

## **Request for Proposals (RFP) for Implementation of Renewable Energy & Energy Efficiency (REEE) Measures in Six (6) Local Communities and One (1) CSO and Seventeen (17) MSMEs in Lebanon**

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### **Annex 6: Technical Specifications**

September 2025

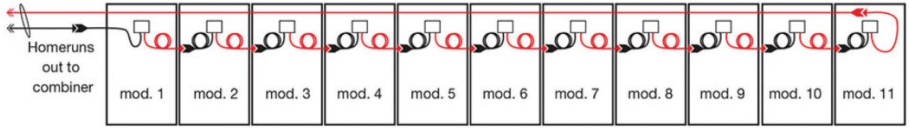
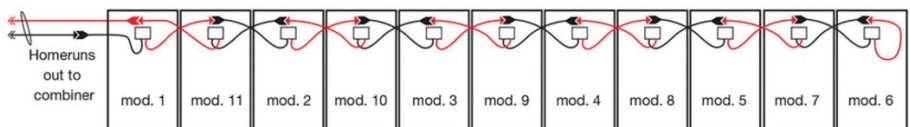
Prepared by the Lebanese Center for Energy Conservation (LCEC)

Beirut, Lebanon

*RFP for Implementation of Renewable Energy & Energy Efficiency (REEE) Measures in Six (6) Local Communities and One (1) CSO and Seventeen (17) MSMEs in Lebanon*

General Requirements	
<b>Net-metering</b>	<ul style="list-style-type: none"> <li>Required as per <a href="#">EDL requirements for net-metering</a></li> <li>The contractor shall provide all necessary documents for the net-metering applications where applicable and shall assist, to the extent reasonably possible, in the application procedure</li> </ul>
<b>Control System</b>	<ul style="list-style-type: none"> <li>Required to ensure the good and safe operation of the installed systems, including but not limited to power export limitation with EDL and to guarantee a minimum load operation of the existing generators where applicable</li> <li>The control system shall also include at the inverter's output, a physical disconnection device in case of a malfunction, fault, or communication issues</li> </ul>
<b>Product Brands</b>	<ul style="list-style-type: none"> <li>The same brand and reference model for PV modules shall be selected for systems of the same lot</li> <li>The same brand of inverters is recommended to be selected for systems of the same lot unless the design and sizing require otherwise (justification is required in this case)</li> <li>The same brand of batteries shall be selected for systems of the same lot.</li> <li>All the other components shall be selected of the same brand (cables, protection devices, protection boxes, etc.)</li> </ul>
Mounting Structure	
<b>Fixation</b>	<ul style="list-style-type: none"> <li>Any direct or indirect impact on the waterproofing, should be remediated</li> </ul>
<b>Material</b>	<ul style="list-style-type: none"> <li>Hot-dip galvanized steel</li> <li>The cutting edges and openings should be cold galvanized</li> <li>Nuts and bolts shall be stainless steel of grade SS 304</li> </ul>
<b>Design</b>	<ul style="list-style-type: none"> <li>Mounting structure must be designed in a way to keep enough passages for maintenance and cleaning</li> <li>In order to reduce the pressure on structure and foundation, clear spacing between two adjacent modules shall be sufficient to allow wind passage</li> <li>The structure shall be designed to allow replacement of any module</li> <li>The mounting structure shall be grounded properly</li> </ul>
<b>Minimum Warranty</b>	<ul style="list-style-type: none"> <li>10 years</li> </ul>

Solar PV Modules	
<b>Type</b>	<ul style="list-style-type: none"> <li>Monofacial, monocrystalline technology</li> </ul>
<b>Power Rating</b>	<ul style="list-style-type: none"> <li>At least 600 Wp per module</li> </ul>
<b>Power Tolerance</b>	<ul style="list-style-type: none"> <li>Positive</li> </ul>
<b>Efficiency</b>	<ul style="list-style-type: none"> <li>At least 21%</li> </ul>
<b>Orientation</b>	<ul style="list-style-type: none"> <li>As per Annex 3 unless design requires otherwise (justification is required in this case)</li> </ul>
<b>Standards</b>	<ul style="list-style-type: none"> <li>Compliance with the following standards:               <ol style="list-style-type: none"> <li>NL EN 61730-1:2016</li> <li>NL EN 61730-2:2016</li> <li>NL EN 61215:2016</li> </ol> </li> </ul>
<b>Minimum Warranty</b>	<ul style="list-style-type: none"> <li>The manufacturer should warrant the solar modules to be free from defects and/or failures due to manufacturing or quality of materials, for a period not less than 10 years from the date of sale to the customer</li> </ul>
<b>Spare Parts</b>	<ul style="list-style-type: none"> <li>10% of the total quantity of panels</li> </ul>
DC Cables for PV Array	
<b>General Specifications</b>	<ul style="list-style-type: none"> <li>Solar DC cables, copper conductor, halogen-free, double insulated, UV protected and fireproof, with IP67 MC4 connectors</li> <li>DC cables between the modules and the inverters section have to be sized to limit the total voltage drop in the DC circuit to a value less than 3% of its value at rated power</li> </ul>
<b>Routing</b>	<ul style="list-style-type: none"> <li>All DC wiring shall be installed so that it is mechanically and electrically sound and neat in appearance</li> <li>DC cables shall be routed from the PV array to the junction boxes, DC protection boxes, or inverters in covered UV resistant cable trays</li> <li>The cable trays shall be hot-dip galvanized and shall be equipped with all the needed brackets, clips, junctions, and accessories for installation and fixation</li> <li>Electric Metallic Tubing (EMT) conduits and cables glands shall also be used where advised</li> <li>The outside corrosion protection of EMT conduits shall be zinc-based and the inside shall have an organic corrosion-resistant coating</li> <li>The cutting edges and openings of cable trays and cable conduits should be cold galvanized</li> <li>Induction loops must be avoided when cabling strings; it is highly recommended to use the skip-wiring method (also known as leap-</li> </ul>

	<p>frog) instead of the conventional daisy-chain method, as per the figure below (Source: UNDP DREG Best-Practices Guidelines and Lessons Learnt for On-grid and PV-diesel Hybrid Systems Guideline Report)</p>  <p>Figure 1a – Conventional daisy-chain wiring (Source: solarprofessional.com)</p>  <p>Figure 1b – Proposed skip-wiring method (Source: solarprofessional.com)</p>
<b>DC Protection Box</b>	<ul style="list-style-type: none"> <li>• The contractor is responsible for the supply and installation of a thermoplastic box for general DC load break of a PV array connected to a single inverter input, with the following requirements</li> <li>• Class II</li> <li>• IP54 for indoor use and IP65 for outdoor use</li> <li>• Includes general DC disconnect switch easily recognizable and readily accessible for disconnection</li> <li>• Includes suitable DC fuses on each (+) and (-) polarities of each string of panels</li> <li>• Includes easily accessible and adequately rated Type 2 SPD with fault signal and thermal disconnection at each DC input of the inverter</li> <li>• Wiring inside the box shall be done with unipolar double insulated cables</li> <li>• The DC protection box shall be equipped with appropriate safety, functionality, grounding and protection</li> </ul>
<b>Labeling</b>	<ul style="list-style-type: none"> <li>• Each string of panels has to be properly labeled with the reference and corresponding polarity, every ten (10) meters and at the input and output of cables trays, junction boxes, DC protection boxes, protection devices, or inverters</li> <li>• Each component installed within the DC protection box shall be labeled</li> <li>• The DC protection box shall include the label “Warning: DC Energized Cables”</li> </ul>
<b>Standards</b>	<ul style="list-style-type: none"> <li>• Compliance with the following standards, or equivalent:</li> </ul>

	<ol style="list-style-type: none"> <li>1. Compliance of DC cables with IEC 62930:2017 and EN 50618:2014</li> <li>2. Compliance of MC4 connectors with IEC 61984:2008 and IEC 62852:2014</li> <li>3. Compliance of DC protection box with IEC 60529 and IEC 62208</li> <li>4. Compliance of circuit breakers with IEC 60947 (Part 1, 2, and 3)</li> <li>5. Compliance of SPD with IEC 61643-11</li> </ol>
<b>Minimum Warranty</b>	<ul style="list-style-type: none"> <li>• 2 year-warranty on DC protection box and components</li> </ul>
<b>Inverter (s)</b>	
<b>Topology</b>	<ul style="list-style-type: none"> <li>• Transformerless</li> </ul>
<b>Coupling</b>	<ul style="list-style-type: none"> <li>• Either AC or DC coupled, with the ability to inject the excess of energy into the EDL grid</li> </ul>
<b>Inverter Loading Ratio (ILR)</b>	<ul style="list-style-type: none"> <li>• Between 1 and 1.2 unless inverter size is specified</li> </ul>
<b>Nominal Output Frequency</b>	<ul style="list-style-type: none"> <li>• 50 Hz +/-0.1%</li> <li>• For on-grid operation, the frequency shall be adjusted to operate as per EDL grid requirements</li> </ul>
<b>Power Factor</b>	<ul style="list-style-type: none"> <li>• Adjustable from 0.8 leading to 0.8 lagging</li> </ul>
<b>Maximum Efficiency</b>	<ul style="list-style-type: none"> <li>• At least 97%</li> </ul>
<b>Number of MPPT</b>	<ul style="list-style-type: none"> <li>• At least 2</li> </ul>
<b>Maximum Total Harmonic Distortion</b>	<ul style="list-style-type: none"> <li>• Less than 3%</li> </ul>
<b>Protection Required</b>	<ul style="list-style-type: none"> <li>• The three-phase inverters should be able to realize 100% unbalanced phase-level output</li> <li>• Anti-Islanding Protection (Integrated)</li> <li>• DC Reverse Polarity Protection (Integrated)</li> </ul>
<b>Protection Degree</b>	<ul style="list-style-type: none"> <li>• At least IP65 if placed outdoor</li> <li>• At least IP 54 if placed indoor</li> </ul>
<b>Labeling</b>	<ul style="list-style-type: none"> <li>• Each inverter shall be labeled with a sticker showing its reference number</li> </ul>
<b>Standards</b>	<ul style="list-style-type: none"> <li>• Compliance with the following standards, or equivalent:               <ol style="list-style-type: none"> <li>1. NL EN 62116:2016</li> <li>2. NL EN 61427-2:2017</li> <li>3. NL EN 61427-1:2017 (if off-grid inverter)</li> </ol> </li> </ul>

	<ol style="list-style-type: none"> <li>4. IEC 61000-3 or equivalent (parts 2,3,4,5,11 and/or 12 to be specified)</li> <li>5. IEC 62109-1</li> <li>6. IEC 62109-2</li> <li>7. IEC/EN 61800 (if solar pumping inverter)</li> </ol>
<b>Minimum Warranty</b>	<ul style="list-style-type: none"> <li>• 5 years</li> </ul>
<b>AC Cables</b>	
<b>General Specifications</b>	<ul style="list-style-type: none"> <li>• Multipolar cables with double insulation (Class II)</li> <li>• AC cables between the inverters and connection have to be sized to limit the total voltage drop in the AC circuit to a value less than 3% of its value at rated power</li> </ul>
<b>Routing</b>	<ul style="list-style-type: none"> <li>• All AC wiring should be installed so that it is mechanically and electrically sound and neat in appearance</li> <li>• AC cables shall be routed in covered UV resistant cable trays unless advised otherwise</li> <li>• The cable trays shall be hot-dip galvanized and shall be equipped with all the needed brackets, clips, junctions, and accessories for installation and fixation</li> <li>• EMT conduits and cables glands shall also be used where advised by the client</li> <li>• The cutting edges and openings of cable trays and EMT cable conduits should be cold galvanized</li> </ul>
<b>AC Protection Box</b>	<ul style="list-style-type: none"> <li>• The contractor is responsible for the supply and installation of a thermoplastic box for general AC protection box with the following requirements</li> <li>• Class II</li> <li>• IP54 for indoor use and IP65 for outdoor use</li> <li>• Includes general AC disconnect switch easily recognizable and readily accessible for disconnection</li> <li>• Includes adequately rated AC circuit breakers</li> <li>• Includes adequately rated residual current devices</li> <li>• Includes easily accessible and adequately rated Type 1 SPD with fault signal and thermal disconnection shall be installed at the grid connection point, if the distance between the inverter and connection point is less than 10m.</li> </ul>

	<ul style="list-style-type: none"> <li>If the distance between the inverter and connection point is more ten (10) meters, an additional Type 2 SPD with fault signal and thermal disconnection must be installed upstream the AC input of the inverter, as close as possible to the AC output of the inverter.</li> <li>The AC protection box shall be equipped with appropriate safety, functionality, grounding and protection</li> </ul>
<b>Labeling</b>	<ul style="list-style-type: none"> <li>AC cables shall be labeled with "AC solar power" cables every ten (10) meters and at the input and output of cables trays, junction boxes, AC protection boxes, protection devices, or inverters</li> <li>Each component installed within the AC protection box shall be labeled</li> <li>The AC protection box shall include the label "Main Switchboard"</li> </ul>
<b>Standards</b>	<ul style="list-style-type: none"> <li>Compliance with the following standards, or equivalent:               <ol style="list-style-type: none"> <li>Compliance of AC cables with IEC 60228, IEC 60332-1-2 and IEC 60502-1</li> <li>Compliance of AC protection box with IEC 60529 and IEC 62208</li> <li>Compliance of circuit breakers with IEC 60947 (Part 1, 2, and 3)</li> <li>Compliance of SPD with IEC 61643-11</li> <li>Compliance of RCD with NL IEC 60364-4-41:2003</li> </ol> </li> </ul>
<b>Minimum Warranty</b>	<ul style="list-style-type: none"> <li>2 year-warranty on AC protection box and components</li> </ul>
<b>Solar Charge Controller</b>	
<b>Type</b>	<ul style="list-style-type: none"> <li>MPPT</li> </ul>
<b>Output Voltage</b>	<ul style="list-style-type: none"> <li>48V</li> </ul>
<b>Charging Algorithm</b>	<ul style="list-style-type: none"> <li>3 stages</li> </ul>
<b>Protection Required</b>	<ul style="list-style-type: none"> <li>Output short circuit</li> <li>Battery reverse polarity detection</li> <li>Over temperature</li> </ul>
<b>Efficiency</b>	<ul style="list-style-type: none"> <li>At least 97%</li> </ul>
<b>Labeling</b>	<ul style="list-style-type: none"> <li>Each charge controller shall be labeled with a sticker showing its reference number</li> </ul>
<b>Standards</b>	<ul style="list-style-type: none"> <li>Compliant with NL EN 62509:2016, or equivalent</li> </ul>
<b>Minimum Warranty</b>	<ul style="list-style-type: none"> <li>5 years</li> </ul>
<b>Battery Bank</b>	

<b>Rated Voltage</b>	<ul style="list-style-type: none"> <li>• 48V</li> </ul>
<b>Battery Technology</b>	<ul style="list-style-type: none"> <li>• Lithium</li> <li>• The battery storage room should be well-ventilated and might require the installation of an exhaust fan and a louvered door</li> </ul>
<b>Roundtrip Efficiency</b>	<ul style="list-style-type: none"> <li>• &gt; 95%</li> </ul>
<b>Lifecycle (at 90% DoD, 25°C)</b>	<ul style="list-style-type: none"> <li>• &gt; 6,000 cycles</li> </ul>
<b>Operating Temperature</b>	<ul style="list-style-type: none"> <li>• -20°C to 50°C</li> </ul>
<b>Status Indicators</b>	<ul style="list-style-type: none"> <li>• ON/OFF LED – Run LED – Alarm LED – State of Charge LED</li> </ul>
<b>Standards</b>	<ul style="list-style-type: none"> <li>• Compliance with the following standards, or equivalent:               <ol style="list-style-type: none"> <li>1. IEC 63056</li> <li>2. IEC 62485-1:2015</li> <li>3. IEC 60695-1-11:2014</li> <li>1. IEC 61000-6-1</li> <li>2. IEC 61000-6-2</li> <li>3. IEC 62619</li> </ol> </li> </ul>
<b>Protection Devices</b>	<ul style="list-style-type: none"> <li>• Overcurrent and over-temperature protection</li> </ul>
<b>Minimum Warranty</b>	<ul style="list-style-type: none"> <li>• 7 years</li> </ul>
<b>Land Preparation, Fence Installation, and Trenching</b>	
<b>Trenching for PV cables</b>	<ul style="list-style-type: none"> <li>• Positive and negative PV cables to be installed in separate dedicated conduits</li> <li>• Depth to be between 20 and 30cm</li> <li>• PV cables to be installed in HDPE conduits</li> <li>• Bottom of trench to be leveled and free of debris</li> <li>• Backfilling with a layer of fine soil followed by compacted soil</li> <li>• Asphalt layer to be applied on top</li> </ul>
<b>Land Preparation &amp; Fence Installation</b>	<ul style="list-style-type: none"> <li>• All debris, non-essential vegetation, and any other obstructions shall be removed from designated area</li> <li>• All elements potentially causing fire hazards to be removed from designated area</li> <li>• Fence to be surrounding area of PV system without causing shading on PV panels</li> </ul>



	<ul style="list-style-type: none"> <li>• Fence to be made of removable and rigid welded mesh panels topped with barbed wire</li> <li>• Fence to be equipped with one (1) gate to enable access into the PV system</li> <li>• Fence's highest elevation to be 3 meters</li> </ul>
<b>Weather Station</b>	
<b>Measurement Device</b>	<ul style="list-style-type: none"> <li>• Supply and installation of one (1) calibrated weather station for the measurement of:               <ol style="list-style-type: none"> <li>1. Pyranometer sensor</li> <li>2. Anemometer sensor</li> <li>3. Ambient temperature sensors</li> </ol> </li> <li>• The weather station shall be installed with a tilt angle that is equivalent to that of the solar PV modules</li> </ul>
<b>General Specifications</b>	<ul style="list-style-type: none"> <li>• IP65</li> <li>• UV-resistant material</li> <li>• Operating temperature range: from -40°C to 80°C</li> <li>• Humidity range: 0-100% RH</li> <li>• Modbus communication</li> <li>• Pyranometer sensor, for global irradiation measurement               <ol style="list-style-type: none"> <li>1. Spectral range (wavelength): 285 to 3000nm</li> <li>2. Maximum operational irradiance: 4000 W/m<sup>2</sup></li> <li>3. Accuracy of bubble level: less than 0.2°</li> <li>4. Field of view: 180°</li> <li>5. On site, the pyranometer shall be installed with a tilt angle that is equivalent to that of the solar PV modules</li> </ol> </li> <li>• Anemometer sensor for the measurement of the wind speed               <ol style="list-style-type: none"> <li>1. Measuring range 0 to 250 km/hr</li> <li>2. Startup wind speed 0.5 m/s or 1.8 km/hr</li> <li>3. Accuracy ± 5%</li> </ol> </li> <li>• Ambient temperature sensors for the measurement of the surrounding temperature and Module temperature sensor for the measurement of the temperature at the back of the photovoltaic panel.               <ol style="list-style-type: none"> <li>1. Measurement range: -50°C to 80°C</li> <li>2. Accuracy: ±0.3 °C</li> <li>3. Resolution: 0.1°C</li> </ol> </li> </ul>

<b>Routing of Communication Cables</b>	<ul style="list-style-type: none"> <li>The minimum separation between communication cables and power cables and routing, should be done as per the international best practices</li> </ul>
<b>Standards</b>	<ul style="list-style-type: none"> <li>Compliant with IEC 61724-1:2017, or equivalent</li> </ul>
<b>Minimum Warranty</b>	<ul style="list-style-type: none"> <li>5 years</li> </ul>
<b>Remote Monitoring</b>	
<b>Data Readings</b>	<ul style="list-style-type: none"> <li>A data monitoring system shall be accessible locally and also remotely via the web</li> <li>The monitoring interface shall provide at least the following readings:               <ol style="list-style-type: none"> <li>On site measured irradiation data</li> <li>DC and AC power</li> <li>DC and AC voltage</li> <li>DC and AC current</li> <li>Energy production (kWh)</li> <li>Battery state of charge</li> <li>Load flow to and from battery (charged or discharged)</li> <li>Faults and alarms</li> </ol> </li> <li>The contractor is responsible for the supply of all the needed components to connect the monitoring system to the internet available in the facility</li> <li>A data access for remote monitoring shall be provided to the owner</li> <li>At least 2 months of local logging and storage of historical data must be available at 10-minute intervals</li> <li>The operators shall have a free remote access to all the requested data, throughout the lifetime of the project (at least 20 years)</li> <li>No license purchase or renewal shall apply throughout the lifetime of the project (at least 20 years)</li> </ul>
<b>Communication</b>	<ul style="list-style-type: none"> <li>WIFI/LAN/RS485</li> </ul>
<b>Minimum Warranty</b>	<ul style="list-style-type: none"> <li>3 years on equipment, data acquisition software, and remote monitoring</li> </ul>
<b>Safety Signage</b>	
<ul style="list-style-type: none"> <li>Suitable signs to warn of electrical hazards associated with the presence of photovoltaic plants should be installed where necessary</li> <li>The material shall be anti-corrosive and durable</li> </ul>	
<b>Labeling</b>	

- Please check the labeling requirements in each section

### Earthing

- The contractor is responsible for the installation of one electrical earthing system in each site where applicable, in the form of earthing rods, with a ground resistance value less than 5 ohms.
- The rods shall be copper, at least 1.5 meters long.
- The distance between rods should be two or three times the rods' depth.
- The contractor is responsible for the interconnection of all the metallic parts of the plant, including but not limited to metallic structure, cable trays, panelboards, inverters, relevant protection devices, etc. on both DC and AC sides. The bonding connection must be connected to the main earthing terminal.
- The earthing and bonding cables have to be yellow-green colored.
- The earthing system shall be compliant with IEC 60364-7-712 – Low voltage electrical installations – Part 7-712: Requirements for special installations or location

### Lightning

- The contractor is responsible for the supply and installation of one (1) complete external lightning protection system (LPS) where applicable.
- The contractor must keep a certain separation distance between the conductive parts of the solar PV system and the LPS, to prevent shadows, induced overvoltage, and arcing.
- If separation distance cannot be maintained, the metal components of the solar PV system must be connected to the LPS through a conductor with a cross-section of at least 16mm<sup>2</sup>.
- The Lightning protection system should be implemented according to IEC 62305-3 and best practices for similar systems.
- The ground rods of the earthing system and lightning protection system should not be bonded.

### Safety Requirements

- The solar PV systems with battery storage shall be designed considering the safety during the construction and operation especially:
  1. Safety of workers
  2. Safety of users
  3. Safety for the equipment of the plant
  4. Safety for existing infrastructures and systems
- Any intervention on the inverters must be possible in full electrical safety.
- The contractor is responsible for the supply, installation, and testing of the following components in the inverters/battery bank rooms:
  1. One (1) portable powder fire extinguisher

2. One (1) standalone smoke detector with alarm
  3. One (1) standalone Hydrogen Fluoride sensor with alarm
- Client to receive alarms when any fault occurs on safety components

### Operation and Maintenance

- The contractor is responsible for the supply and installation of the following components where applicable:
  1. One (1) weatherproof electrical socket for maintenance purpose
  2. One (1) water access point next to the PV array, for cleaning activities
- The contractor shall be responsible of the O&M of systems for a period of one (1) year, following the issuing of the Provisional Acceptance certificate by LCEC and the successful commissioning of the systems.
- The contractor shall furnish all necessary staff, supplies, materials, and equipment needed for the O&M activities.
- The O&M activities will include:
  1. Daily remote monitoring of systems performance, alarms and diagnostics
  2. Preventive maintenance
  3. Corrective maintenance to take the necessary remedial measures or exchange the failed components
  4. Component replacement
  5. Updates of documentation where applicable
  6. Reporting to LCEC when requested
- The preventive maintenance shall be conducted twice per year with the presence of LCEC representatives, to inspect and maintain the PV array and mounting structures, the inverters/chargers, the batteries, the weather station, the remote monitoring, sensors, the wiring systems and enclosures, the connectors, the protection devices, the metallic parts, the earthing and lightning systems, in addition to the labels and signage:
  1. During the preventive maintenance, the contractor shall clean the PV panels, check any visual defects, discoloration, corrosion, deterioration, or mechanical damage of the components and take the suitable remedial measures in coordination with LCEC.
  2. The contractor shall observe and ensure that the amount of power/energy being generated by the PV systems is typical of the conditions. The contractor shall compare current readings from the inverters with a diagnostic benchmark.
  3. The contractor shall make sure that there are no loose or missing panels clamps
  4. The contractor shall make sure that the enclosures show no signs of internal heating and that the fuses, holders and protection devices are still intact.

5. The contractor shall verify the open circuit voltage and short circuit current to make sure that the system is still functioning correctly. 6. The contractor shall make sure that the labels and signage are still visible, legible, and adequately labelled. <ul style="list-style-type: none"> <li>Any proposed remedial solution has to be approved by LCEC, prior to taking any action on site.</li> <li>The contractor shall respond to field failures within 3 days from LCEC approval.</li> </ul>	
<b>Testing and Commissioning</b>	
<ul style="list-style-type: none"> <li>The contractor is responsible for obtaining the necessary tools and conducting the testing and commissioning of the solar PV systems, including but not limited to the below tests where applicable.</li> <li>If the results of the tests are not compliant with the requirements of the RFP, the contractor is responsible for taking the necessary remedial measures in coordination with LCEC.</li> </ul>	
<b>Final Checkouts and Visual Inspection</b>	<ul style="list-style-type: none"> <li>The site is clean and orderly</li> <li>The installation matches the design documentation</li> <li>The modules and cable routing are done properly</li> <li>The equipment is securely mounted</li> <li>Cut metallic edges and openings are cold galvanized</li> <li>The installations are matched to the manufacturer's specifications and recommendations</li> <li>Warning signs and labels are posted appropriately</li> <li>Safety equipment is installed properly</li> <li>The installations are compliant with standards and best practices</li> </ul>
<b>Mechanical Systems and Civil Works</b>	<ul style="list-style-type: none"> <li>Make sure that all clamps, nuts, and bolts are secured and tightened as per the manufacturer's recommendations, using a torque meter</li> </ul>
<b>Electrical Systems</b>	<ul style="list-style-type: none"> <li>DC voltage test and comparison with expected voltage</li> <li>Polarity test</li> <li>AC voltage test at inverter output and compare to inverter datasheet</li> <li>Open circuit test</li> <li>Short circuit test</li> <li>Insulation resistance test</li> <li>Ground resistance test</li> <li>Voltage drop tests</li> <li>Battery bank tests</li> </ul>
<b>Functional Tests</b>	<ul style="list-style-type: none"> <li>Start-up procedure</li> </ul>

*RFP for Implementation of Renewable Energy & Energy Efficiency (REEE) Measures in Six (6) Local Communities and One (1) CSO and Seventeen (17) MSMEs in Lebanon*

	<ul style="list-style-type: none"> <li>• Verify the proper operation of components' connection and disconnection sequences</li> <li>• Verify that the inverters and AC modules de-energize their output to utility grid upon loss of grid voltage</li> <li>• Verify that inverters automatically reconnect to their output to the grid once the voltage has been restored</li> <li>• Verify the proper grid voltage and frequency to operate inverters</li> <li>• Verify that the data communication is working properly</li> <li>• Conduct a communication equipment functional test</li> <li>• Check validity of all data recording and readings including export, download and data transfer</li> <li>• Parallel operation with existing power sources</li> <li>• Battery bank tests</li> </ul>
<b>Performance Test</b>	<ul style="list-style-type: none"> <li>• The performance ratio (PR) test method is explained in Form 6 – Performance Guarantee Letter</li> </ul>
<b>Documentation and Training</b>	
<b>O&amp;M Manual</b>	<ul style="list-style-type: none"> <li>• Two (2) printed copies of the O&amp;M manual shall be delivered to the client. One copy should be in Arabic and the other one in English</li> <li>• The O&amp;M manual shall provide an overview of the project and shall include considerations for operation in the presence of faults including but not limited to:               <ul style="list-style-type: none"> <li><b>A. Contact Details of contractor and suppliers of main equipment</b></li> <li><b>B. Remote Monitoring System Usage and Control</b> <ol style="list-style-type: none"> <li>1. Dashboard details and functionality</li> <li>2. Alarms systems levels and categories</li> <li>3. Generate reports and analyze the data received</li> </ol> </li> <li><b>C. Monitoring Equipment Maintenance and Data Collection System</b> <ol style="list-style-type: none"> <li>1. Define each sensor installed</li> <li>2. Define parameters - tolerances and accuracy</li> <li>3. Explain how each sensor is cleaned and maintained</li> <li>4. Explain the dashboard and interface</li> <li>5. How to read data</li> <li>6. How to retrieve data</li> <li>7. How to save as .csv file</li> </ol> </li> <li><b>D. Panel Cleaning and Panel Replacement</b> <ol style="list-style-type: none"> <li>1. Cleaning method and tools used</li> </ol> </li> </ul> </li> </ul>

	<ol style="list-style-type: none"> <li>2. Importance of cleaning and soiling effect on the performance of the system</li> <li>3. Handling method of the replacement</li> </ol> <p><b>E. Inverter Functionality, Resets, and Interface</b></p> <ol style="list-style-type: none"> <li>1. Explain interface and advantages</li> <li>2. Explain alarms and categories</li> <li>3. Procedure for alarms categories</li> <li>4. Explain the string monitoring system</li> <li>5. Explain the security components and importance of each component</li> </ol> <p><b>F. As built drawings (Layouts, Stringing Summary, SLDs, etc.), datasheets, sequence of operation, etc.</b></p>
<b>Training of Operators</b>	<ul style="list-style-type: none"> <li>• A training of operators shall be conducted by the contractor at the end of the project, introducing the systems and explaining the different parts of the O&amp;M manual in a power point presentation.</li> </ul>
<b>Technical Documentation to be Submitted by Bidders</b>	
<ul style="list-style-type: none"> <li>• Project Timeline</li> <li>• System description and components selection</li> <li>• Software simulation report showing the sizing, shadowing scenes, simulation and data analysis of the PV system</li> <li>• A layout plan indicating the structure of modules, number of modules, dimensions of arrays, tilt and orientation, distances between rows, passages, and clearance from parapets</li> <li>• Single Line Diagram (SLD) including panels, inverters, protection devices, and earthing</li> <li>• Stringing summary and layout</li> <li>• Civil design notes based on wind loads as per Lebanese Standard NL 137:2020, signed by a civil engineer member of the Order of Engineers and Architects of Beirut or Tripoli</li> <li>• Declaration of the civil engineer that the solar system does not affect the structural safety of the building</li> <li>• A copy of the membership card of the civil engineer in the Order of Engineers and Architects of Beirut or Tripoli</li> <li>• Datasheets of mounting structure, panels, inverters, batteries, DC/AC cables, DC/AC protection devices, sensors and monitoring equipment, etc.</li> <li>• Certificates for standards compliance</li> <li>• Guaranteed monthly performance ratio (PR) letter signed by the bidder</li> </ul>	
<b>Irradiation Data</b>	
<ul style="list-style-type: none"> <li>▪ All bidders are requested to use the following daily global horizontal irradiation data for solar PV software simulation.</li> </ul>	

- If different irradiation data is used, this would result in the rejection of the bid.

Month	Coastal Beirut (Wh/m2)	Coastal Bayssour (Wh/m2)	Western Mid- Mountain (Wh/m2)	Inland
January	2,387.6	2503.6	2471.8	2522.2
February	3,195.8	3208.1	3165.9	3282.2
March	4,898.1	4777.7	4734.8	4861.2
April	6,012	6018.3	5991.8	5979.5
May	6,837	6833.2	6834.1	6837.6
June	7,192	7209.7	7192.7	7211.3
July	7,010.4	7024	7032.8	7037.5
August	6,343.7	6353.2	6337.4	6405.2
September	5,374.6	5389.1	5362	5466.1
October	3,873.5	3896.9	3851.8	3828.4
November	2,757.2	2770.7	2669.5	2765.4
December	2273.4	2287.3	2162.4	2241.2
<b>Average</b>	<b>4854.6</b>	<b>4864.1</b>	<b>4825.6</b>	<b>4877.6</b>