Terms of Reference (ToR)
Appointment of Consulting Firm for
Detailed Feasibility Study for Construction of Solar Park at Jamalpur Char Area (Package S-32)

BACKGROUND

Electricity plays a pivotal role for the socio-economic development of a country. Bangladesh has experienced booming economic growth, rapid urbanization, and increased industrialization. The Government of Bangladesh (GoB) has taken a diversified fuel-based power generation program to fulfill the vision and commitment of the government.

To fulfill the GoB's vision and objectives of electrification, development of renewable energy (RE) resources will play a vital role. The government has taken appropriate measures for generating clean electricity from renewable energy sources. The Government has a target to generate 10% of the electricity from RE sources by 2030.

To meet the target, the government has taken all efforts to promote generation of electricity from RE sources. Under a study conducted by The World Bank, a potential site at Jamalpur has been identified for a solar PV development, as a *solar hub* comprised of multiple solar photovoltaic parks (solar parks). The purpose of this feasibility study is to assess the economic and technical viability of the designated area in Jamalpur, covering the 20,000 acres marked through the specified geographic coordinates outlined in the Annex.

The study will be carried out under Power Cell, Power Division, Ministry of Power, Energy, & Mineral Resources (the Client), and will be financed by the World Bank under the ongoing TA for Strengthening and Development of Sustainable Power Sector in Bangladesh Project. A consulting firm (the consultant) will be hired to carry out a feasibility assessment on grid-connected solar PV generation at the designated area in Jamalpur, while evaluating its technical, financial, economic, social, and environmental viability, considering different variables outlined and subsequent impacts.

PURPOSE OF THE ASSIGNMENT

The main objective of this assignment is to determine and evaluate the technical and economic feasibility for a solar hub in a designated area within Jamalpur district, Mymensingh division.

DURATION AND LOCATION OF THE SERVICES

The assignment shall be completed within a maximum period of 8 (eight) months. The location of service will be Jamalpur district, Mymensingh division, Bangladesh.

SCOPE OF SERVICES

The scope of services for the feasibility study includes the following tasks detailed below, for the designated area in Jamalpur, as identified in the coordinates reflected in the annex. The bidder can propose some modifications in the scope of work to meet the objectives of the assignment.

The consultant shall review all previous studies relevant to the designated site, whether conducted by the World Bank or other utilities under Power Division. In summary, the feasibility study will include the following tasks:

- Task 1: Land Assessment
- Task 2: Solar Resource Assessment
- Task 3: VRE Grid Integration Assessment
- Task 4: Techno-Economic Assessment
- Task 5: Development Roadmap

The tasks are further defined and elaborated below.

Task 1: Land Assessment

The land assessment shall leverage the existing data collected and synthesized through various studies, mainly to assess the viability of the land for the solar parks, and the necessary investments needed for land preparation. The consultant will be provided with the following geospatial datasets to carry out Task 1: (i) drone imagery (3D, 5cm spatial resolution), and orthorectified satellite imagery (medium spatial resolution) of the designated sites; (ii) topographic layers, including DEM, DSM, and contour lines. As per the Annex, the geospatial dataset that will be provided covers a section of the area (marked in red), while the entire area that is included in the scope of this study covers a wider geographic area. The consultant shall collect and consolidate the same geospatial datasets necessary for designated areas not marked in red, to have a complete representation for the entire land within the purple line. The overall designated area is identified by the coordinates outlined in the Annex.

Additionally, the preliminary hydro-morphological assessment results for the designated area will be provided to the consultant. The Land Assessment, particularly in Task 1.4, shall incorporate the potential climate risks (especially, flood, cyclone, storm surges, etc.) for the designated area, considering the future scenarios and potential impact of climate change on the entire area. Such climate risks shall include the risks associated with floods and dynamic hydro-morphological changes over the years expected for the solar park's operation (~ 30 years).

The aim of the assessment is to determine the suitability of the planned solar parks and the associated land preparation investments required, considering the current and projected topographic and hydromorphic conditions. The subtasks outlined below shall result with independent deliverables produced by the consultant, in addition their consolidation informing the completion of Task 1.4.

Task 1.1: Hydro morphology Analysis

The morphological assessment based on satellite imagery indicates that the river's width in the study area has remained relatively stable over the past two decades, suggesting the river's current stability in proximity to the designated area. Notably, the *chars* in the study area exhibit varied growth patterns, resulting in differences in their ages. A detailed assessment of the hydromorphic condition and future risks of the land shall be performed by the consultant and must include the following:

- **Sediment data collection**: Obtain data on both suspended and bed sediment to comprehensively understand sediment distribution in the area.
- **Cross-section of river through field surveys:** Conduct field surveys to collect cross-sectional data, enabling a better understanding of bed level changes of the river within the site.
- **Morphological model development**: Develop a morphological model capable of providing a probabilistic assessment of future planform changes, mainly for defining the required alignment and type of bank protection work.

The detailed investigations shall outline the potential risks associated with the land development, considering the long term potential morphological changes. The output from Task 1.1 shall be consolidated, together with the Tasks 1.2, Task 1.3, to inform Task 1.4 which quantifies the potential land preparation requirements, and its associated costing and investments for the solar parks considered in the designated area.

Task 1.2: Geotechnical Analysis

The consultant shall conduct a thorough geotechnical analysis of the designated area to inform the overall study and land preparation costs and needs, based on the available data and through direct site assessment. The geotechnical analysis should be consistent with international best practices and standards, considering the contextual requirements in Bangladesh and the nature of the elements present in the local geography. The

geotechnical analysis shall include soil testing, and analysis to assess factors such as soil properties, soil stability, load bearing capacity, ground water condition, and foundations requirements.

Task 1.3: Flood Risk Assessment (2D model)

The consultant shall conduct a comprehensive and scenario-based 2D hydrodynamic model-based flood risk assessment, coupled with the collection of essential data such as cross-section details, water levels, and discharge at specific locations. The assessment shall reflect and incorporate lateral flow variations and flood propagation. The assessment aims at defining the alignment of flood protection measures, with the modeling activities required considering 'before-and-after' conditions of the area.

The assessment shall build on an available 1D model, which lacks the depiction of flow patterns with lateral variations, integral to overall hydrodynamics. Flood maps offering a basic overview of whether an area is at risk of flooding would be provided to the consultant.

Task 1.4: Investment Plan for Land Preparation

The consultant shall determine the scope of the necessary land preparation infrastructure (embankments, elevation, reinforcement, and other forms of land preparation), in addition to quantifying the necessary investments for the land reinforcement to accommodate the solar parks determined to be viable on the multiple islands within the designated area. The plan shall reflect the outputs and assessments produced in Tasks 1.1, 1.2 and 1.3. The preparation investments, costs and plans shall reflect the entire designated area, and the potentially segmented solar parks.

Task 2: Solar Resource Assessment

The objective of the assessment is to determine the maximum viable *solar PV generation capacity* in the designated area. The assessment shall incorporate the potential yield based on irradiance and the different segmented solar parks that can be developed based on the viable sections of the land identified under Task 1 (Land Assessment).

The assessment of potential solar PV resources and capacity shall incorporate the following considerations:

- **Viable land sections:** The solar PV generation shall be quantified by the consultant considering different categories of land sections, where variation of costs associated with the preparation and reinforcement are clearly defined.
- **Grid limitation and upgrades:** The consultant shall consider the various solar PV technical configurations based on grid constrains, future expansion plans, and optimal evacuation plans.
- **Technology and configuration**: The consultant shall assume the deployment of the most efficient and cost-effective solar PV module technology and mounting structures that are suitable for the land conditions, when determining the maximum potential viable on site.
- **Solar yield:** The consultant shall determine and quantify the potential available solar resources in the designated area, based on the most up-to-date irradiation data.

The output from Task 2 shall be used in the analysis required under Task 3 *(VRE grid integration and upgrade assessment)*, as well as Task 4 *(Techno-Economic Assessment).*

Task 3: VRE Grid Integration Assessment

The objective of Task 3 is: (i) to determine the grid-upgrades required for the integration of the identified solar parks into PGCB's transmission system; (ii) evaluate the different optimal technical configurations for the solar parks, in multiple solar plants, together with energy storage capacity, and (iii) quantify the grid

investments required. Task 3 builds on and utilizes the findings from Task 2 (solar resource assessment). The subtasks are the following:

Task 3.1: ***VRE Grid Integration Analysis***

Based on the solar parks determined based on generation capacity evaluated in Task 2, the consultant shall identify, plan, and implement the modeling and simulation functions required for the purposes of evaluating the integration of those solar parks into the grid in coordination with PGCB, while utilizing existing datasets through PSS/E – or other similar software (e.g ETAP, PLEXOS, DigSILENT).

The analysis shall include the following:

- Building network case files for multiple scenarios (evacuation, sizing, and other variables).
- A comprehensive transmission expansion planning.
- Load Flow Analysis, Short Circuit Analysis and Contingency Analysis.
- Dynamic Stability Analysis (to include dynamic modeling).
- Dispatch protocol of the dedicated solar parks in Mymensingh zone.

The analysis performed shall reflect the following:

- **Loading and Power Transfer:** Identification of power transfer capability from Mymensingh area considering load-generation scenario with all planned/proposed solar parks of that area (in addition to the proposed solar parks identified in this feasibility study).
- **Power Evacuation:** Identification for plans for power evacuation, potentially for one combined solar hub or multiple independent solar parks – within the overall designated area, as per the available solar PV generation capacity (Task 2). For example, the analysis may result in having two pathways for evacuation as an optimal approach (e.g., through two substations, at different points of interconnection with the transmission network).
- **Energy Storage**: The consultant shall identify the optimal location(s), technical configurations (including interconnection with the solar parks and the grid) and sizing for BESS assets, whether in one or multiple locations. The consultant shall also identify and evaluate the optimal operational functions for effective integration, maximum penetration, and grid-reliability (e.g., frequency regulation, voltage control, energy shifting, etc.).
- **Grid upgrades**: The consultant shall identify and quantify all necessary grid-upgrades for reliable integration of the identified solar parks to the national grid, including the optimal substation(s), transmission infrastructure, and point(s) of interconnection.

Additional considerations:

- ***Network case files****:* All network case files to be built by the consultant, shall be provided to PGCB in PSS/E compatible format. The analysis is expected to build on currently available and future planned grid models from PGCB, including models from ongoing studies (not only for designated area in Jamalpur, but also for the entire power system/grid).
- ***Solar hub segmentation***: The analysis shall integrate updates into existing and planned grid infrastructure, including in the northeastern region, and shall consider the multiple scenarios and timelines for power evacuation. The consultant shall evaluate a phased approach and a single phase, multiple lot approach, for planning and deployment of the solar parks in the designated area -- in a series of solar parks comprising a range 100-400 MW each, or different capacities as deemed acceptable and necessary by Power Division.
- ***Grid upgrades to accommodate segmented solar parks****:* The grid upgrades to be identified and quantified shall reflect the possible technical configurations of the independent solar parks, and the overall solar hub (comprising all solar parks combined).
- ***BESS integration with the solar parks:*** The sizing of the BESS assets and the evaluation of the operational functions shall be performed in consultation with the relevant stakeholders, including PGCB and Power Division. The BESS assets shall be considered in multiple use-cases, including but not limited to; energy shifting, voltage control, and frequency regulation.

Task 3.2: ***Investments Quantification***

The consultant shall develop a list of the specific grid investments identified through the analysis, which are required for the solar parks' integration into the national grid. The investments shall be outlined in detail, based on the market costs, and shall be categorized as both; (i) investments to be undertaken by the developer (IPP) as part of the solar parks capital investments, and (ii) those to be undertaken by the government at the substation, transmission, and interconnection levels as '*shared solar hub/parks infrastructure'*.

Task 4: Techno-Economic Assessment

The consultant shall assess the technical and economic viability of the solar parks, considering the land preparation requirements, grid upgrades and integration requirements, public investment needs in the power system, and the economic potential for the electricity generation expected from the solar parks, while integrating Production Cost Modeling, for determining the LCOE of all solar parks in the designated area, compared to other resources. Such analysis may utilize specific assumptions around land development costs, solar resource assessment, amongst others, to be coordinated and agreed upon with relevant stakeholders in Bangladesh (PGCB, Power Division, Power Cell, SREDA, etc.). The assessment shall utilize the outputs of Tasks 1, 2, and 3.

The Techno-Economic Assessment shall reflect the following:

- **Scenarios of solar hub development:** The consultant shall consolidate outputs from previous tasks to determine the different potential development scenarios for the overall solar hub and the individual solar parks, based on the economically and technically viable land, grid-upgrades for optimal evacuation and integration, and other variables. Such assessment shall outline the specific overall capacity to be developed effectively, with all relevant economic and financial metrics.
- **Economic and financial analysis:** The consultant shall conduct a financial analysis to determine the anticipated solar LCOE tariff based on overall solar hub and the individual solar parks, while reflecting the public and private investments identified (land preparation, grid upgrades, etc.). The analysis shall consider all necessary financial and economic parameters that determine the investment's return and viability.
- **BESS ownership model:** The consultant shall analyze and evaluate different options for the ownership and operation of the BESS assets; for (i) a model where BESS is privately owned, developed, and operated (whether combined with the solar park PPA contract with an IPP, or independently own), (ii) a model where BESS is publicly ownership and operated, and (iii) a model combining both public and private ownership. The evaluation shall compare the different models and determine the most technically and economically viable (considering full financial evaluation)[1]. The evaluation shall also reflect the capabilities and requirements of PGCB and other relevant stakeholders.

All financial and technical assumptions that inform the assessment shall be validated and confirmed at every stage of the analysis with the relevant stakeholders and with the Power Cell as necessary.

Task 5: Development Roadmap

The consultant shall prepare a *Development Roadmap* based on the findings from other Tasks 1-4. The roadmap shall detail the most effective approach and strategy that the Government of Bangladesh can pursue to develop the solar hub, outlining the specific steps based on required phases for the entire designated area (land preparation, grid upgrades, tendering, etc.). Additionally, the Roadmap shall provide details on different possible commercial models for development and ownership, combining and comparing IPP-owned model, PPP models, and a fully publicly owned model as necessary.

[1] For reference on potential solar-plus-storage IPP owned models, please see: www.esmap.org/unlocking_energy_transition

The development roadmap shall include the following:

- ***Development phases:*** The consultant shall devise the practical steps, considering the timelines, necessary public investments for project preparation, stakeholders, and standard milestones to be achieved. The consultant shall also identify the relevant resources and services to be acquired to facilitate the implementation of different phases *(e.g. transaction advisory, technical consultant, etc.*), while clearly identifying the scope of work and cost estimates.
- ***Regulatory and policy framework*:** The consultant shall evaluate the existing legal documentation and framework and propose the necessary transaction advisory functions for an effective implementation of the Roadmap. For example, documentation to be evaluated include the Power Purchase Agreement (PPA), the Intent to Award (IA), land lease agreement (LLA), and other relevant documents. The consultant is not expected to develop legally binding documents or templates, rather determining the improvements and gaps to be addressed as part of the Roadmap.
- ***Role and responsibilities***: The Roadmap shall outline the roles and responsibilities at the various stages between the different stakeholders, including BPDB, PGCB, Power Cell, GENCOs, DISCOs, transaction advisors, technical consultants, amongst other relevant stakeholders. The role and responsibility matrix shall consider the different development and ownership models and commercial structures identified.
- ***Evaluation of different commercial structure*s**: The Roadmap shall consider the different potential commercial structures: (i) private sector owned competitively procurement IPP project(s), and (ii) JV that combines public and private sector stakeholders, and (iii) fully publicly model. The consultant shall perform an objective evaluation for each of those commercial structures, reflecting the advantages, disadvantages, key features, and financial implications on the tariffs to be achieved through the projects.

Two stakeholders' workshop shall be organized by the consultant to provide in-depth review of the various results, deliverables, outputs produced and transfer of knowledge during the assignment.

TEAM COMPOSITION AND QUALIFICATION REQUIREMENTS FOR THE KEY EXPERTS

Consulting services are solicited from Renewable Energy consulting firms experienced in providing consultancy services in RE power plant of minimum capacity of 100 MW on individual sites, with a total cumulative consulting experience of no less than 300 MW.

Consulting firms should have experience of similar assignments and in similar conditions, relevant to each of the individual tasks outlined. The bidder's capability and availability of appropriate skills among key staff would be evaluated. A consortium reflecting the necessary competencies and experiences is encouraged, especially pertaining to the local partners in Bangladesh.

The following is a tentative list of key experts with **40 indicative man-months** that will be required for the assignment. It is the consultant's responsibility to ensure sufficient resources to deliver the assignment successfully based on the outlined scope of work and deliverables.:

- **Team Leader and Renewable Energy Specialist (Position-1 International):** The Team Leader and RE Specialist must have at least a bachelor's degree in engineering or Masters in Renewable Energy from any recognized university with minimum of 20 years of experience including minimum 10 years of experience in the field of utility-scale solar PV. He/she should preferably have experience of carrying out feasibility study of minimum of 100 MW solar park. The Team Leader should have proven knowledge and experience relevant to the Tasks outlined under this assignment.

- **Power System Specialist (Deputy Team Leader) (Position-1 National):** The Power System Specialist should have at least a bachelor's degree in electrical engineering from any recognized university and 15 years of experience in the power sector including in power generation,

transmission/distribution network analysis, grid integration of renewable energy-based generation. He/she should have knowledge and experience in grid integration for solar parks, as well as other necessary grid and power technical studies.

- **Transmission Specialist (Position-1 International):** The Transmission System Analyst should have at least a bachelor's degree in electrical/power engineering from any recognized university and 10 years of experience in the relevant field, including in transmission network analysis and grid integration of renewable energy-based generation. He/she should have proven experience and knowledge of solar parks grid-integration studies. Candidates with a master's degree in electrical/Power Engineering from any reputed university are preferable. Proven experience and proficiency in using power system transmission planning simulation software is necessary.

- **Battery Storage Specialist (Position-1 International):** The Battery Storage Specialist must have at least a bachelor's degree in engineering from any recognized university with minimum of 15 years of experience, including minimum 5 years of experience in the field of utility-scale BESS projects planning and implementation.

- **Legal & Institutional Specialist (Position- 1 National):** The Legal Expert must have a master's degree in law from a recognized institute of higher learning. The expert must have a strong background and experience in Bangladesh law and legislation related to land management, environment and conservation and natural resource management. The expert must have a minimum of 5 years of relevant and practical experience. The expert must preferably have experience in drafting commercial documents.

- **Financial / Economic Analyst (Position- 1 National):** The Financial/Economic Analyst must have a master's in economics/Finance/Business Administration from any recognized university with a minimum of 5 years of experience in financial/economic analysis. The specialist shall be able to provide the cost benefit analysis of the solar park in financial and economic terms.

- **Bid Advisor / Transaction Specialist (Position- 1 International/National):** The consultant should preferably have a degree in business administration, engineering, or economics from any recognized university, and preferably 10 years of working experience in the energy sector, specifically on renewable energy. The specialist should have experience of preparing or associated with such long-term strategic document preparation.

- **Civil Engineer (Position-1 National):** The Civil Engineer should have at least a bachelor's degree in civil engineering from any recognized university and 15 years of experience in the construction, soil testing, hydro-morphology and water resources engineering. Experience in power sector along with experience in the foundation and layout design of solar power plant in marshy and flood prone area with buoyancy uplift challenges will be an added qualification.

TIMELINE AND MILESTONES

The following tentative schedule is based on the expected maximum implementation duration of 8 (eight) months:

Milestone	Period from signing the contract
Inception Report	15 days
Interim Report	3 months
Stakeholders Workshop	After Submission of Interim Report
Focal Point Meeting on Task 1,2,3	5 months
Draft Report (Tasks 1, 2, 3)	5 months
Focal Point Meeting on Task 4, 5	6 months
Draft Report (Tasks 4, 5)	6 months
Draft Final Report (1, 2, 3, 4, 5)	7 months
Stakeholders Workshop	After Submission of all Draft Reports
Final Report	8 months (incorporating comment from stakeholders)

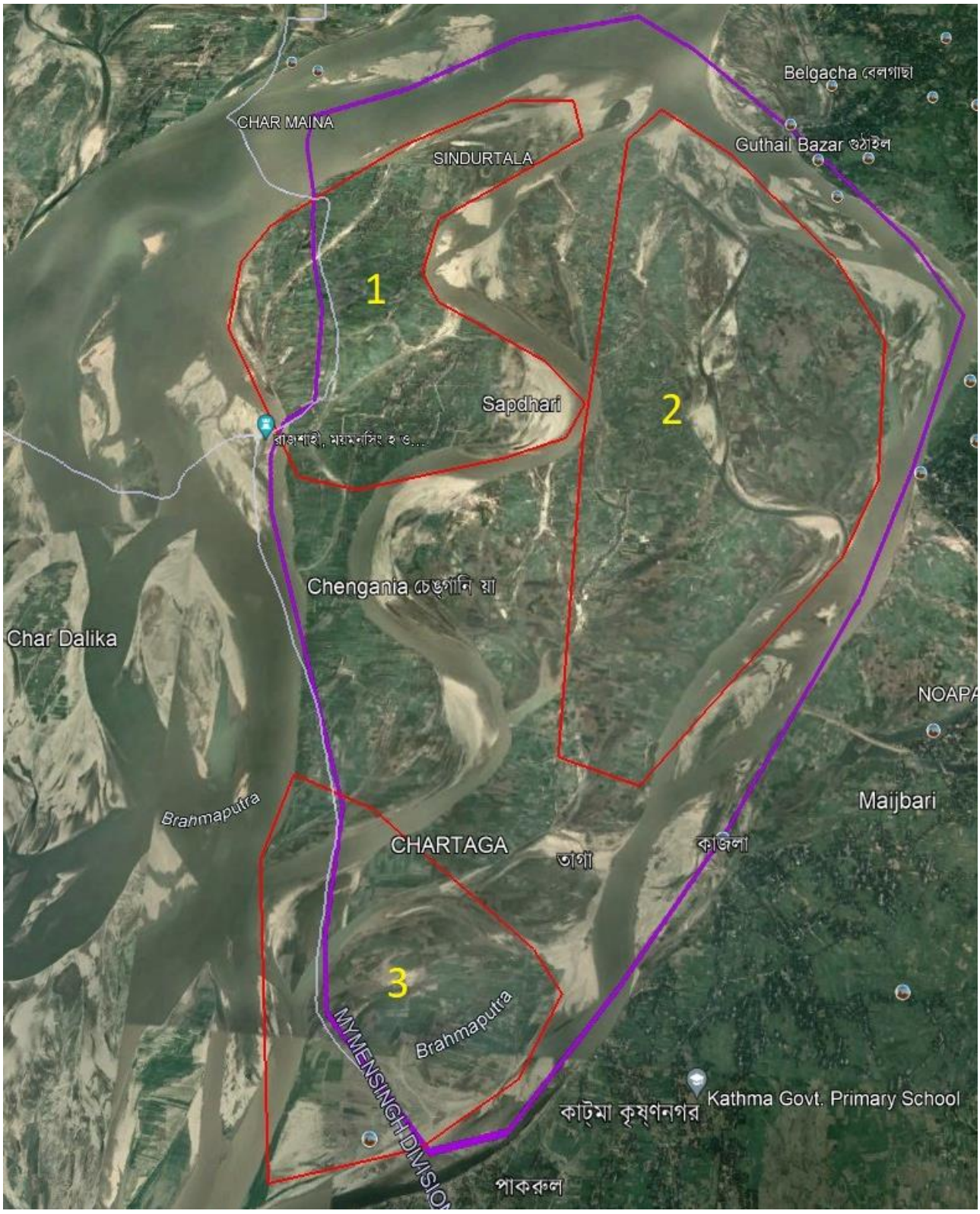
For the formal deliverables, 10 (ten) copies of each report shall be submitted along with a soft copy. The soft copy version of reports and financial model/any simulation must be provided along with each submission. All deliverables shall be submitted formally to Director General, Power Cell.

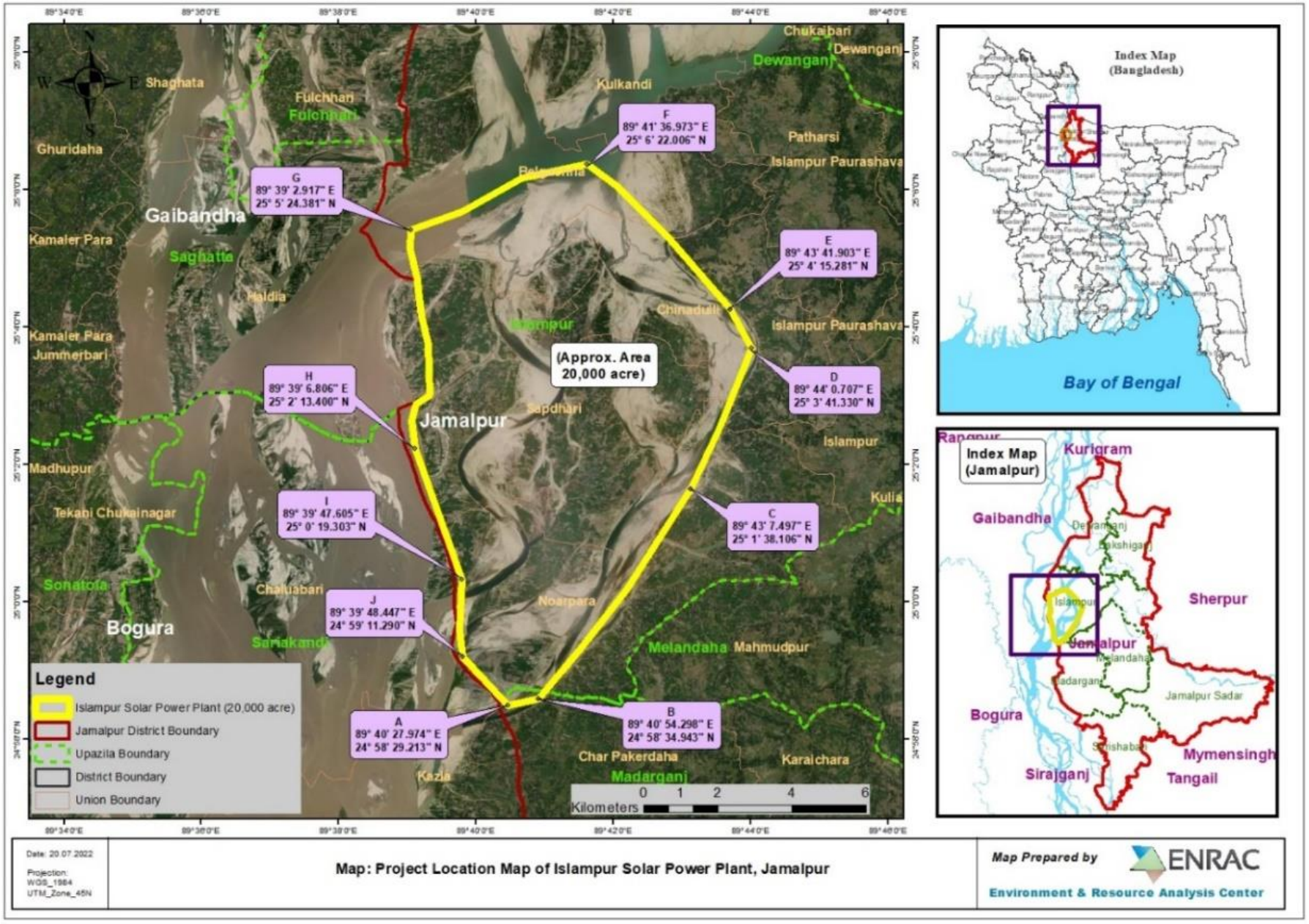
The consulting firm will report to Director General, Power Cell for billing and contract management. For assignment execution purposes, the consulting firm shall work closely with the associated utility and departments and teams in Power Cell, and other stakeholders as necessary.

CLIENT'S INPUT AND COUNTERPART PERSONNEL

- **Facilitation and reporting:** The consultant shall work in close association with Power Cell and other relevant utilities. The utility companies will ensure access to the available pertinent information to this assignment. A coordination mechanism will be set up to review progress, provide guidance and advice. The consultant shall be available for biweekly status-update meetings, as well as stakeholder meetings as necessary, with the expectation that the dedicated team will participate.
- **Focal points:** The designated personnel of each entity will interact with the consultant and provide relevant data, arrange discussions, and assist as required. The consultant will work under the guidance of Director General, Power Cell, and relevant utility company.
- **Logistics Support:** Office accommodation, site visits, secretarial service will have to be arranged by the consulting firm at their own costs.
- **Data access:** The relevant stakeholders will provide the inputs, project data and reports during the study period. However, the consultant will have to collect relevant project data and reports from the respective departments as required to successfully completing the study, including grid data from PGCB, BPDB, amongst others.

ANNEX:
Geographic areas that are covered in an existing study for compiling detailed geospatial datasets for Jamalpur site (*marked in red, areas 1, 2, and 3*).




Index Map (Bangladesh)
Bay of Bengal
Index Map (Jamalpur)
Kurigram
Gaibandha
Sherpur
Jamalpur
Bogura
Mymensingh
Sirajganj
Tangail
Jamalpur Sadar
Islampur
Melandaha
Madarganj
F 89° 41' 36.973" E 25° 6' 22.006" N
G 89° 39' 2.917" E 25° 5' 24.381" N
E 89° 43' 41.903" E 25° 4' 15.281" N
D 89° 44' 0.707" E 25° 3' 41.330" N
C 89° 43' 7.497" E 25° 1' 38.106" N
B 89° 40' 54.298" E 24° 58' 34.943" N
A 89° 40' 27.974" E 24° 58' 29.213" N
J 89° 39' 48.447" E 24° 59' 11.290" N
I 89° 39' 47.605" E 25° 0' 19.303" N
H 89° 39' 6.806" E 25° 2' 13.400" N
(Approx. Area 20,000 acre)
Legend
Islampur Solar Power Plant (20,000 acre)
Jamalpur District Boundary
Upazila Boundary
District Boundary
Union Boundary
Kilometers
Date: 20.07.2022
Projection: WGS_1984 UTM_Zone_45N
Map: Project Location Map of Islampur Solar Power Plant, Jamalpur
Map Prepared by
ENRAC
Environment & Resource Analysis Center