

TERMS OF REFERENCE FOR THE PREPARATION OF SUDAN WIND ATLAS

“Promoting Utility Scale Power Generation from Wind Energy”

A. Introduction:

Like many developing countries, Sudan has a shortage of electricity. Approximately 38% of the population has access to electricity. Even then, it is not reliable and experiences regular power outages. Hydro-power has the largest share of energy generation. The potential to expand hydro-power to meet future needs is limited. Sudan does not have significant oil or gas production and as a result will have to turn to importation of fossil fuels to meet future energy needs. Climate change threatens to affect rainfall patterns on which Sudan relies for the water that generates its hydro-power. This further emphasises the need for Sudan to diversify its energy sources. The wind energy project, which is a joint government/UNDP initiative and financially support by the Global Environment Facility (GEF), seeks to address these problems by promoting the generation of electric power from wind energy at utility scale in Sudan.

Currently, Sudan has a power generation capacity of about 3,300 MW, has no wind generation capacity and no grid-connected solar capacity. Governmental utilities own all of the power generation facilities, transmission and distribution lines in Sudan. The Government owns 5,984 km of 220 kV transmission lines and 965 km of 500 kV transmission lines. In 2012, the power consumption per capita was 233 kWh/ year. There are no independent power producers (IPPs) in the country, though initiatives are underway to promote private investment in power generation. This project seeks to support those initiatives where they relate to wind power.

In geographical terms the project is targeting Dongola as the baseline location to be followed by the Red Sea coast as the first replication area. In the meantime, meteorological data collection is underway in other potential areas covering the northern state and western Darfur which are the future targets in the long term planning of wind power application in Sudan.

The baseline wind power plant represents the first of its kind in the country and as such tangible efforts are needed to make a success out of it as any failure will represent a setback to any future efforts in grid connected renewable energy projects. Therefore, the project is following a holistic approach whereby all technical and non-technical issues surrounding the project are carefully addressed and a wide scale stakeholder involvement is ensued. This includes hardware design, planning and installation, meteorological data collection, analysis and mapping, land ownership, effect on local communities, effect on migratory soaring birds and ecosystem in the project areas.

The Ministry of Water Resources, Irrigation and Electricity (MWRIE) has made a contract with Lahmayer International GmbH (LI) to conduct a country-wide Wind resource assessment program and measurement campaigns. At the end, the first version of wind atlas for Sudan has been published in February 2012. This wind atlas is basically developed in a mesoscale model and validated with few ground measurements available at that time.

For validation purpose, the consultant recommended to make further measurement campaigns targeting the three hotspot areas in the North of Sudan, Red Sea, and Nyala region in South Darfur.

Since that time, the Ministry of Oil and MWRIE made several wind measurements campaigns and erected a total number of (14) measurement stations scattered in the three windy areas.

The Wind Energy Project is a Government of Sudan/UNDP/GEF initiative for the development of grid connected wind power generation in Sudan and part of its activities is to Strengthen the wind technology support and develop and update a state of the art wind atlas for Sudan - taking into consideration the recent measurements - in a GIS system, with additional layers for geology, geomorphology, land ownership and type (e.g. protected areas / forests), settlements and routes of migratory birds, moreover microscale maps will be developed for the three mentioned area.

B. Objectives of Development of Sudan Wind Atlas:

The Wind Energy Project endeavors to prepare the Sudan Wind Atlas for the following objectives:

- Compilation and reconciliation of existing wind data and recommendation for establishment of wind measurement masts where needed.
- Compilation of sources of data for geology, geomorphology, land ownership, settlements, electric grid connections, bird migration, cultural heritage, etc.
- Estimation of wind energy production costs in selected regions of Sudan based on geographical conditions and wind speeds, and grid availability/stability.
- Integration of wind and other datasets, including the wind cost estimates mentioned above, into a GIS system capable of Web-based (off-site) interrogation and analysis.
- Development of a national wind map to highlight priority areas for wind projects development.
- Building capacity regarding wind resource assessment and GIS system throughout the development of the wind atlas.

C. Scope of Work

Wind Energy Project - MWRIE is seeking the services of an International Consultancy Firm with vast experience in the development of wind resource maps.

The scope of the consultancy should include, but not limited to:

1. A diagnostic review of the current Sudan Wind Atlas (Issued: February 2012), And Preparation of a comprehensive technical report regarding the findings, and specify the methods to develop the new wind atlas regarding the improvement on uncertainty levels of the measurements, methodology used, wind flow model, elevation map, digital Roughness Model and other technical issues.
2. Development of a comprehensive country wide wind atlas with horizontal spatial resolution of 2 km taking into consideration all the outcome and findings of the reports above and according to the **Technical Specifications: Annex (1) - GIS system requirement**.
3. Development of a micro-scale wind resource maps with high resolutions up to (100m) for the identified potential areas (which are: (1) Red Sea coast, (2) Northern Sudan and (3) Nyala Region). This offer should include the cost breakdown for developing of the map per the unit area in square km.
4. The available meteorological data will be submitted to the consultant as a pre-processed text (WINDPRO exported) format in addition to a time-series raw format. The consultant shall perform all necessary manipulation on the provided raw data such as: time-series validation, anomaly values substitution, tower distortion corrections, and long term correlation. Notice that, all of the data used in the current wind atlas is already correlated and manipulated and available in WASP (*.tab) format.
5. The consultant shall give a recommendation for future measurement campaigns, including the advices on the required additional number of measuring stations and identification of measuring locations, and the period for the campaign.
6. The consultant shall identify the appropriate future review mechanisms and how to perform further updates for the wind atlas.
7. The consultant must compile the data of wind energy production costs study and the Feed-In-Tariff study provided by the Wind Energy Project/MWRIE for the above selected areas into a separate GIS layer(s) of wind atlas as specified in **Annex (1) - GIS system requirement**.

8. The consultant must compile the data of Sudan Protected Areas and Migratory Soaring Birds study provided by the Wind Energy Project/MWRIE into a separate GIS layer of wind atlas as specified in *Annex (1) - GIS system requirement*.
9. The consultant shall assist during the installation of wind atlas packages, geo-data implementation and the integration process into the GIS server of Sudanese transmission company (SETCO).
10. The consultant shall provide training program on Sudan wind atlas development and future update method for further updating, wind resource assessment and GIS system integration.
11. The consultant shall provide a separate final reports for both (country wide wind atlas and microscale maps) describing the methods and procedure for establishing the wind resource assessment. The reports shall contain all necessary documentation of data and wind maps in electronic form (including WAsP compatible rsf / wrg file-format).
12. Suggest any additional component to this TOR document to fill any gap.

D. Expected Outputs and Deliverables

Deliverables / Outputs	Due Dates	Submission Requirements	%of Payment	Review and Approvals Required
An Inception report including: A diagnostic review of the current Sudan Wind Atlas	Within 10 days from the commencement of the contract.	Inception Report.	Nil	Project manager
Draft report for the developing a country atlas, and developing a microscale maps for the three areas.	Within 45 days from the commencement of the contract	Draft Report	25%	Project manager
Presentation to the project stakeholders and getting comments.	Within 50 days from the commencement of the contract	Presentation to get comments	40%	Project manager

Provide training program on the wind atlas development and future update mechanism for further updating, wind resource assessment and GIS system integration. The training will be in Khartoum.	Within 53 days from the commencement of the contract	Training workshop		Project manager
Submission of the finals in electronic format for the following: - A separate final reports for both (wind atlas and microscale wind maps). - New wind atlas for Sudan. - Microscale maps for the three areas. - GIS layer(s) for of wind energy production costs for the three areas, as well as Feed-in-Tariff price. - GIS layer for MSB and protected areas in Sudan.	Within 67 days from the commencement of the contract	Final revised versions	25%	Project manager
Installation of wind atlas packages into the GIS server of SETCO.	Within 75 days from the commencement of the contract	Completion certificate	10%	Project manager, SETCO GIS responsive.

E. Institutional Arrangement:

The consultant will work under the supervision and guidance of the Wind Energy project-MWRIE through the project team.

F. Duration of the Assignment:

The assignment is expected to complete Within 75 days from the commencement of the contract.

The assignment is expected to start on and concluded not later than 2018.

G. Duty Station

The consultant duty station during the presentation and the training workshop is Khartoum and working exclusively with the project team.

H. Qualifications:

The consultancy firm or institution is required to attach any other relevant/useful information which may support the study such as:

1. Company profile
2. Knowledge and understanding on renewable energy policy and objectives in Developing countries.
3. Relevant track record.
4. Brief information and methodology in carrying out the study
5. List of activities in carrying out the study and proposed milestones.

I. Recommended Presentation of Offer

Interested consultants shall present:

- a) Duly accomplished Letter of Confirmation of Interest and Availability.
- b) Company profile and Personal CVs, indicating all past experience from similar projects, as well as the contact details.
- c) Methodology of implementing the assignment.
- d) Financial Proposal that indicates the all-inclusive fixed daily

J. Scope of Financial Proposal and Schedule of Payments

Interested consulting firms shall submit technical and financial offers for the above scope of work.

The proposal shall be based on Daily fees and all-inclusive payable as follows:

1. 25% on completion and submission of Draft report.
2. 40% on completion and conducting a consultation workshop to the stakeholders.
3. 25% on receipt and acceptance of the Submission of the Final versions of:
 - a. Final reports.
 - b. New wind atlas for Sudan.
 - c. Microscale maps for the three regions
4. 10% on completing the installation of the wind atlas packages into the GIS server of SETCO

K. Evaluation Criteria and selection of the consultant:

The selection of the prospective consultant will be based on the combined weight of:

1. Qualifications and methodology 70%.
2. Financial offer 30%;

Assessment Criteria	Maximum Obtainable Points	Weightage (%)	Evaluated Points Obtained by the Offerors		
			A	B	C
Methodology					
The completeness of the proposal and the comprehensiveness of the methodology.	5	7%			
The work plan schedule and timeline to complete the study and List of activities in carrying out the study and proposed milestones.	5	7%			
comments on this TOR document	5	7%			
Qualification					
Company profile and Personal CVs	30	43%			
Relevant track record, similar works, including working experience in Sudan and understanding on renewable energy policy and objectives in Developing countries.	25	36%			
TOTAL	70	100%			

Annex (1)
Technical Specifications

1. Wind atlas technical specifications:

Regardless of the adopted and agreed upon methodology for the preparation of the new version of Sudan wind atlas (Numerical, observational or hybrid, etc...), The consultant must follow the guide-lines issued in the publication of The World Bank's Energy Sector Management Program '*ESMAP*' entitled as (*Best Practice Guidelines for Mesoscale Wind Mapping Projects for the World Bank, October 2010*) for developing of the wind atlas.

Additionally the following specifications must be followed:

- a. The consultant must provide all wind maps for in respective hub –heights: 20m, 50m, 80m and 100m above ground level.
- b. The consultant shall deliver sets of color-coded maps of mean wind speeds in m/s, power density in W/m², Weibull parameters 'A' in m/s and 'K' for each of the heights above ground level.
- c. The consultant shall not smooth map colors between the cells for which data has been calculated through interpolation or other techniques. Each cell should be of uniform color in order to alert users to zones with abrupt color changes between cells
- d. The consultant should provide a separate color-coded map for prevailing wind directions or alternatively use other means to represent local wind directions, such as arrows or representative miniature wind roses on a map. The map should specify the height above ground level the map represents, which should be the most probable hub height for commercial wind projects. In addition this data should be included in the GIS database.
- e. The consultant should provide an elevation map for the elevations actually used in each cell of the map.
- f. The consultant should provide a surface roughness length map for the selected roughness length used for the calculation wind maps.
- g. The consultant must offer a map, which shows annual energy production (or capacity factor) from a typical mainstream pitch controlled wind turbine located in the center of each cell of the simplified model landscape, based on the hourly wind speeds simulated by the model, with appropriate corrections for air density based on a standard atmosphere. It is preferable that air density correction be done using the actual power curves for the wind turbine for different air densities rather than simply using a correction proportional to air density. The consultant should specify in the final report in detail which assumptions and methods (turbine power curves, air temperatures and densities etc.) are used in these calculations, and should alert users to probable systematic biases in the calculations.
- h. In addition, the wind map shall also be provided as a 3D-Hill shaded relief map.

2. GIS system requirement:

- a. The wind maps data and GIS map files may be supplied as ARC GIS Geodatabase format, Raster Data Set, shape files or a similar standard format that allows the user to display the maps on his computer screen down to the level of individual cells together with the current cursor longitude and latitude, and to switch each layer on and off.
- b. The complete wind atlas system will be hosted in MWRIE and the Sudanese transmission company (SETCO) GIS servers, the consultant has to perform the installation of wind atlas software packages, geo-data implementation and the integration process to the GIS system.