



**Directorate of Alternative Energy
Energy Department
Government of Sindh**

Distributed Solar

Terms of Reference

Distributed Solar Building Survey

January, 2019

1. BACKGROUND

The Government of Sindh (“GoS”) through the Directorate of Alternative Energy, Sindh Energy Department (“SED”, the “Client”) proposes to engage the services of a consulting firm or firms (the “Consultant”) to identify a portfolio of public buildings suitable for installation of at least 20 MW of solar photovoltaic (PV) capacity, and possible energy efficiency upgrades, over multiple sites. The study falls under the Sindh Solar Energy Project (SSEP) being implemented by GoS with financing provided by the World Bank.¹

SED intends to utilize spare rooftop and other available space on and around public buildings to create a win-win situation for the public sector, electricity distribution companies (DISCOs), and electricity consumers by: (i) reducing recurrent expenditure on electricity by GoS, freeing up budget for other priorities; (ii) providing the DISCOs with cost-effective power during periods of peak hours, while allowing the payments to be netted off against outstanding public sector debts; (iii) private sector involvement through third party contract operating large distributed solar PV installations, thereby reducing costs; and (iv) improving the supply of affordable power to consumers, without the need for ancillary transmission investment. At least 20 MW of capacity would be installed under SSEP, in a phased manner, and the project may be expanded to a much larger capacity target in future years. SED will identify portfolios of candidate sites and will liaise with other departments for installation of solar equipment and energy efficiency upgrades. The portfolios would be awarded to solar developers for installation under an EPC contract that includes performance-based provision for O&M or other applicable modalities. The Project will target sites where no export of electricity is required, and will be expanded to larger sites under NEPRA Net metering Regulations.

2. OBJECTIVE OF THE ASSIGNMENT

The Consultant shall carry out a comprehensive survey of at least 200 suitable public sites/buildings for installation of solar PV and energy efficiency measures in the cities of Karachi and Hyderabad. Under the assignment, they shall undertake a technical and financial study of each site/building in terms of electricity requirement, solar PV design, integrity of civil structure with reference to solar PV installation, specification, BoQs (Bill of Quantities), depending upon available areas and electricity consumption for development of an EPC Contract.

3. SCOPE OF WORK

The assignment has four major components as outlined below. Details of the activities are provided in the next section.

3.1. Development of a shortlist of sites/buildings that have high potential for solar PV:

SED will provide database of around 2,800 sites/buildings that come under administrative control of GoS. The Consultant shall work with SED to rank the sites/buildings in the database according to suitability for installation of solar PV in terms of the total potential capacity that can be installed at each site/building, taking account of available rooftop space and also the space within the total site (e.g. car park or unused land). The Consultant shall then create a shortlist consisting of the highest ranking 400 sites/buildings that will be approached for a comprehensive building survey.²

¹ Further details on the project available from: <http://projects.worldbank.org/P159712?lang=en>

² In many cases, there may be multiple buildings on a combined site that could be candidates for installation of solar PV. In such cases the site will be treated as a single unit. A site is defined as a contiguous series of

- 3.2. Design and implementation of survey: SED will co-operate by providing authorized list of around 2800 sites/buildings in the survey. Out of 400 sites/buildings that will be approached, the survey shall be completed for at least 200 sites/buildings, and an assessed solar PV installation capacity of at least 20 MW.³ The Consultant shall deliver *completed* technical and financial feasibility studies for the surveyed sites/buildings. The Consultant is expected to calculate a reasonable survey response rate that should be reflected in its pricing. With inputs from SED, the Consultant shall prepare work scope and standard forms for the energy survey of sites/buildings. The Consultant shall compile technical details by taking into account both capacity of distributed energy systems and energy efficiency of each site/building by providing baseline data. For financial analysis, the Consultant shall conduct on-site interviews by coordinating with the administration/finance team of that building and collect historical data of the electricity bills to understand energy consumption patterns of the building.
- 3.3. Compilation of surveys from each site/building and archiving them in a suitable format for further use in the RFP for the EPC contractors: The collected data shall be entered into a database and cleaned via tablet or smartphone-based surveys i.e. computer assisted personal interviewing (CAPI) techniques for both technical and financial details. The final data, including raw and clean datasets shall be delivered in Excel, word and technical drawings should be delivered in CAD (Computer Aided Design) software. Once the data is compiled, the consultant is expected to provide detailed analysis of each building in terms of its solar installation capacity and energy efficiency standards. Similarly, a financial analysis needs to be provided in terms of consumption cost from all sources that the building is utilizing and the impact on electricity bills for the consumer. Furthermore, the Consultant shall work with SED to draft standards forms to be used in the technical and financial proposal.
- 3.4. Submission of complete survey report: The Consultant shall carry out a detailed technical and financial analysis of the cleaned data. The report shall include among others, a detailed description of all pre-survey and survey activities, including issues that arose during the survey, and provide the means used to resolve them in addition to data findings. The report shall also include final details of each building that will suffice the technical and financial requirement for development of an EPC Contract.

4. ACTIVITIES AND DELIVERABLES:

The Consultant shall be responsible for delivering high-quality data and within the specified time frame. Specifically, the hired consulting firm shall be responsible for the following activities and tasks:

- 4.1 Development of categorical database of GOS and its stakeholders: This includes compilation of data provided by SED of the buildings that come under Government of Sindh. The Consultant shall analyze existing data on around 2,800 buildings provided by

buildings and land that is owned and/or managed by a single public sector agency or authority (e.g. a university or hospital, where multiple buildings are likely within a single site).

³ If the Consultant reaches 200 surveys but has not surpassed the 20 MW capacity target, consultant may be considered to continue to achieve the target of 20 MW.

SED and develop an initial shortlist of about 400 public sites/buildings to be approached. The Consultant shall assist SED in short listing the sites/building based on the eagerness of their corresponding departments for inclusion in the program and other requirements by the client. The database shall comprise and may not be restricted to the following categories:

- i. Building name
- ii. Department affiliation e.g. the affiliated ministry
- iii. Category e.g. energy, health, finance etc.
- iv. Geographic location

4.2 Design and implementation of the survey: The Consultant shall conduct following activities for accomplishment of the task:

The survey should be designed in three parts i) Initial Information ii) Technical iii) Financial. The initial information will capture basic information and availability of rooftop space, integrity of civil structure with respect to solar PV installation, load of the building and willingness to convert to solar. If there is interest in converting to solar, and rooftop space available, then the consulting firm will proceed to part two and three of the survey.

4.2.1 *Development of survey forms for technical analysis:* The Consultant shall prepare standard forms which need to be utilized for survey of all sites/buildings. These forms should be able to specify all technical details of the sites/buildings which are required for implementation of solar rooftop installation and energy efficiency. The Consultant shall ensure that the technical survey forms should cater for but not be limited to the following requirements:

- i. Site Information
 - Site Introduction
 - Site Location- The consultant shall be able to provide satellite location and GPS Points (Very important for solar survey calculations)
 - Site Description- The site should be described as the number of main buildings with their block and floors.
- ii. Power supply arrangement:
 - Power control room design provided by the consultants with following details:
 - a. Dimensions and design of control room for finding out the installation of inverters.
 - b. Distance of control room from rooftop. If further away then, the client will have to build up an inverter room on the rooftop to prevent the DC losses.
- iii. Main Power Supply
 - Capacity of transformer in terms of KVA
 - DISCO supplying to the buildings from the National Grid
 - Feeder Name
 - Sanctioned Load
 - Tariff block assigned to the building
- iv. Emergency power supply
 - Generators information:
 - a. Number
 - b. Capacity

- c. Fuel source (usually diesel)- important for finding payback and energy efficiency cost for distributed generation supply
- v. Site Area Availability for Modules:
 - Measuring the area of rooftop of the buildings per component
 - Providing GPS coordinate for solar energy supply calculations
 - Using the rule of thumb (130 sq. ft /KW) to find out rooftop capacity of solar installation which is a generic formula for installation of 250 to 300 W solar panels.
- vi. Summarized Load Calculations:
 - Based on data tabulate the load requirements of each floor and buildings per department to find energy efficiency and distributary energy measures
- vii. Rooftop Strength
 - PV modules with base and structure enhance the load by 30 kg/m^2 on the roof so, ensure that building is in good condition
 - Calculate the live and dead load of the rooftop by adding PV module weight
 - a. Ensure availability of beams and columns for strength of the rooftop
 - b. Use the density value 2240 kg/m^3 of concrete and 7800 kg/m^3 density of steel used on the rooftop
 - c. Provide diagrams
- viii. Base Structure
 - Base structure should be defined by taking into account blocks of concrete for the PV modules providing 30 degree angle of tilt (find the most optimized value later in the EPC contract)
 - Ensure strength of the base structure to be able to withhold 120 km/h wind speed
- ix. Construction of Inverter Room:
 - See availability of space in control room for installation of inverters
 - a. Check the horizontal/vertical distance of the inverter room from the PV string to prevent DC losses.
 - b. Calculate optimized area of inverter room that increases ventilation facilities for the inverter to increase the lifetime of its fans.
- x. Shadowing Analysis:
 - The consultant should be able to identify barriers for shadows on rooftop using the following equipment or equivalent:
 - a. Hori-Catcher: Easy tool to take the pictures of the horizon for finding out the barriers effect on the sunlight impact of the system.
 - b. Solar pathfinder: Most convenient use of tool for conducting solar site analysis
- xi. Solar & Civil Engineering:
 - The consultant should identify:
 - a. Estimation of PV system & supply load
 - b. Estimation connection point
 - c. Plant and other equipment including electro-mechanical engineering
 - d. O&M safety, environmental management

- xii. Energy Efficiency Survey
- General conditions (indoor environment, operation and maintenance, service agreements, energy meters, energy monitoring system, cleaning routines)
 - a. The consultant shall be able to install an energy monitoring device like Effergy or equivalent to monitor the energy consumption pattern, identifying peak load time
 - b. The consultant is expected to measure air conditions, comprising of but not limited to temperature, CO2 concentration, humidity level etc.
 - Building envelope (external wall, windows, roof, heated/cooled area, basement, visible thermal bridges, visible damages, external areas with cool air losses, etc.)
 - lighting system inside and outside (type of lighting, wattage used, energy consumption, automatic control, quantity)
 - a. The consultant shall be able to identify current illumination in the area as per the following standards by National Optical Astronomy Observatory (NOAO): ⁴

Activity	Illumination (lux, lumen/m²)
Public areas with dark surroundings	20 - 50
Simple orientation for short visits	50 - 100
Working areas where visual tasks are only occasionally performed	100 - 150
Warehouses, Homes, Theaters, Archives	150
Easy Office Work, Classes	250
Normal Office Work, PC Work, Study Library, Groceries, Show Rooms, Laboratories	500
Supermarkets, Mechanical Workshops, Office Landscapes	750
Normal Drawing Work, Detailed Mechanical Workshops, Operation Theaters	1,000
Detailed Drawing Work, Very Detailed Mechanical Works	1500 - 2000
Performance of visual tasks of low contrast and very small size for prolonged periods of time	2000 - 5000
Performance of very prolonged and exacting visual tasks	5000 - 10000
Performance of very special visual tasks of extremely low contrast and small size	10000 - 20000

⁴[https://www.noao.edu/education/QLTkit/ACTIVITY Documents/Safety/LightLevels_outdoor+indoor.pdf](https://www.noao.edu/education/QLTkit/ACTIVITY_Documents/Safety/LightLevels_outdoor+indoor.pdf) pg 3

- Cooling system (energy consumption, automatic control, presence of inverter air conditioners)
 - a. For each type of air conditioning unit (window, split, mini-split, central AC (air cooled or water cooled)), the Consultant should also take into account the refrigerant used (quantity, capacity (in kW), type of refrigerant used, and refrigerant charge (in kg))
- Other electrical supplies (e.g., fans and pumps, electrical installation, various equipment)
 - a. For each type of electrical appliance, the consultant shall be able to tabulate quantity, unit wattage and consumption of the appliance.
 - b. It is expected that energy savings labeled appliance should be recommended if the current equipment are not up to the standard.

4.2.2 Development of financial survey forms: The Consultant shall gather sufficient information to be included in the RFP for EPC contractors for attaining a more efficient way of gathering all the data only once. For that the Consultant shall include, but not be limited to, the following data:

- i. Summarizing the data from the electricity bills over the last years so that the feasibility of energy efficiency RPV (rooftop Solar PV) can be better understood. It will also provide a baseline for the client for monitoring and evaluation purpose after installation of RPVs by the EPC contractors.
- ii. Amend following forms as per the World Bank Contract guidelines:
 - Bank Guarantee
 - JV agreement (if Applicable)
 - Bill of Quantities
 - EPC and O&M price (subject to client's requirement)
 - Warranty and technical specifications of each equipment

4.2.3 *Compilation of survey of each building and achieving them in a suitable format for further use in the RFP for the EPC contractors:* The Consultant shall complete the survey using the following methodology:

- i **CAPI:** The Consultant shall develop the necessary scripts programs for customize existing scripts in case of CAPI enter the survey forms electronically into tablets into suitable formats, and develop necessary web-server with the capability to receive the completed questionnaires via the internet (using the Wi-Fi technology and cloud-based computing technology) and process them. The preferred CAPI software in survey solutions, however, other well-known programs will be accepted. However, this will be mutually agreed on. The programs will have the basic capabilities of tablet-based questionnaires such as efficient response entry, skip patterns basic validation of the data to mention a few. The Consultant shall outline how the data will be stored, validated, backed-up and transmitted to SED. SED should be able to access the data throughout the data collection process. Paper-based survey will only be allowed in specific cases with valid justification and upon agreement with SED e.g. due to security concerns.

- It is the responsibility of the Consultant to acquire software license and equipment for surveys.
- Questionnaires shall be programmed with logical skip pattern. The first draft of CAPI version should be done before the CAPI training begins. After the training and pre-testing CAPI program shall be revised incorporating the feed-back from the training and pre-testing.
- The questionnaire shall allow valid open ended and other textual responses outside of the response options provided in the questionnaire. The other category shall be elaborated in the text.
- The program shall incorporate basic validation such as range and consistency checks as data are entered.

- ii **Compilation of technical and financial data:** The Consultant shall provide filled out technical and financial survey forms with information provided as per the above guidelines. The data shall be clearly categorized for each building. The energy calculations and rooftop capacity shall be provided in Excel format. The Word document shall comprise of all the other site information as per pre-determined standardized format of each building. The Consultant shall provide detailed civil and electrical drawings for control room and installation areas using AutoCAD or equivalent.

4.2.4 Submission of complete survey report: The Consultant shall carry detailed technical and financial analysis of the cleaned data. The report shall include among others a detailed description of all pre-survey and survey activities, including issues that arose during the survey and provide the means used to solve them in addition to data findings. The report shall also include final details of each building that will suffice the technical requirement to install energy efficient and rooftop photovoltaic. The report shall also include a financial section in which costs of energy consumption from all sources are considered for M&E purpose of the client.

5. TEAM COMPOSITION & QUALIFICATION REQUIREMENTS

The Consultant should have at least five (5) years of undertaking similar assignments. They should have completed at least three activities of similar scale and complexity in the public or private sectors. Firm should have an appropriate team mix of experience and expertise in energy, structural engineering, surveys, data management and field supervision of surveys. At least 15% of the project team hired by the firm should comprise of female and/or disabled staff. The key positions are indicated below:

Table 2: Essential team members of the Consultant

Team Member	Qualification	Years of Experience
Project Manager Team Leader	At least MS or equivalent	15-20 years
Energy Specialist	BS or equivalent	10 years
Economist	At least BS or equivalent	5 years
Survey Coordinator	At least BS or equivalent	5 years

Translator	At least BS or equivalent	5 years
CAPI Programmer/Software Engineer	At least BS or equivalent	5 years
Civil Structural Engineer	At least BS or equivalent	5 years
Electrical Engineer	At least BS or equivalent	5 years
Data Management agents	At least BS or equivalent	3 years
Field Supervisors	At least Associate degree or equivalent	2 years
Surveyors	At least Associate degree or equivalent	2 years

6. **REPORTING REQUIREMENTS AND TIME SCHEDULE FOR DELIVERABLES**

Following are the deliverables and tentative schedules for the task, which should serve as an input for the schedule to be included in the technical proposal.

Note: Deliverable is considered on Lot basis and each Lot consists of any 10 sites/buildings. Successful completion of each Lot leads to the same activity for the next Lot till the analysis of all sites/buildings as prescribed above is completed.

Table 1: Deliverables and submission schedule

Sr. No.	Deliverables (and Activity)	Submission Schedule
01	Time Schedule for the Survey of Each Lot	2 weeks after the award of contract
02	Technical Survey Questionnaire for Approval	1 week after the approval of Sr. No. 1
03	Financial Survey Questionnaire for Approval	1 week after the approval of Sr. No. 1
04	Technical Survey Report of Each Lot	1 month for Each Lot
05	Financial Survey Report of Each Lot	2 weeks for Each Lot
06	Building Electrical Load Calculation Report	1 week for each Building
07	Building Structural Load Bearing Analysis Report	1 week for each Building
08	Design of Solar System for each load based on Electrical & Structural Load	1 week for each Building
09	Submission of Drawings, BOQs & Specifications	1 week for each Building

7. Selection Method

The Consultant shall be selected through Quality and Cost-Based Selection (“**QCBS**”) in accordance with the procedures set out in the World Bank Procurement Regulations for Borrowers, 2016 (revised November 2017 and August 2018).