**Ministry of Finance**

Republic of Maldives

**ACCELERATING RENEWABLE ENERGY INTEGRATION AND SUSTAINABLE ENERGY (ARISE) PROJECT**

**Terms of Reference**

**Owner’s Engineer for advisory support to the Government of Maldives in the implementation of Accelerating Renewable Energy Integration and Sustainable Energy (ARISE) Project**

1. **COUNTRY AND PROJECT CONTEXT**

Maldives is an island archipelago comprising of 1,192 coral islands grouped into 26 atolls, spread across roughly 115,300 square kilometres of Indian Ocean. The dispersed nature of the islands and high reliance on imported diesel for electricity production has posed challenges in delivering secure electricity service at an affordable rate to the citizens. Increasing amount of Government’s spending on subsidies to the electricity sector has caused an extra strain to the government’s budget.

Large scale adaptation of renewable energy technologies such as solar PV is an effective approach to address the challenges associated with conventional power generation methods. Supportive policies and programs have been made to effect to achieve the ambitious RE goals of the country. The National Strategic Action Plan (2019-2023) (SAP) set targets to increase the share of renewable energy by 20% compared to 2018 levels. Furthermore, enhancing national energy security through diversification of sources of energy production and expansion of energy are underlying policies of the SAP.

The World Bank Group (WBG) has been supporting Maldives in decarbonizing its power sector since 2014, particularly, in building a conducive environment for private sector investments in Renewable Energy through technical assistance and financial leverages delivered under the World Bank’s initial project, Accelerating Sustainable Private Investment in Renewable Energy (ASPIRE). Through two separate subprojects, private sector financing for a cumulative 6.5 MW solar PV has been mobilized to the Maldives. The risk mitigation measures have set a trajectory for renewable IPP’s in Maldives and substantial reduction in PPA tariffs has been achieved relative to the first project under the model.

The Maldives solar PV targets are ambitious and thus have risk factors that need further interventions for establishing a free market. Hence, the World Bank intends to continue supporting Maldives in achieving its RE targets and is in the final stages of formulating a new project for the purpose. The Accelerating Renewable Energy Integration and Sustainable Energy (ARISE) project will broaden the coverage of the Greater Male’ to other outer islands and will bring in close to 36 MW of solar PV supplemented with sufficient capacity of Battery Energy Storage Systems (BESS) and upgrades to the electricity infrastructure, enabling higher penetration of solar PV and ensuring reliable supply of power.

1. **BACKGROUND**

The scope of ARISE project falls within the broader engagement areas of the World Bank in Maldives and aims to support electricity generation from renewable energy and improve climate resilience by diversifying energy mix; and also contribute to strengthening fiscal sustainability by reducing fossil fuel imports and thus government subsidies to fossil fuel and electricity. Furthermore, the project is supplementary to various other initiatives and agendas of WBG such as Solar Risk Mitigation Initiative (SRMI) and Global Battery Storage Program.

The scope of work outlined in this ToR is for the implementation support of ARISE Project which will come into effect in June 2020. The Ministry of Environment (ME), Government of Maldives (GoM)- has initiated the preparatory work for the first sub-projects to be rolled out under ARISE. The 1st phase of the project will involve the installation of 21 MW grid-tied solar PV systems in selected outer islands (7 individual power grids) under IPP model followed by a separate bid for battery installation in these islands.

Additional projects will be implemented to achieve the 36MW solar PV indicator target determined for the ARISE project.

The table 1 provides a summary of 7 separate electricity island-grids spread across 13 islands[[1]](#footnote-1) selected for solar PV installation, It includes the current electricity demand in terms of average peak power and annual electricity demand, along with existing and planned solar PV capacities, and ballpark figures for battery capacity based on initial assessments for each grid.



Table 1: Islands selected for implementation of battery & EMS under Phase-1 of the project

Further to the installation of Battery Hybrid Solar PV systems at utility scale, modernization of the existing grids in islands will take place under ARISE, enabling Integration of Variable Renewable Energy (VRE) to sufficient levels to achieve national energy targets.

 This assignment is expected to supplement the ongoing technical assistance from the World Bank to support the implementation of the ARISE Project for Maldives.

1. **OBJECTIVE OF THIS ASSIGNMENT**

The overall objective of this assignment is planning, design and deployment of utility-scale Battery Energy Storage Systems (BESS) and Energy Management System (EMS), and complementary grid upgrading that is required to ensure successful integration and operation of the specified solar PV capacities for the selected islands (specified in Section B of this ToR), in a safe, reliable, efficient and sustainable manner over the short and long-terms.

Key outcomes of the assignment are:

* Conducting a detailed technical, financial and economic analysis of the power system of each island, including the planned solar PV capacity addition, to inform the maximum solar PV penetration with appropriate VRE integration solutions and plant locations in the short, medium and long term.
* Evaluate optimal battery sizing and EMS design required to integrate the planned solar PV into the power system of each island.
* Identify grid upgrade/reinforcement requirements for integrating the planned solar PV into the power system of each islands, which may include upgrade of the existing distribution infrastructure, SCADA, protection and control systems, and any other investments required for operational efficiency and flexibility.
* Develop detailed engineering designs, and technical specifications for BESS and grid upgrades that will ensure a safe, environmentally sound, reliable and efficient operation of power system of the selected island-grids operator, FENAKA.
* Prepare tender document(s) and assist the client throughout the tendering process, including marketing the Request for Proposal (RfP) among potential competent solution providers internationally, promoting competition for the tendering, and providing technical support in the procurement processes for their supply and installation.
* Upon award of contract- supervision and monitoring of contractors works. Also, to ensure safe and reliable operations and for proper management of the Battery & EMS throughout its design life, ME will need support in establishing monitoring procedures and operational standards for such systems.
1. **SCOPE OF WORK**

Upon commencement of the assignment, the consultant will be provided with detailed technical information/data for all selected islands in electronic format. These include, but not limited to, existing generation statistics (loads, kWh generation and consumption, diesel use, etc.), demand forecasts, infrastructure details of generation systems and distribution networks (distribution cable sizes, transformer sizes and specs, etc.), power system expansion plans, and any other information necessary for the optimal design of BESS/EMS and grid-upgrade specified in the scope of work.

However, this would need to be verified in consultation with FENAKA Corporation[[2]](#footnote-2) (State-owned utility), and site visits wherever and whenever required. The consultant will be responsible for ensuring the accuracy of the information/data to the best extent possible to enable error-free analyses and designs.

For ensuring the optimal share of renewable energy in the grids while maintaining grid stability and reducing diesel consumption of the generators, experiences and lessons from previous solar projects in Maldives (ASPIRE Phase 1&2, POISED Project and other ongoing and planned solar PV projects in the country) and other similar countries need to be taken into consideration in the design of the systems under this assignment

The consultant will be required to provide technical assistance & implementation support to ME and FENAKA throughout the contract term to achieve the objectives stated above, and overall the services are expected in the following areas/tasks.

1. **Carryout Techno-Economic assessments of the power system of each island**

The Consultant will undertake the techno-economic analysis of the power system of each island to determine the maximum penetration rates for variable renewable energy (VRE) electricity generation from solar PV. The analysis will include modelling and analysis of the existing distribution network to determine the required network strengthening investments needed for: (i) the connection of VRE generation plants, (ii) improving supply quality and reliability, and (iii) improving operational effectiveness and oversight of the network such as SCADA, protection, and control functions. To this end, the Consultant shall be required to:

* Evaluate the maximum penetration rates and plant locations for VRE in the short, medium and long term, for the current system and the future reinforced system.
* Assess the key requirements for VRE grid integration that should be prioritized to accommodate these resources. This will include battery storage, either co-located with VRE plants or as a standalone installation, grid modernization techniques, and grid support requirements for renewable energy integration.
* Determine the requirement of BESS and EMS through dynamic simulation studies to provide system inertia, peak-shaving functionalities, back-up power for system stability, reliability, safety and resilience.
* Carry out a cost-benefit analysis of the application of BESS (for various possible value-added services/use-cases) and EMS to determine configuration for minimal system operation costs and minimise network investment requirements. Further, the Consultant shall analyse the optimal configuration and sizing of the BESS and the right battery technology type.
* Assess the key reinforcements required on the grid to cope with the given penetration rates, and their associated cost. These reinforcements may include upgradation of the existing distribution infrastructure, SCADA, protection and control systems, and any other investments required for enhancing the operational efficiency and flexibility.
* Undertake load growth projections and carry out distribution network studies to determine a least cost approach for the recommended network reinforcements to reduce losses and improve supply quality and reliability. Under this activity, the Consultant will develop alternative scenarios/options for effective utilization of the existing network using different reinforcement options and suggest the most technically appropriate and cost-effective options.
1. **Development of optimal configurations of BESS to integrate the planned solar PV addition in island diesel grids**

The consultant is ultimately required to determine, through in-depth simulations/analyses, and as per outcomes of techno-economic assessments, the optimal BESSs’ configurations, including its power/capacity and grid services to be provided, depending on actual PV capacities planned for each island-grid. The sizing should also factor in the funding allocation for establishing BESS for each system. To ensure accuracy and consistency of the results, the data inputs and software simulation results[[3]](#footnote-3) from the assessment should be verified and validated by ME & FENAKA.

**Identification of grid-upgrade requirements in consultation with FENAKA to develop detailed engineering design and technical specifications:** The consultant is required to identify constrains and corresponding grid upgrade needs and specify technical requirements to ensure seamless integration of PV/BESS/EMS System, taking into account any grid expansion, interconnections between adjacent island grids, power generating station relocations, upgrade of existing grid-infrastructure components that already exist by FENAKA. Such may include, but not limited to, the following:

* Identification of potential interconnection/feed-in-points of for solar PV and BESS distributed throughout the island,
* Conduct a network study to determine power flow, voltage and frequency variations, transients, etc. to ensure absorption 100% of the solar capacities (as specified in Section B) into the respective island grids,
* Assess the key reinforcements required on the grid to cope with the planned solar PV capacity addition. These reinforcements may include upgrade of the existing distribution infrastructure, SCADA, protection and control systems, and any other investments required for operational efficiency and flexibility,
* Conduct calculation of transmission line loss and recommend necessary cable size upgrade to maintain maximum voltage drop as per local standards and required DB box upgrade,
* Consideration for minimizing diesel generation investment and deferred future investments in infrastructure upgrades.
* Compilation of relevant technical information from the island surveys/site visits and preparation of single line diagrams (SLD’s) of existing power infrastructure. Any necessary upgrades to the electricity grid or parts of it shall be identified in the process,
* Review existing grid codes (or equivalent) and recommend improvement and standards in light of the findings of BESS/EMS and grid-upgrade assessment.

Where grid upgrade plans and specifications have been identified by FENAKA for a particular island grid, the consultant will build upon this, through verification of such upgrade requirements’ sufficiency for the solar PV integration and BESS/EMS system. The consultant would need to ensure the final grid upgrade requirements are in line with an optimal design for PV/BESS hybrid system.

The grid upgrade requirements would need to be translated into technical specifications that could be incorporated in the bid.

1. **Develop detailed engineering design and specifications for procuring the works for supply and installation of BESS & EMS, and required grid upgrades**

Through independent field surveys and in consultation with ME/FENAKA, the consultant will need to develop the functional requirements along with the full detailed system design and specifications to a sufficient level, for procuring a contractor to supply and install grid upgrades, and PV/BESS components, EMS/SCADA for the hybrid grid as per the outcomes of the techno-economic assessments from task 1.

The scope of development of the final design & technical specifications includes, but is not limited, to the following.

* Identify the site conditions and define such parameters along with design configurations, engineering and functional requirements for each power grid to an extent sufficient for tendering the supply, installation and commissioning of solar PV, BES and EMS,
* Compilation of relevant technical information from the island surveys/site visits and preparation of single line diagrams (SLD’s), wiring diagrams, network layouts, communication systems, etc. Any upgrades to the existing system need to be specified and included as part of the specifications,
* Identify types of input, output data requirements along with communication protocols, hardware and software requirements,
* Identify operational strategies of EMS and their benefits such that hybrid power system operation ensures fast response frequency control and maximised diesel. Furthermore, along with benefits of other use cases (such as spinning reserves, investment deferral) and define corresponding control strategies, and minimum performance requirements of overall system and its components/parts,
* Identify requirements for integration of the EMS into the existing Central (Supervisory control and data acquisition) SCADA [[4]](#footnote-4)system/database, and ensure the technical specifications are fully compatible,
* Identification of all associated civil, electrical and any other ancillary work and related equipment along with full specifications for establishing the solar PV/BESS along with EMS,
* Identification of the relevant standards and specifications for the design, works and equipment after taking into consideration the climate and environment of the Maldives,
* For ensuring quality and reliability as well as to assure excellent workmanship, the consultant shall identify standard engineering practices and relevant standards (IEC or equivalent) to be complied for all key equipment and associated civil/electrical works,
* Recommend and formulate standards for battery (safety and environmental), in accordance with local and international practices, preferably IEC,
* Ensure compatibility with existing and planned to generate sources, demand profiles and growth while ensuring overall power system’s efficiency, reliability and safety of operation.
* Prepare BOQ to benchmark cost and compare with actual bid outcomes, and update any cost models if required (eg-LCOE, Capex, O&M, etc.) in Task 1,
* Identify use cases of battery storage indicating specific events and related benefits for operation,
* Finalization of technical specifications of the system based on an assessment of site conditions, renewable energy resource, load flows and any other relevant parameters in discussion with the utilities, ME, FENAKA, and National & international consultants engaged under the project. Standard industry software (preferably open source) would need to be used to demonstrate the performance of the proposed system to verify optimal design configuration.
1. **Development of bidding document and tendering support**

The consultant would be required to develop the full bidding document(s) for the procurement of Grid Upgrades and BESS on Design, Supply, Build and Transfer basis and provide support to ME/FENAKA in tender related activities. These may be in the form of 2 separate bidding documents and will be determined upon completion of the grid upgrade assessments.

The design specification and technical requirements identified in **Task 3** shall be incorporated, and the document shall be in accordance with the World Bank procurement standards and guidelines.

The activities to be undertaken will include but is not limited to the following support tasks

* Develop standard bidding document following the World Bank guidelines/templates and incorporate system design details, engineering drawings and other technical specifications and details in a manner suitable for bidding,
* Identify and incorporate to the bidding document, the requirements for training to be supplied by the bidder that will ensure sufficient capacity building of utility to enable reliable operation of the battery throughout the project period,
* Develop performance guarantee requirements, including (but not limited) the recommended period of warranties and minimum scope of warranties. Such may include, but not limited to, formulation of a payment structure and payment schedule which also incorporates performance guarantees (such as long-term performance bank guarantees for the battery system),
* Propose and incorporate evaluation criteria to ensure the most cost-effective and reliable bid is selected. This also needs to link up with the methodology for benchmarking the performance of the BESS/ EMS. The evaluation criteria should be discussed and finalized in consultation with ME/FENAKA, WB and other consultants and would need to include (but not limited) to any requirement set by FENAKA,
* Reach out to potential manufacturers and bidders that are globally or regionally competent, in collaboration with ME/FENAKA, to advertise the tendering,
* Provide overall support in tender activities such as conducting pre-bid meeting(s) and in drafting responses to bidder queries, as well as during bid evaluations and contract negotiations,
* Provide approval of the power system design proposed by the Contractor in consultation with the utility company (grid operator) to ensure if it is in line with the design proposed in **Task 2,**
* Any material variations in the design proposed by the contractor should ensure no impacts on normal grid operation and overall safety, efficiency and reliability of the grids and its components,
* Any other technical support that might be requested related to this task.
1. **Ensuring compliance with environmental and other performance standards**
* Ensure that environmental and social performance standards mentioned in the Environment and Social Management Framework (ESMF) of the project in relation to BESS and grid upgradation are met,
* Recommend best practice environmental and safety standards based on international best practice,
* Conduct battery life cycle assessment to identify long term benefits, and disposal/recycling/re-use, including any environmental impacts and mitigation measures,
* Compile and provide technical information required for Environmental and Social screening required under ESMF in relation to BESS and grid upgradation.
1. **DELIVERABLES**

For the specific areas in the scope of work, the consultant is required to submit relevant reports, documents, analysis results, etc. in electronic format, that is acceptable to ME and FENAKA,

The payments will be made to the consultant on acceptance of each of the following milestones by ME and as per the percentage of the total contract value of the consultancy.

|  |  |  |
| --- | --- | --- |
| D1 | Techno-Economic Assessments Report | 10% |
| D2 | Grid-upgrade requirements & equipment specifications | 20% |
| D3 | Detailed Hybrid System Design including technical specification | 40% |
| D4-1 | Bidding Document - Grid Upgrade | 10% |
| D4-2 | Bidding Document – BESS | 10% |
| D5 | Tendering Support | 10% |
|  |  | **100%** |

1. **TIMING AND SCHEDULE**

|  |  |  |
| --- | --- | --- |
| Deliverable | Description | Days from Contract start date |
| D1 | Techno-Economic Assessments Report | 44 |
| D2 | Grid-upgrade requirements & equipment specifications | 64 |
| D3 | Detailed Hybrid System Design including technical specification | 90 |
| D4-1 | Bidding Document - Grid Upgrade | 58 |
| D4-2 | Bidding Document – BESS | 82 |
| D5 | Tendering Support | 252 |

1. **REPORTING OBLIGATIONS**

The consultant is required to report to designated persons/focal-points at ME and FENAKA, and in general work in close coordination with all relevant teams of World Bank, FENAKA and ME throughout the assignment.

1. **MINIMUM QUALIFICATIONS**

The detailed eligibility criteria are provided in table below:

| **S.No.** | **Eligibility Criteria** | **Documentary Evidence**  |
| --- | --- | --- |
| 1. | The bidder should be a registered entity (company or not-for profit organization or partnership firm, etc.) as per the relevant laws of bidder’s country of origin. | Certificate of registration |
| 2. | The bidders should not have been blacklisted by the World Bank. | Undertaking from bidder |
| 3. | The bidder should have experience of at least seven years in providing consultancy services for bid process management and preparation of tender documents in accordance with international best practices and World Bank procurement guidelines, requirements & standards relevant to the scope of work. | Project description sheet (as per the World Bank format)Copy of contract along with a certificate of satisfactory performance provided by the client, may also be sought, if needed at the evaluation stage |
| 4. | The bidder should have experience of at least ten years in power systems planning, engineering, design, and implementation which includes diesel and solar-based distributed energy systems along with Energy Management System, SCADA systems, as well as procuring, supervising, commissioning | Project description sheet (as per the World Bank format)Copy of contract along with a certificate of satisfactory performance provided by the client, may also be sought, if needed at the evaluation stage |
| 5. | The bidder should have experience of at least five years in working on the area of battery technology applications for grid-connected electrical systems and experience of providing consultancy services for designing, procuring, supervising, commissioning BESS/EMS systems ] | Project description sheet (as per the World Bank format)Copy of contract along with a certificate of satisfactory performance provided by the client, may also be sought, if needed at the evaluation stage |
| 6. | The bidder should have a valid professional indemnity insurance | Copy of insurance certificate  |
| 7. | The proposed team should consist of experts in areas of project economics, power systems planning, modelling & design, BESS and EMS technologies systems design and grid integration of VRE. All members in the respective areas are required to have a master’s degree in the related field.Members of the proposed team should also have the experience mentioned in point number 3, 4 and 5 above. | The nature of experience, the clients for which the assignments were carried out, and contact reference of the clients should be mentioned in the CVs. |

1. **FACILITIES TO BE PROVIDED BY THE CLIENT**

ME and FENAKA will provide the following support to the consultants, when and as required.

* Provide all necessary details of each grids, including but not limited to, existing generation statistics, demand forecasts, infrastructure details of generation systems and distribution networks, generation expansion plans, and any other information necessary for the optimal design of BEMS specified in the scope of work,
* All administrative and promotion works for the tender,
* Administrative support in facilitating meetings, obtaining data, field visits, assign personnel for trainings, etc.
1. *The islands covered in the Initial Phase of the project can change or additional islands for next phases of the project can be added to the scope of this consultancy* [↑](#footnote-ref-1)
2. FENAKA Corporation Ltd was established on 18th June 2012 by a presidential decree under the companies Act of 10/96, as a limited liability company. The company is registered on 1st of August 2012 and it is 100% Government owned utility company with a mandate to provide island communities with electricity, water and sewerage services. [↑](#footnote-ref-2)
3. [↑](#footnote-ref-3)
4. FENAKA is in the process of linking up their islands to a Central SCADA system to monitor all islands. Some small islands (outside the scope of this assignment) had already been connected to the same. [↑](#footnote-ref-4)