepare, conduct, and describe in the ESIA the subprojects' public consultation process proceedings in report format and Grievance Redress Mechanism (to be operational from pre-construction through implementation phase). As part of informing project design, and in addition to risk mitigation measures to reduce negative impacts on communities, public consultations should explore positive impacts of solar mini-grids and promotion of efficient cooking technologies, as well as possibilities and modalities of Anchor - ESCO (business)-community (ABC) benefit sharing schemes.
- As part of the ESIA, assessment of social aspects (land acquisition including temporary, involuntary resettlement, indigenous people, gender, public consultation, etc.) of the project planning and design must be in full coordination with the environmental assessment and planning aspect.
- As part of the ESIA, assessment of social aspects required to consider opportunities for job creation and income generation for women and youth.
- If found necessary based on the ESIA findings, prepare a Vulnerable Community Development Plan (VCDP).
- Prepare the Environment and Social Impact Assessment (ESIA) study report in accordance with AfDB's OSs.
- Provide Environmental and Social Management and Monitoring Plans for the overall project (including defining institutional responsibilities, capacity building and training, and the required budget). ESMPs must be complete with mitigation plan, compliance monitoring plan, effects monitoring plan, institutional arrangements, training needs, documentation and communication protocol, grievance redress mechanism, cost of implementing ESMP, and mechanism to integrate ESMPs with the projects (e.g., through contractual clauses). If any contractors are to be involved, risk management plans must include clear provisions for contractors, incorporating among other things labor-related clauses for contractors and their workers.
- The Consultant shall liaise with the Client to be obtain final ESIA approval from the Ethiopian Environmental Protection Authority.

(ii) Stakeholder Engagement:

As part of the ESIA, environmental and social consultant with support from the Client and

concerned Local Authorities – will conduct the following activities in a fully coordinated manner:

- Stakeholder identification / mapping and analysis exercise (to be included in the ESIA report) - Information disclosure and consultations: Hold two rounds of consultations.
- During ESIA study, conduct consultation meetings, including consultations for obtaining the informed views of the affected people, youths, women, vulnerable groups, local nongovernmental organizations (NGOs), regulatory authorities, community-based organizations.
- Hold consultative workshops at the site. After preparing draft ESIA report (during Public Hearing) with local communities.
- Capture outcomes of negotiation and partnerships with communities (in view of benefit sharing schemes). More specifically, community mobilization will be essential to foster support from residents and businesses of the community for the project. Community mobilization has both social and commercial implications for the projects. This critical aspect needs to cover by ESIA and ESMP and planned well-in-advance.
- Design, process, and resources allocated to grievance redress mechanism (co-managed, contractors, etc.)
- Describe potential options of community involvement in project monitoring.

(iii) Structure of the ESIA Study Report

The ESIA and ESMP reports shall be in the English Language and should be clear and concise. The Report shall have but not limited to the following thematic structure:

- Executive or non-technical summary.
- Introduction
- Policy, legal and administrative framework and gap analysis
- A thorough capacity assessment of the public entities in charge of ESIA enforcement and oversight, including how they are decentralized in the project implementation regions/jurisdictions
- Project description and justification
- Description of the project environment, i.e. a comprehensive analysis of the project influence area (site, direct influence area, indirect/wider affected area), including associated facilities.
- Baselines studies (split into three parts: biological, social, physical and economic)
- Impact identified and mitigation measures.
- Analysis of residual impacts
- Project alternatives
- Anticipated environmental impacts and mitigation/enhancement measures.
- Environmental hazard management
- Environmental and Social Management Plan – ESMP (A well-costed environmental and social management plan (ESMP), including any relevant specific sub-plan, and summarized in a matrix.)
- Public consultations: Evidence of stakeholder's consultation (comprehensive lists of participants with contact, pictures, etc.), including a stakeholder's engagement plan-

SEP.

- Implementation schedule
- Conclusions
- Appendices
- Annexes: (i) Baseline Report and (ii) ESMP (iii) Stakeholder Consultation Minutes of meeting

The consultant is expected to use professional judgement and proactively identify necessary areas of engagement, ensuring that the analysis is complete and thorough. The Consultant shall recognize that the project design, including the proposed technology and technical schemes. Hence the consultant should base the assessment process on available data, highlight where technical choices could significantly affect the E&S risks and impacts of the projects, and provide guidance to ensure mitigation measures and stakeholder concerns are considered in project design.

6.2. Resettlement Action Plan (RAP)

If land acquisition or land use restrictions lead to significant economic displacement, a separate livelihood restoration plan will be developed to provide displaced people with opportunities to restore or improve their livelihoods; if a project only involves economic displacement, the resettlement plan may be referred to as a "livelihood plan."

If the resettlement plan is necessary, it will be executed as indicated below in this section but if a resettlement plan is not necessary and just a livelihood plan/ livelihood restoration plan shall be caried out. Hence, the consultant shall propose the RAP as option in accordance with the required scope of work, schedule, and cost.

The RAP will be prepared based on the Identification (Census) of PAPs/displaced persons, and Public Consultations and Disclosure Procedures (PCDP). It will include information and principles regarding compensation/resettlement of potential affected persons and their properties. A detailed RAP will be prepared whereby the land demarcation and detailed identification of PAPs and socio-economic baseline will be carried out.

The main objectives of the Resettlement Action Plan (RAP) are as follows:

- To undertake socio-economic studies and document baseline conditions in terms of demographic, livelihood and socio-economic conditions, and document all forms of entitlement under the project.
- To identify and quantify different categories of project-affected persons (PAPS) who would require compensation, rehabilitation or relocation, and some form of assistance.
- To undertake consultations and public engagement and produce a stakeholder report.
- To recommend cost effective measures to be implemented so as to mitigate the expected impacts.
- Formulate criteria for eligibility and entitlement as well as methods and mechanisms for the valuation of various categories of household and community assets for compensation, design strategies for restoration of the income and livelihood of PAPs,

special support measures for vulnerable groups and social and community development projects.

- To undertake land survey to be able to delineate land requirements for the wayleaves corridor and produce a survey report (strip maps) and use the information in the preparation of cost estimates and budget for the RAP.
- Design mechanisms and procedures for the resolution of conflict and redress of grievances arising from the implementation of the RAP and the project.

The resettlement action plan (RAP) study is a process of developing a document that describes the measures and procedures for addressing the impacts of involuntary resettlement caused by a development project. The RAP study will identify the following aspects:

- The project description, rationale, and objectives, as well as the actions taken to avoid and minimize the need for resettlement.
- The relevant policies, laws, and regulations that apply to the land acquisition and resettlement activities, as well as the entitlement policies and the methods of valuation and compensation for the affected assets and livelihoods.
- The baseline situation of the affected population and the extent and nature of the resettlement impacts, based on a census and a socio-economic survey.
- The procedures and mechanisms for acquiring and developing the land and facilities needed for resettlement and relocation, as well as the arrangements and schedule for the implementation of the resettlement activities.
- The measures and programs to restore and improve the income and livelihoods of the affected people, as well as to address any social and cultural impacts of the resettlement.
- The roles and responsibilities of the various institutions and stakeholders involved in the planning, implementation, and monitoring of the resettlement activities, as well as the coordination and communication mechanisms among them.
- The procedures and mechanisms for receiving, recording, and resolving the complaints and grievances of the affected people and other stakeholders.
- The estimate of the costs and sources of funding for the resettlement activities, as well as the financial management and disbursement procedures and the audit and reporting requirements.
- The detailed timeline and sequence of the key resettlement activities, as well as the milestones and deliverables for each activity and the responsible parties.
- The monitoring and evaluation indicators and mechanisms to assess the effectiveness and sustainability of the resettlement activities.

(i) Structure of the RAP Study Report:

The consultant shall prepare the Resettlement Action Plan report including a Livelihood Restoration Plan. The report shall be in the English Language and should be clear and concise. The Report shall have but not limited to the following thematic structure:

- Executive summary
- Introduction

- Project description
- Legal and regulatory framework
- Socioeconomic environment
- Impact of the project on PAP
- Public consultations
- Eligibility criteria and entitlement
- Institutional framework for the implementation of the RAP
- Monitoring review and evaluation framework
- Implementation schedule and budget
- Annexes: (i) livelihood Restoration Plan; (ii) compensation summary sheet (iii) Stakeholder Consultation Minutes of meeting

7. Capacity building and Application software/tools

The capacity building scheme is intended to help to conduct early project development activities (such as site screening, resource assessment, energy analysis, RE integration and project feasibility study activities) internally using theoretical and practical training in this project. The capacity building training consists of local theoretical and practical trainings, on-job trainings, study tour, provision of relevant Solar and Grid Integration software simulation and analysis packages which enables the EEP staff to conduct such project development activities. The trainings should include practical case study scenario which helps for practical demonstrations. The consultant shall prepare and provide detailed capacity building scheme with the Inception report but outline indications shall be presented in its technical proposal. The consultant shall consider all respective costs for the capacity building including trainings, workshops, study tour and software application.

7.1. Local Training and On-job Trainings

The section of the capacity building is one of the main packages which emphasis classroom and practical trainings including on-job trainings. The training should include but not limited to the following:

- Solar PV site selection, measuring campaign, solar irradiation data collection and preparation of data
- Solar irradiation data (solar resource) assessment, Solar PV Project Site screening, pre-feasibility study,
- Solar PV modules, Inverters, and Solar related technologies and trends
- Solar data, Techno-economic analysis, energy analysis and simulation using the proposed Solar PV system software
- Cost estimation, Energy yield assessment and Detail feasibility study,
- PV system Design and layout, installations, commissioning etc
- Grid integration and impact study which includes at least steady state, dynamic and Electro_Maganetic stabilities analysis

- Financial and Economic analysis including financial and economic analysis, financial model and related activities
- E & S Scoping.

The capacity building program shall empower EEP to conduct project earlier development activities by in-house capacity which helps to continue more sites data collection, resource assessment and feasibility studies. Thus, availing new additional project sites to accelerate the solar project development in the country to meet the national energy goals.
Besides, the consultant shall prepare and submit procedures and guidelines Solar PV Resource Assessment and Feasibility studies as part of the capacity building.

7.2. Simulation Software and Devices

The Consultant shall provide the necessary software tools to the Client to facilitate the capacity building and training program. The following software tools shall be provided to the client:

a) **Solar PV simulation & analyses software package**

Latest version Solar PV software with two licenses and perpetual service and 5 years maintenance support. The consultant shall provide practical training with case study for selected EEP's staffs how to use the software by the relevant proficient expert (s) or supplier. The Solar PV simulation & analysis software package has at least the following functional & technical requirements for designing of Solar PV system:

- Capability to deal with grid –connected (including utility scale), stand alone, BESS and DC/AC-grid PV systems.
- Has ability to assess Solar Energy resource, and import and export the data
- Has an extensive/scalable database for PV systems' components and general solar energy tools.
- Ability to offer PV system study capability at different stages (preliminary, detailed analysis stages, etc) of solar PV projects.
- Ability to sizing the required PV power and battery storage requirement for grid connected and stand-alone systems based on load profile and defined probability values.
- Capability to perform a detailed system designing such as PV array sizing using selected inverter model, battery , module layout etc.
- Capability to assist in analyzing the effect of selected parameters such as thermal behavior , wiring , module quality ,mismatch and losses , uncertainty, shading, efficiency, etc.,
- Capability to analyze and simulate inter-annual Energy yield (1, 5, 10, 20 and 25 years) with P50, P75 and P90.
- Capability to perform detailed Financial and economic evaluation and analysis using, for examples, component prices, and other costs such as investment & operating costs.

- Capability to import and export meteorological data from other sources in different file formats, such as ASCII files.
- Capability to manage databases of manufacturers product catalogues of PV components, such as PV modules, invertors, generators, BESS, etc.

b) Grid Integration simulation & analyses software package

Latest version Grid Integration and power system analysis single user software (Digsilent powerfactory software) with perpetual licenses and five years maintenance agreement. The consultant shall provide practical training with case study for selected EEP's staffs how to use the software by the relevant proficient expert (s) or the supplier. The software package shall have advanced function including Data management, Load flow sensitivity's, Protection functions, ARC-Flash analysis, Optimal power flow, Transmission network tools, Distribution network tools, Cable analysis, Reliability analysis functions, Small signal stability, Reliability Analysis Functions, Connection Request Assessment, Unit Commitment and Dispatch Optimization, State Estimation, Motor Starting Functions, Connection Request Assessment, System Parameter Identification, Probabilistic Analysis, DPL/DSL/QDSL Encryption, and Interfaces. Specifications for the software is attached in Annex A.

c) Devices

To use for the analysis and simulation software applications to Grid Integration and Renewable energy, three computers (#3) shall be provided which are capable of running the Analysis software of the Grid Integration (DigSilent), Wind resource and Solar resource simulation with the following specification. Besides, one projector shall be provided for in-house trainings. Specifications for the devices are attached in Annex B.

The Solar PV and Grid Integration Software packages shall be provided within four months from commencement of the project.

7.3. Study Tour

As part of the capacity building program there shall be an oversea study tour which consists of simulation and demonstration workshops at training center, Visiting utility scale Solar PV Plant and factories of PV modules and inverters. The study tour shall be provided within four months from commencement of the project and the consultant shall include all respective costs including accommodation, meal, per diem and logistics. The study tour shall be two weeks for eight (8) EEP staffs and it shall include but not limited to the following study tour activities in the consultant's country (or other relevant country as per the consultant propositions):

- High level simulation and demonstration training /workshops at training center for Solar PV site selection, measuring campaign, collection and preparation of data, analysis of solar irradiation data, Solar PV modules and

inverters technologies, feasibility study, PV system Design, Techno-economic analysis, Energy yield assessment, PV system software simulation, installations, commissioning and RE grid integration which can't be fully addressed in the local training

- Visiting utility scale and grid connected solar PV power plants with BESS
- Visiting Solar PV modules, Battery, inverters and other solar related technologies manufacturers in the consultant's country.

8. Inputs from Ethiopian Electric Power (Client)

The Client will provide the following data, report and documents:

- The Client will provide the existing geotechnical investigation reports, Topography, Hydrology, Grid Integration study and E & S Scoping reports for the Solar PV Site.
- The network data in DigSilent (Power factory) format,
- The demand forecast,

9. TIMETABLE, REPORTING AND DELIVERABLES

9.1. General

The duration of the Assignment is expected to be up to **10 months** from the signing of the Consultancy Contract.

The Consultant will visit the Client and the Project site in the first month from signing of the consultancy agreement for the Assignment.

9.2. Timeline for Deliverables

The following deliverables shall be submitted by the Consultant in accordance to the deadline indicated here, counted from the date of signing of the consultancy service agreement:

- Kick-off meeting (with the client and the Bank) and Work Plan within (2) week of signing,
- Inception Report within 1-month of the signing the contract,
- Draft Preliminary Feasibility Study within 4-months,
- Draft Preliminary ESIA Report within 4-months,
- Draft Preliminary Design Report within 5-months,
- Draft Preliminary RAP Report within 6-months,
- Draft Final Feasibility Study within 6-months,
- Draft Final ESIA Report within 6-months,
- Draft Final Design Report within 7-months,
- Draft Final RAP Report within 7-months,
- Draft Bidding Documents within 7-months,
- Final Feasibility Study, Design Report and Drawings, Bidding Documents, ESIA and RAP by end of the 8th month.

Note: -The Feasibility study shall include as Annex or a separate file all the site investigation/study reports.

-The consultant shall submit working files for the analysis and simulation including working/analysis excels, financial model, network model (digsilent format), solar energy analysis, spatial files etc.

9.3. Deliverables

The followings are the deliverables of the Assignment:

- **Report 1:** Feasibility Study.
- **Report 2:** Grid Impact Study
- **Report 3:** Design Report: complete with drawings, calculations, technical specifications, employer's requirements and required guaranteed data sheets.
- **Report 4:** Bidding Documents for each contract package.
- **Report 5:** Environmental and Social Impact Assessment (ESIA)
- **Report 6:** Resettlement Action Plan (RAP

9.4. Reporting

During the assignment the Consultant shall organize bi-weekly progress meetings (virtual meeting) with the Client and the Bank. During the meeting the work progress during the last two weeks, planned tasks for the coming weeks, difficulties, risks and proposed mitigations shall be discussed.

Monthly Progress Reports: The consultant shall provide the Client with a summary of progress made within each calendar month. The report shall be submitted within one (1) week of the end of the relevant month.

9.5. The payment schedule:

The payment of the contract shall be linked to the deliverables and presented as follows.

1st Payment is 10% of the contract and shall be paid after delivery Inception report.

2nd payment is 20% of the contract and shall be paid after delivery of:

- Draft Preliminary Feasibility Study within 4-months,
- Draft Preliminary ESIA Report within 4-months
- Capacity Building (Software Applications delivery and Trainings)

3rd payment is 20% of the contract and shall be paid after delivery of:

- Draft Preliminary Design Report within 5-months,
- Draft Preliminary RAP Report within 6-months,
- Draft Final Feasibility Study within 6-months,
- Draft Final ESIA Report within 6-months,
- Provision of respective Capacity Building

4th payment is 20% of the contract and shall be paid after delivery of:

- Draft Final Design Report within 7-months,

- Draft Final RAP Report within 7-months,
- Draft Bidding Documents within 7-months,
- Provision of respective Capacity Building

6th Final payment is 30% of the contract and shall be paid after delivery of:

- Final Feasibility Study,
- Final Design Report and Drawings,
- Final Bidding Documents,
- ESIA and RAP (if applicable).
- Closing workshop for client, Bank and relevant stakeholders

The Final delivery shall be provided by end of the 8th month.

10. EXPERIENCE OF CONSULTANCY AND STAFFING

10.1. Experience of the Consultant

The implementation of the Assignment will be carried out by a well-established consulting firm (the Consultant). The firm must have a general experience in the energy sector minimum 15 years while minimum experience of 10 years in project preparation and development in the energy sector with particular experience in preparing feasibility study and design for Utility-Scale Solar PV project. In addition, the prospective firm shall have proven international experience in multidisciplinary consulting services in engineering, project management, environmental management and development activities.

The Consultant must comprise a team of experts with extensive experience from similar feasibility study and design of solar PV plants. The project management and key personnel must have experience and the team should be supported by local expertise (if needed). Experience in Solar PV projects within the sub-Sahara region will be an added advantage.

The consultant must have worked on at least three (3) projects involving Feasibility Studies and design and preparation of tender documents for Solar PV plant of Utility-Scale, each project of at least two studies of 50 MW capacity each.

10.2. STAFFING

Execution of the Assignment may require the services of a multi-disciplinary team with expertise and experience in, as a minimum and not limited to, the following areas:

- Project Manager/Team Leader
- Solar Energy Yield (PV) Expert
- PV Hybrid and Storage Expert
- Power System (Grid Connection) Expert
- Transmission line expert
- Substation expert (electrical engineer)
- Civil /Structural design expert
- Economist / Financial Modeling Expert
- Contract and Tender (procurement) Expert
- Environmentalist
- Social Development Expert

The following lists the minimum experience and expertise for the key roles and ancillary roles that it is envisaged will be required for the Assignment and which cover many of the areas listed above. The experts are expected fluent in English. The following positions may be aggregated and covered by a single expert where relevant. In such cases, he/she must demonstrate relevant cumulative experience.

- **A Team Leader or Project Manager** who will be responsible for coordinating tasks and activities and liaising with the Client. The Team Leader will be an engineer shall have professional experience of 14 years in the energy sector and with at least 8 years' experience and in-depth knowledge of the Feasibility Study, engineering, design and construction of solar PV projects. He/she should demonstrate management and administration experience, including experience with procedures of international financing institutions (IFIs). He/she should have experience in a similar position for at least three similar Projects studies in the last 8 years. He/she shall have a professional degree (Master's or higher) in a field directly relevant to the Study.
- **Solar Energy Yield (PV) Expert** with an engineering degree (minimum BSc) and shall have professional experience of 10 years in the energy sector. He/she shall be with minimum 7 years' experience in the solar energy resource assessment, Feasibility study, engineering, design and energy yield assessment for solar PV plants, experience in PV and storage projects, PV simulations, PV yield assessments, PV design optimization as well as hybrid renewable energy systems design optimization. He/she should have experience in a similar position for at least two similar Projects/studies in the last 7 years.
- **PV Hybrid and Storage Expert** with an engineering degree (minimum BSc) and shall have professional experience of 10 years in the energy sector. He/she shall be with minimum 7 years' experience in the electrical storage project, BESS sizing and optimization, technical-financial simulation and optimization. He/she should have experience in a similar position for at least two similar Projects /studies in the last 7 years
- **Power Systems (Grid Connection) Expert**: Electrical engineer with at least a BSc in Electrical Engineering and shall have professional experience of 10 years in the Power system; power system study/network analysis, generation and transmission planning, modeling and certification of photovoltaic plants. He/she must use DigSilent or other similar network studies simulation tool, and experience in power system investment planning and at least with minimum 7 years' experience in the grid integration (connection) requirements and studies for solar PV plants. He/she should have experience in a similar position for at least two similar grid Projects in the last 7 years
- **Transmission Line expert:** Civil or Electrical engineer with at least a BSc and specialized in the design of power transmission lines (230 kV or higher). He/she shall have professional experience of 10 years in the energy sector. He/she shall be with minimum 7 years' experience, in the projects/studies initiated in developing countries. He/she should have experience in a similar position for at least two similar Projects in the last 7 years
- **Substations expert (electrical engineer):** Electrical engineer with at least a BSc and shall have professional experience of 10 years in the energy sector. He/she shall be with minimum 7 years' experience specialized in substations design (230 kV or higher). He/she should have experience in a similar position for at least two similar Projects in

the last 7 years

- **Civil /Structural Engineer** with an engineering degree at least a BSc and shall have professional experience of 10 years in the Engineering works. He/she shall be with minimum 7 years' experience in foundation, civil and structural works design for solar PV plants, substation civil design and transmission line foundation design.
- **Economist / Financial Modeling Expert** with a degree at B.A. in finance discipline or in economics and with minimum 10 years' experience in financial and economic analysis. He/she shall be with minimum 7 years' experience in energy projects financial and economic analysis and assessment of public and private sector power projects including solar PV projects; and with very good knowledge of recent market conditions for EPC contracts and project cost estimations.
- **Contract and Tender (Procurement) Expert** with a degree at least a B.Sc./ BA in public or business administration or engineering or law or another related field and shall have professional experience of 10 years in the Procurement works. He/she shall be with minimum 7 years' experience in solar PV plant contracts and good understanding of solar PV plants and experience in procurement rules and procedures of the AfDB and/or other similar Multilateral Development Banks (World Bank, Asian Development Bank, European Investment Bank, etc.)
- **Environmental Expert** with a degree at least a BA degree in Environmental science/ Environmental Engineering and related fields/ and shall have professional experience of 10 years in the Environmental/ESIA works. He/she shall be with minimum 7 years' experience of similar experience in preparing an ESIA, site inspections and auditing of management plan, preferably on infrastructure projects (road or power or water, etc.).
- **Social Development Expert** with a degree at least a BA or BSc degree in Social Sciences or related fields and shall have professional experience of 10 years in the Social /ESIA works. He/she shall be with minimum 7 years' experience of similar experience in preparing an ESIA and RAP, expertise in social assessment, resettlement planning, socioeconomic surveys, stakeholder consultation, grievance redress, monitoring and evaluation preferably on infrastructure projects (road or power or water, etc.).

The consultant shall be expected to submit documented evidence and references to support each of the above required key expertise. The Consultant will take all the necessary measures for the good execution of the assignment and within the timeframe allocated. The Consultant is free to add any key expertise he judges essential to perform the assignment.

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10.3. Man – Month Allocation

- The Consultant will indicate in its proposal sufficient man-months for proper execution of the project.
- The consultant should clearly indicate the man-months to be spent on each activity.

- Considering the technical and financial evaluation, contract shall be awarded to the consultant whose entire result reflects the evaluation criteria.
- The Consultant should assume that some experts should be mobilizing to the site at the same time. Data collection, Analysis & any other related investigations shall progress in parallel.
- The Consultant shall provide a detailed schedule with breakdown for the various activities called for in the TORs, including the project office and field activities.
- The consultant should clearly indicate the man-months to be spent on field activities, and project Office.
- The consultant will be evaluated with the total man-month proposed for both countries. The total man-months are proposed to be 40.
- The minimum proposed man-month by the Consultant shall not be less than the estimated man-month by the clients as follows, for each key personnel and activity.

Sr. No.	Descriptions of Key Expert staffs	Number of Expert	Estimated Man-Month	
			In Ethiopia	Home office
1	Project Manager/Team Leader	1	6	3
2	Solar Energy Yield (PV) Expert	1	3	2
3	PV Hybrid and Storage Expert	1	2	1.5
4	Power System (Grid Connection) Expert	1	2	1.5
5	Transmission line Expert	1	1	1
6	Substation expert (electrical engineer)	1	1	1
7	Civil /Structural design expert	1	2	1
8	Economist / Financial Modeling Expert	1	1	1
9	Contract and Tender (procurement) Expert	1	2	1
10	Environmentalist	1	3	1
11	Social Development Expert	1	2	1
Total Man months			**25**	**15**

11. OFFICES AND OFFICE FACILITIES

The Client will not provide office and furniture thus, the consultant shall consider for its staffs.

12. DUTIES AND RESPONSIBILITIES OF THE CLIENT

The Client shall provide the following to the Consultant:

- Access to the project areas.
- Access to relevant as-built documentation to the extent of their availability of the existing transmission line and substations.
- Liaise with the government and facilitate all requirements/supports needed for the Consultant to perform their duties in Ethiopia.
- Counterpart staff to work with Consultant's team.
- Support the Consultant with work permits and visas for Ethiopia plus introductory letter for travels in the region related to the project.

13. TRANSPORTATION

The Client will not provide transportation for the consultant's staff. All costs shall be included in the consultants offer.

14. IMPROVEMENT OF THE TOR

Any comments and suggestions on the terms of reference are welcome.

Annex A: Grid Integration Software Application

Grid Integration and power system analysis software (DIGSILENT) with maintenance agreement to critical updates for five (5) years. The application includes basic and advanced functions such as:

Base package	Small signal stability
Contingency analysis	Reliability Analysis Functions
Quasi-dynamic simulation	Connection Request Assessment
Network reduction	Unit Commitment and Dispatch Optimisation
Power quality and harmonic analysis	State Estimation
Techno-Economic analysis	Motor Starting Functions
Stability analysis function (RMS)	Connection Request Assessment
Electromagnetic transient (EMT)	System Parameter Identification
Scripting and automation	Probabilistic Analysis
Data management	DPL/DSL/QDSL Encryption
Transmission network tools	Interfaces
Distribution network tools	
Cable analysis	
Reliability analysis functions	

Annex B: Minimum required specifications for Devices

a) Minimum required specifications for computers

Quantity: Three

Component	**Minimum Specification of Laptop**
Processor:	12th Gen or higher Intel Core i7 or i9 Processor with processor speed of 3.3 Quad core processor, Intel
Operating System:	Genuine Microsoft Windows 10 or Windows 11 Enterprise
Application:	Genuine Latest MS Office Professional, Adobe Pro DC and other relevant PC Applications
Memory (RAM):	32 GB of RAM
Storage:	1 TB of SSD
Battery	Capable of working for at least for 9 hours
Video/Graphics	NVIDIA GeForce GT 5xxM or higher. graphic cards. ·- minimum 4

:	GB RAM
Monitor:	14″
Mouse:	Built-in or external trackpad, wireless and/or USB, 2-button, optical mouse

b) Minimum required specifications for Projector

Quantity: One

- Projector Size; 7.60" x 20.50" x 17.60" (HxWxD);
- Weight; 28.0 lbs;
- Audible Noise; 30 dB / 22 dB (Eco),
- Maximum Input Resolution 4096 x 2160.