

## SECTION 26 60 00: PHOTOVOLTAIC SYSTEM SPECIFICATIONS

### **PART 1 – GENERAL**

#### 1.01 RELATED DOCUMENTS

- A. The RFP and all Attachments.
- B. Division 1 of the Specifications
- C. Section 26 00 00: General Electrical Specifications
- D. Section 05 90 00: PV Mounting Specifications

#### 1.02 GENERAL

- A. The project includes the design and construction of complete Photovoltaic Systems (PV), including all AC and DC components. The design and installation shall conform to all requirements as defined by the applicable codes, laws, rules, regulations and standards as specified in the RFP.
- B. The Contractor shall include all items and all work reasonable required to complete the System in accordance with the Agreement. If the Contractor is in doubt as to the intent of any portion of these specifications, or necessary information is omitted, the Contractor shall notify the Institute in writing for clarifications or corrections to be provided by addendum.
- C. All design documents, cut sheets, and technical specifications shall be submitted, reviewed and accepted by the Owner per the guidelines specified in RFP Attachment A3 – Submittals and Project Acceptance.

#### 1.03 WORK INCLUDED

- A. The work shall include the design, engineering, materials, labor, equipment, installation, testing, services, and incidentals necessary to install complete Photovoltaic (PV) Systems in conformity with applicable codes and professionally recognized standards.
- B. PV systems shall consist of arrays of framed photovoltaic modules, mounting hardware, terminal boxes, combiner boxes, quick-connect electrical connectors, DC wiring, DC disconnects, utility interactive inverters, AC disconnects, AC feeders, AC circuit breakers, AC panel boards / switchgear, and complete data acquisition and monitoring systems.
- C. The PV systems shall be utility grid connected. The Contractor shall be responsible for all required utility company coordination, applications, inspections, permits, and final approval for the complete interconnection of the PV systems with the utility company grid, including bi-directional utility meters at each location.
- D. The Contractor shall ensure adequate clearance and equipment space within the allotted areas and existing building and site conditions. All equipment and sizes / clearances shall be coordinated with the Institute prior to rough-in.
- E. The Contractor shall be provide for the disconnection, disposition and proper disposal of all

existing equipment to be replaced.

### 1.04 QUALITY ASSURANCE

- A. All equipment shall be listed to Underwriters' Laboratories (UL) standards as applicable.
- B. Installer Qualifications – The installing contractor shall be familiar with the equipment to be installed and have the necessary training to install in the equipment.

### 1.05 MATERIALS, DELIVERY, STORAGE, AND HANDLING

- A. All materials shall be delivered new, undamaged and without defects.
- B. All equipment and panels shall be handled with care so as not to damage the delivered products. All equipment shall be installed in new and neat condition.
- C. Appropriate protective clothing shall be worn when handling the equipment.
- D. All materials stored on the roof shall be distributed so as not to overload the roof at any point. All materials stored on roof shall follow the guidelines of the roofing system manufacturer including protection boards, pallets and/or mats to prevent damage to the roof system and insulation assemblies. All roof top construction, construction related traffic and staging areas shall have protection boards in place to prevent damage to the roofing system and insulation assemblies.

## PART 2 – PRODUCTS

### 2.01 ACCEPTABLE MANUFACTURERS

- A. Acceptable system manufacturers/vendors shall be as specified in other sections of this RFP. Manufacturers shall provide their latest line of equipment, meeting all current industry standards and all performance criteria set forth in this RFP. The Owner seeks equipment from proven, industry leading manufacturers in solid financial standing, producing tier-one equipment.
- B. Contractor proprietary products shall have an ICC report, or a testing report stamped and signed by a licensed California engineer.

### 2.02 EQUIPMENT AND MATERIALS

- A. All PV Modules shall meet the following specifications:
  - 1. Module manufacturer that has produced no less than 250MW of modules in the prior year.
  - 2. Modules are from a field-tested product line that has been commercially available for no less than three years.
  - 3. Module manufacturer shall provide a 25-year warranty on the solar modules with at least 80 percent power output guaranteed at 25 years.
  - 4. Have a minimum 25-year design life, designed for normal, unattended operation.
  - 5. UL 1703 listed.
  - 6. UL listed for the specified voltage (typically 1000 V-DC).
  - 7. Meet IEC 61215 (crystalline silicon PV modules) or IEC 61646 (thin film PV modules) standards.
  - 8. Project costs shall include all known and future duties, tariffs, export tariffs, customs, demurrage, and shipping costs.

9. Meet California SB1 Guidelines for Eligibility.
- B. No substitution for contracted equipment shall be made without the written consent of Institute. Such consent will not to be unreasonably conditioned, delayed, or withheld.
- B. All Inverters shall meet the following requirements:
  1. String-type inverters.
  2. Integrated AC and DC disconnects
  3. Include a 10-year warranty.
  4. Manufacturer produced no less than 250 MWp of inverters in the prior fiscal year.
  5. Field-tested product line that is commercially available for no less than 2 fiscal years.
  6. UL 1741 listed and Comply with IEEE 1547, including testing to IEEE 1547.1 and IEEE C62.45. Regulatory standards compliance shall also include IEEE C62.41.2 and CSA107.1-01.1.
  7. Incorporate disconnect switch for main DC power disconnect in compliance with applicable codes and utility requirements.
  8. Sized as required to support the PV module production load within the rating of the equipment, together with all other components.
  9. CEC approved, Rule 21 compliant and shall be utility line interactive type.
  10. Capable of producing reactive power to operate between a power factor of 0.9 lagging to 0.9 leading (as adjusted on the inverter equipment).
  11. Meet the following requirements:
    - a) Nominal AC Voltage (Three-phase, + 10%): 208, 240, or 480 VAC (as required per site)
    - b) Nominal AC Frequency (+ 0.5 Hz): 60 Hz
    - c) Line Power Factor (Above 20% rated power): >0.99
    - d) AC Current Distortion (At rated power): <5% THD
    - e) Maximum Open Circuit Voltage DC: 1,000 VDC
    - f) Maximum Ripple Current (% of rated current): <5%
    - g) Minimum Inverter Efficiency: >96%
    - h) Temperature Range Ambient: -4° F to 122° F (-20° C to 50° C)
    - i) Enclosure Environmental Rating (minimum): NEMA 3R
    - j) Relative Humidity (non-condensing): 0-95%
    - k) Sound level: <85 dBa
    - l) Protective Functions: Standard wakeup voltage, wakeup time delay, shutdown power, shutdown time delay, AC over / under voltage and time delays, AC over / under frequency and time delays, ground over current, over-temperature, AC and DC over current, DC over voltage
    - m) User Display: Standard-LCD with on/off capability
    - n) DC Disconnect: 1,000 VDC load break rated
    - o) Isolation Transformer (if applicable): High efficiency type, supplied by the manufacturer of the Inverter Systems, mounted within same enclosure or directly adjacent, with factory designated wiring provisions.
    - p) Zone 4 Seismic Rating (free standing) or wall mounted
    - q) Internal combiner panel option to allow connections of sub-arrays at the Inverter without the use of additional equipment.
- G. Upon connection of the new PV systems, provide a placard on the respective Main Switchboard to identify the two sources of power feeding the equipment.

- H. Combiner boxes (where used) shall be NEMA 3R rated (minimum) and shall include fuses for string inputs and a bus bar to combine the strings into sub-arrays, for input into the Inverter system. Minimum combiner box output bus ampacity shall be 156% of the rated short circuit current available to be carried on the bus (the sum from all strings to the bus).]
- I. All AC interconnecting feeders shall be sized to NEC Table 310.16 (75 degree column) based on associated disconnect amperage. Conduit fill to 40% max. Include temperature derating as required for the ambient temperatures and roof conditions per NEC. Provide equipment grounding conductor in each conduit.
- J. All roof and exterior mounted raceways shall be designed and installed to accommodate expansion and contraction due to heating affects, including adequate cable length and listed expansion couplings. All expansion couplings or installations shall include grounding bonding jumpers as required by code.
- K. All AC circuits to be 3-wire or 4-wire + ground. All grounding per NEC 690, Part V.
- L. All DC circuits and feeders sized to NEC table 310.16 (90 degree column) based on associated disconnect amperage. Minimum ampacity shall be 156% of the rated short circuit current available to be carried on the specific conductor. Conduit fill to 40% max. Include temperature derating as required for the ambient temperatures and roof conditions per NEC. Provide equipment grounding conductor in each conduit.
- M. All DC circuits to be 2-wire + ground.
- N. All AC and DC wiring in conduit to be RHW-2, PVWIRE, THWN-2, or XHHW-2 (90 degree) wet rated for use with 90 degree listed terminals on PV equipment.
- O. All exposed DC wiring to be USE-2, PVWIRE, or SE (90 degree) wet rated and sunlight resistant or PV Wire.
- P. Above ground exposed conduit shall be rigid galvanized steel with threaded fittings except where DSA and other applicable codes specifically allow for the use of EMT conduit. All conduit shall meet NEC Code, DSA Guidelines and any applicable standards. Exterior installations shall have watertight fittings. All conduit shall be rated for exposed installation and a minimum design life equivalent to the solar panels. Paint all visible exposed raceways and boxes to match adjacent surface finish after installation. Colors to be selected and approved by the Owner, such approval not to be unreasonably conditioned, delayed, or withheld.
- Q. All conduits and stub-ups under array canopies shall be encased within concrete caissons or piers or, protected from parking traffic with appropriately sized bollards if protection is required by electrical engineer.
- R. All interior conduit to be EMT with steel set-screw fittings (no cast fittings).

### 2.03 WIRE MANAGEMENT

- A. All inter-array wiring methods must meet or exceed current industry standards for wire management, strain relief and fastening.
- B. All inter-array wire management shall use stainless steel or galvanized steel cable clips, Heyco or similar. UV rated cable ties shall be used minimally and only in locations where the use of cable clips are impossible.

- C. Where exposed, wires, cables and conductors shall be managed in a neat and orderly manner. Where exposed to environmental conditions e.g. sunlight, rain, wind etc. and visible from below, wires shall be fastened in a uniform and discrete fashion.
- D. All conductors and conduits between separate arrays shall be routed underground. Wiring shall be routed down columns, encased in piers/caissons, routed underground between arrays or carports, and up the nearest column on the adjacent array. Under no circumstance will circuits, conduits, or chaseways be mounted overhead between separate structures, including seismic gaps).
- E. Strain relief and drip loops shall be utilized at all entrances to and from conduit bodies, junction boxes, weather heads, switchgear, inverters and panelboards etc. Conductors shall be strapped with strain relief as not to stress panel leads, home runs or mechanically crimped connections within the array.

### 2.04 MISC. SYSTEM REQUIREMENTS

- A. All exterior equipment to be sunlight and UV resistant as well as rated for elevated temperatures at which they are expected to operate (on roofs in hot sunlight).
- B. No dissimilar metals are allowed to contact each other (use plastic or rubber washers) with the exception of anodized aluminum module frames in contact with galvanized carport purlins. Best practices shall be used to avoid corrosion.
- C. No aluminum in contact with concrete or masonry materials.
- D. Bolted connections shall be non-corrosive and include locking devices designed to prevent twisting over the design life of the PV system.
- E. Environmental impact of system equipment containing hazardous materials shall be disclosed, as well as maintenance and disposal instructions for equipment at the end of its useful life.

### 2.05 SYSTEM ELECTRICAL

- A. The modules shall be interconnected using cable assemblies. The pigtails shall be quick-connect electrical wiring connections rated for the application (90 degree rated).
- B. Raceway system shall be installed in a manner that prevents water from draining into electrical equipment.
- C. Full specifications of the inverter shall be supplied as part of the system submittal.
- D. All major components of the systems and the installation procedures shall meet National Electrical Code requirements, including Article 690.
- E. The PV system shall be designed to automatically drop offline when normal utility power is lost to avoid unintentional islanding effects as required by the local utility.
- F. All electrical system equipment shall be properly rated to withstand and interrupt (in the case of over current protection devices) the available fault current at the point of use.
- G. The system shall be capable of producing reactive power to operate between a power factor of 0.9 lagging to 0.9 leading (as adjusted on the inverter equipment).
- H. All required overcurrent protection and electrical bussing sizes per NEC 690.

- I. Means of system grounding to be approved by professional Electrical Engineer of record and GFCI protection shall be in accordance with latest NEC requirements.

### 2.06 MONITORING

- A. A Data Acquisition and Monitoring System (DAS) shall be provided for all points of interconnect. The system shall include, but not be limited to, the measurement, calculation, display, and reporting of the following items:
  1. PV production in 15-min reporting intervals.
  2. Energy consumption in 15-min reporting intervals.
  3. Weather data in 15-min reporting intervals
  4. System electrical functions (instantaneous and accumulated power output (kW and kWh), AC and DC system voltage and amperage, and peak value tracking with associated time stamps).
  5. Pounds of CO<sub>2</sub> emissions avoided from the generation of PV energy at the site (compared to local utility fuel mix electric carbon content).
  6. Generation data in the Western Renewable Energy Generation Information System (WREGIS) format.
  7. Lifetime access to data reported by DAS.
  8. DAS shall allow customer or customer's third party designee to programmatically download data through Application Program Interface ("API"). This data shall, at a minimum, include PV production data, energy consumption data, weather station and/or satellite data, and alarm status readings. All data shall be available over multiple timescales, ranging from 15-min intervals to annual intervals and shall include both real-time and historic data.
- B. Cellular data shall be used for communications with the DAS and metering systems. In the absence of cellular service availability, the Institute may, at its own discretion, provide internet connections on a site by site basis.
- C. Separate consumption meters shall be provided for each utility account. Consumption meters shall include a web-enabled interface and 15-min reporting intervals to be synced with PV meter production intervals. Consumption meter standard assumption is 480V POI, assumption for anything above 480V POI without a storage component will be monitored at additional cost.
- D. Contractor shall load software (as applicable) on Institute provided computers and train Institute in operation and maintenance of software or cloud based systems and related monitoring functions.
- E. A weather station shall be provided at one site in the Institute's portfolio of Systems, located geographically to best provide coverage for the portfolio of sites being considered. The station shall provide at a minimum: solar irradiation (coplanar and horizontal), ambient temperature, wind speed and any other data relevant to weather correction of solar PV system performance.

## PART 3 - EXECUTION

### 3.01 REQUIRED PLACARDS

- A. All placards shall be machine generated phenolic type with red background and white

lettering, affixed to equipment with stainless steel screws or with permanent adhesive where set screws are not feasible. Minimum lettering size to be 1/4" unless otherwise noted or required for legibility.

- B. Provide a placard clearly visible at each main service panel to identify both sources of power, with the following wording in 1/4" high lettering per NEC 690.64(B)(4): "Warning - This Service Is Fed By Two Sources Of Power – The Utility Service Main Disconnect And The PV System Main Disconnect – Both Services Must Be Disconnected To Remove Power From The Switchboard".
- C. Provide a placard on each PV system input circuit breaker (where used) at the main panel with the following wording in 1/4" high lettering per NEC 690.64(B)(7): "Warning – Inverter Output Connection – Do Not Relocate This Overcurrent Device".
- D. Provide a placard on all disconnects with the following wording in 1/4" high lettering per NEC 690.17: "Warning - Electric Shock Hazard - Do Not Touch Terminals - Terminals On Both The Line and Load Sides May Be Energized In The Open Position".
- E. Provide a placard on the Main PV System Disconnect (adjacent to each main service panel) with the following information in 1/4" high lettering per NEC 690.53: "Photovoltaic Power Source Disconnect - Operating Current: X Amps; Operating voltage: XX VAC; Maximum System Voltage: XX VAC; Short-Circuit Current: XXX Amps", where X is the operating current, XX is the system voltage, and XXX is the maximum short circuit current contribution of the generating facility at the point of interconnection with the utility system.
- F. Provide a placard at each Main Switchboard with the following information in 1/4" High lettering per NEC 690.54: "Caution - Possible Backfeed From Photovoltaic Power System – X VAC, XX Amps", where X is the system voltage and XX is the maximum AC amperes of the installed system.
- G. Provide a placard on each PV System Inverter with the following information in 1/4" high lettering: "Photovoltaic Power Source Inverter Rating - Operating Current: XX Amps; Operating voltage: XXX VDC; Maximum System Voltage: 1,000 VDC; Short-Circuit Current: XXXX Amps", where XX is the maximum DC amperes of the installed system, XXX is the operating voltage DC, and XXXX is the short circuit current that the Inverter can provide (from all strings in parallel).
- H. Provide utility-required System Directory placard and utility safety switch Identification placard as required by local utility company, to identify all system components.
- I. Provide a placard for all Combiner Boxes to read: "DC Combiner Box [XXX]– [System Voltage] VDC Maximum".

### 3.02 UTILITY INTERCONNECTION

- A. The Contractor shall complete the submissions for the utility interconnection agreement with the Owner's approval. The Contractor shall submit the required authorization form with the utility to act on behalf of the Owner.
- B. The PV system at each Site shall not be interconnected with the Utility's distribution facilities until written authorization from the Utility Company has been obtained. Unauthorized interconnections may result in injury to persons and damage to equipment or property for which the installing contractor may be liable.

### 3.03 INSTALLATION STANDARDS

- A. System Installation shall conform to the equipment manufacturers Installation Manual(s) and requirements or guidelines.
- B. All Local, State, and NEC codes shall be observed, including all industry standards related to the installation, operation, and maintenance of photovoltaic power systems.

### 3.04 TESTING

- A. Photovoltaic modules shall be tested in the factory for design performance and results shall be included in the Operation and Maintenance manuals.
- B. Inverters shall be factory tested for performance and the results shall be included in the Operation and Maintenance manuals.
- C. System testing of the installed photovoltaic array shall be performed on all system strings and recorded in commissioning documentation and the Operation and Maintenance manuals.
- D. Commissioning of PV Systems at a minimum shall include:
  - 1. Conductors
    - 1.1. AC & DC conductor inspection / megger testing
    - 1.2. Wire management check
    - 1.3. DC string Voc/sc testing and recording
    - 1.4. Confirm all conduits & junction boxes are installed properly/watertight
  - 2. Inspection of DC fusing and disconnects
  - 3. Inspection of AC components: AC Disconnect, Main Switch Board, AC Combiner Panel Boards, Breakers, Fuses, Terminations, Phasing, OCPD operation, etc.
  - 4. Grounding & bonding system inspection & continuity testing
  - 5. Inverters
    - 5.1. Inverter inspections & tests per manufacturer instructions
    - 5.2. Inverter start-up & confirm proper inverter settings
    - 5.3. Inverter output tests - Confirm PV system AC output as expected based on design, insolation and inverter readings
  - 6. IV Curve Trace, Performance testing and recording
  - 7. Thermal Imaging
    - 7.1. Check all electrical components while systems are energized
    - 7.2. Spot check, Modules, Inverters, Disconnects, AC system etc.
  - 8. Torque spot check on mechanical and electrical terminations
  - 9. Inspection of corrosion control measures
  - 10. Confirm signage and placards meet plans
  - 11. Workmanship evaluation
  - 12. Inspection of DAS / CT metering and monitoring equipment
  - 13. Weather station component inspection and performance audit
  - 14. Confirm web-based monitoring interface operations
  - 15. Lighting Controls
    - 15.1. Confirm canopy lighting levels match photometric design
    - 15.2. Verify component installations
    - 15.3. Confirm lighting controls function as specified
  - 16. Commissioning of any other major electrical infrastructure installed on the project per manufacturer requirements



## ATTACHMENT A4.2: PHOTOVOLTAIC SYSTEM SPECIFICATIONS

RFP for Design Build Contract: Solar Power Generation System at  
Ocean Discovery Institute – Living Lab

---



- E. Testing to be performed per CPUC Electric Rule 21 testing procedures and requirements. All testing to be done on “no-cloud” days to avoid system fluctuation by passing clouds. Installer to provide all testing and certification / commissioning.
- F. System start-up procedure shall be as outlined by the Manufacturer’s Installation Manual and the Inverter Manual.

**END OF SECTION**