SECTION 26 3100 - PHOTOVOLTAIC SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included:
   1. PV Module and Array
   2. Communications

1.2 RELATED SECTIONS

A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition provide:
   1. Overview of major system components and principals of operation.
   2. Complete parts lists, including electrical components, mechanical hardware and other equipment required for installing the systems. (Must include description, make, model/part number and source for the equipment provided.)
   3. Diagram indicating overall layout of entire system, including PV array, and location of GII and combiner boxes with respect to the array.
   4. Electrical schematics and diagrams showing major components and devices, including conductor types and sizes, connections of individual modules and array source circuits, terminations at junction boxes, connection to surge suppression devices and the GII, and the GII interface with the utility grid.
   5. Mechanical drawings showing details of module/array mechanical support structure and instructions for assembling and installing arrays on rooftops.
   6. Complete assembly and installation instructions for mounting array, junction boxes and enclosures, routing conduit, wiring arrays, and terminating conductors at array, combiner boxes and GII.
   7. Procedures for operating, disconnecting, servicing and maintaining complete system and individual components.
   8. Warranty information on individual components as required in this bid document.
   9. Equipment manufacturer's specifications and operations manuals, including those for PV modules, GII, overcurrent devices, disconnects and optional equipment
   10. Qualifications for installer(s), including minimum 5 grid-interactive PV projects of minimum 15 kilowatts at STC within 200 miles of the project site.

1.5 QUALITY ASSURANCE

A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. IEEE Standards Coordinating Committee 21, IEEE 1547 Standard for Interconnecting Distributed Resources with Electrical Power Systems.
   2. Underwriters Laboratories, Standard for Safety: Flat-Plate Photovoltaic Modules and Panels, Standard UL 1703.
   3. Underwriters Laboratories, Standard for Safety: Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources, Standard UL 1741.
   4. System designed and installed by a qualified installer with a minimum of 5 years of experience in installation of commercial photovoltaic systems.

1.6 WARRANTY

A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Provide minimum 20 year warranty on power output of PV modules.
   2. Provide GII with minimum 10 year replacement warranty from the manufacturer covering parts and labor.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Modules
   1. Monocrystalline or Polycrystalline Modules (60-cell):
      a. SolarWorld (Basis of Design)
      b. Basis of Design: SunPower
      c. Canadian Solar
      d. Trina Solar
      e. LG
      f. Or approved equivalent.

B. Inverters
   1. Micro-Inverters
      a. Enphase Energy (Basis of Design)
      b. APsystems
      c. Or approved equivalent.

C. Combiner/Rapid Shutdown Boxes
   1. SolarBOS
   2. Yaskawa Solectria RSDCOM
   3. Basis of Design: Enphase Combiner Box

4. Or approved equivalent.

D. Power Optimizers
1. Tigo
2. Or approved equivalent.

2.2 PV MODULE AND ARRAY

A. PV Modules: Monocrystalline or Polycrystalline.

B. Non-Thin Film Modules Include: Tempered glass, EVA laminate, weatherproof film. Black, anodized aluminum frames and trim strips. Rated for 1-inch diameter hailstones at 52 mph.

C. Performance requirements:
1. Module Maximum Power (STC): 370 Wp.
2. Minimum Module Efficiency: 22%.
3. Maximum System Voltage: 600 Vdc.
4. Minimum Array Size (STC): 14.8 kW.

D. Physical/mechanical characteristics:
1. Dimensions 61.3-inches by 41.2-inches by 1.8-inches.
2. Weight: _____ pounds.
3. Operating temperature: ____ degrees F to _____ degrees F.

2.3 GRID-INTERACTIVE INVERTER (GII) AND UTILITY INTERCONNECTION

A. Design with GII built specifically for grid-interactive connection photovoltaic arrays to utility, and capable of automatic, continuous, and stable operation over the range of voltages, currents, and power levels for the size and type of arrays used.

B. Provide each GII to be compliant with IEEE 1547 (Standard for Interconnecting Distributed Resources with Electric Power Systems) and meet UL1741 (Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources) or equivalent product listing. GII to comply with the latest applicable ANSI and FCC standards and addenda dated prior to the award of the purchase order for this procurement.

C. Provide GII with communications connection for remote monitoring of inverter operation through the internet. Provide and configure software for receiving and tabulating this information through a graphic user interface accessible over the internet. Provide communications card in each GII to allow daisy-chained RS-485 connection between GII's, and interface card for internet communications. Software to provide DC voltage, current, power and energy production, AC voltage, current, power and energy production, operational status of the GII, and graphical record of past production for minimum of 365 previous days on 15 minute increments. Prior to construction, determine location and accessibility to LAN connection point.

D. Provide GII with minimum 10 year replacement warranty from the manufacturer covering parts and labor.

E. Base Bid Inverter _____:
1. GII Performance Criteria:

a. Maximum Array Input Power: ___ W.
b. Maximum Input Voltage: ____ Vdc.
c. Maximum AC Output Current: ___ A at ___ V, 3-phase.

2.4 COMMUNICATIONS

A. Provide internet portal account through inverter manufacturer to allow real time monitoring of total system and individual inverter power and energy production, with logs going back to at least 365 days.

B. Portal interface:
1. In bar graph, show power (watts) and energy (kilowatt-hours) production on hourly basis for one day, daily basis for one month, and daily basis for one year. Provide means to examine past power and energy production for at least the previous 365 days.
2. Program interface to allow end user to examine power and energy production for the total site, as well as for each individual GII.
3. Supplemental Display Information: Show PV system size in KW, maximum output production in KW, quantity and manufacturer/model of GII and quantity and manufacturer of PV modules, installation date.
4. Lifetime Energy Production: Show lifetime total equivalents (e.g. number of typical residences that could be powered for one day, number of cups of coffee that could be brewed with same energy, gallons of gasoline offset, etc.).
5. Greenhouse Gas Offsets: Show offset quantities for clean energy produced (example: weight of carbon dioxide, nitrogen oxides, sulfur oxides).
6. Environmental Information: Show current ambient temperature, cell temperature, irradiance, wind speed and direction.
7. Integration of Other Meters: Show power and energy consumption from sub-metering on main electrical service; see Drawings for locations. Provide and connect to Veris H8163 Series and matching split-core CT.

C. Basis of Design:
1. Tie inverters to internet-based data logger via RS-485 connection.
2. Tie data logger to internet portal via TCP/IP connecting via building local area network. Fronius Interface Card or approved equivalent.
3. Provide RS-485 and telecommunications cabling and connectivity under Division 27, Communications as required to fulfill Basis of Design.
4. Provide tele/data outlet in Main Electrical Room where directed by Owner to allow Owner to add flat screen monitor and/or computer for remote monitoring of PV power and energy production through kiosk, remote internet portal site.
5. Display Package: Provide internet gateway compatible with GII communications, including: Full weather station for display of environmental information specified in this Article, lobby kiosk display software and connectivity as required by Owner, system installer support portal for commissioning system, electrical demand measurement and connection from main electrical sub-meter to internet gateway. Fat Spaniel Insight Views Package, or approved equivalent.

PART 3 - EXECUTION

3.1 SYSTEM DESCRIPTION

A. These specifications cover the design and procurement of equipment, hardware and documentation required for the installation of grid-connected PV systems.

B. Provide complete system installation, in addition to documentation on the design, configuration, permit acquisition, installation, operation and maintenance of the complete system and individual components.

C. System designed for installation in Arlington, VA . Supplied equipment must be rated and warranted to withstand and operate under normal weather conditions at the site.

D. Each PV system will be connected to the utility electric grid through a grid-interactive power conditioner (inverter). The design and functional specification of the PV modules, power conditioners, utility interconnections, PV system electrical design, and PV array mechanical design are described in the following articles.

E. Utility Coordination: Coordinate with local Utility Company prior to start of work for location of their net metering equipment, including CT enclosure provided under this Contract per the Drawings, and any additional utility required disconnects which will also be provided under this Contract.

F. Basis of Design: Provide PV system designed to meet or exceed the performance requirements of the equipment, listed in this specification, while staying under the physical size and weight requirements listed. Costs to allow approved alternative manufacturers and models to meet the performance requirements as specified are part of the scope of this Contract.

3.2 PV SYSTEM ELECTRICAL DESIGN

A. Provide electrical design and installation instructions for the PV systems conforming to the NEC. Article 690 of the NEC applies specifically to photovoltaic system safety, protection, control and interface with other sources. Other articles of NEC also apply. Comply with IEEE 1547, Standard for Interconnecting Distributed Resources with Electric Power Systems.

B. Electrical components, including overcurrent protection, disconnects, surge suppression devices, conduit, wiring and terminals must have UL or equivalent listing and have appropriate voltage, current and temperature ratings for the application. Special attention should be given to appropriate ratings for components used in DC circuits.

C. Wiring must be listed for 600VDC and 600VAC, and a temperature rating of 90C in wet locations. The use of exposed conductors or cabling (excluding grounds) is not acceptable, except MC cable connectors installed under PV modules. Exposed conduit to be painted to match surrounding area. Confirm color with Architect.

D. Ampacity calculations must take into account appropriate deratings as required. Conductors in the system are subject to a 125 percent NEC derate, and DC source circuit conductors and overcurrent devices must include an additional 125 percent derate for solar radiation enhancements. Appropriate temperature deratings for conductors used in module junction boxes

must be considered for peak module operating temperatures, as well as deratings for instances where more than three current-carrying conductors are enclosed in a conduit.

E. Voltage drop in array DC source circuits should be limited to no more than 2 percent, including losses in conductors, and through all fuses, blocking diodes and termination points.

F. Overcurrent devices must have trip ratings no greater than the derated ampacity of the conductors that it protects.

G. Series connected strings of modules (source circuits) must include a series fuse as required by UL and NEC to prevent excessive reverse current flow through modules in source circuits. Parallel connections of modules in individual source circuits are not permitted. Parallel-connected cells within individual modules are allowable as long as the module listing allows for the series fuse required for this configuration.

H. Series connected strings of modules (source circuits) must also include a blocking diode to minimize overall array losses due to partial shading of source circuits. These diodes should have low voltage drop to meet the requirements above, and have a voltage and current ratings (at temperature) at least twice the open circuit voltage and short-circuit ratings of the source circuits.

I. Terminations must use listed box terminal or compression type connections. Twist on wire splices, crimped, soldered or taped connections are not permitted for the required field installed wiring. Proper torque specifications should be provided for the required field connections.

J. Module frames, metal enclosures, panel boards and the grid-interactive inverter (GII) should be provided with connections for bonding to a common grounding conductor and terminating at the ground electrode system at the utility service entrance point. In addition, provide for grounding the neutral of the GII output. The DC negative circuit may be common to the AC neutral in the GII design and under no circumstances should multiple connections to ground be specified for current carrying conductors in the system.

K. Provide a weathertight, vented, locking, pad mountable enclosure, suitable for housing the GII, AC/DC disconnect devices, and source circuit combiner boxes (as required). Enclosure rating: NEMA 4, 3R or better and have superior strength and corrosion resistance properties based on the project location.

3.3 PV ARRAY MECHANICAL DESIGN

A. Provide hardware as required for assembling the photovoltaic modules and panels, and structurally attaching them to the base support structure.

B. Coordinate PV array and equipment mounting with PV system mounting structures shown on Structural Drawings. Where array and supporting equipment deviate from Basis of Design, include cost of engineering services to update Structural Drawings and Structural Installation for submitted design. Array design that requires modification of building structure in addition to structure supporting PV array and equipment is not acceptable under this Contract.

C. Provide panel layout design with firefighter access and egress paths per local Codes.

D. Include a 36-inch wide pathway maintained along three sides of the solar roof. Exceptions to comply with Oregon Solar Installation Specialty Code. For arrays larger than 150-feet, measured in length or width, to have a 36-inch intermediate pathway for service, maintenance and egress. Disconnects, junction boxes, combiner boxes or gutters not to be located in any required pathway or cutout.

E. Array mounting hardware supplied by the bidder to be compatible with the site considerations and environment. Minimize risk from exposed fasteners, sharp edges, and potential damage to the modules or support structure. Emphasize corrosion resistance and durability of the mechanical hardware. Avoid use of ferrous metals, contact of dissimilar metals or wood or plastic components.

F. As these are high profile, publicly visible installations, the aesthetics of the overall installation is extremely important to the Owner. To create a uniform appearance of the array, spacing between individual modules and panels should be kept to a minimum. As much as possible, conceal mechanical hardware, conduit, junction boxes and other equipment beneath and/or behind the array.

G. Be consistent with the ordering and labeling of source circuits in the array combiner boxes. Ease of access for array troubleshooting and maintenance is desired by allowing access to the back of the array for module junction box servicing, and removal/replacement of individual source circuits and modules if necessary.

3.4 INSTALLATION

A. Grid-Interactive Inverter:
   1. Provide fusing for incoming strings.
   2. Clean interiors and ensure airways for convective cooling are clear and debris-free.
   3. Verify that inverter display measures for AC voltage match measurement from a true-RMS AC digital voltmeter.
   4. Check that maximum power point tracking circuit is operational. Monitor array voltage from open circuit condition until it reaches a point where system power peaks and then starts to drop again. Provide chart of field measurements input and output voltage and current through the day as part of O&M manual.
   5. Provide factory required clearances and air space for cooling and ventilation.

B. Photovoltaic System Wiring:
   1. Field connections: Use crimp-on connectors that maintain connection even when screw loosens.
   2. Size wiring from inverter to PV modules based on less than 2 percent voltage drop in any string.
   3. Conceal flexible conduit and MC cable to underneath the PV modules. Outside of the PV modules, use rooftop conduit per Division 26, Electrical.
   4. PV module wiring to be secured to run parallel and perpendicular to module frame lines, as well as be secured to module and module support structure. Do not allow PV module wiring to rest unsupported against the roof surface.
   5. Provide strain reliefs and cable clamps on cable and cords for PV modules.
   6. Retorque terminations prior to completion of construction.

C. Grounding:
   1. Verify that one connection to DC circuits and one connection to AC circuits is being used for system grounding referenced to the same point. Bond to buildings main grounding system.
   2. Provide bonding for non-current carrying metal parts to ensure they are grounded properly.
   3. Grounding electrode to be installed in accordance with NEC Article 250.122 (AC) but not smaller than #6 AWG copper or #4 AWG Aluminum.
   4. Provide grounding electrodes at the location of ground and pole mounted arrays as close as possible. Bond to buildings main grounding system.

D. Signage:
   1. Post an "Interactive Point of Connection" sign per NEC Article 690.
   2. Place a sign at building service entrance indicating type and location of on-site interactive electric power production sources and disconnects per NEC Article 705.
   3. At each inverter, post a sign indicating:
      a. Label for Inverter.
      b. Operating current and voltage.
      c. Maximum system voltage.
      d. Short circuit current.

E. Install PV panels, inverter, wiring, protection device as per written installation instructions from the manufacturer.

F. Coordinate mounting of panels with structural engineer and roof system installer prior to submitting design documents.

3.5 TESTING

A. Test each PV panel per manufacturer's written instructions prior to connection to inverter. String level testing is allowed. Document test results and submit in O&M manuals.

B. Test inverters per manufacturer's written instructions. Document test results and submit results with O&M manuals.

3.6 DISPLAY COMMISSIONING AND TRAINING

A. Coordinate with Owner for TCP/IP address for PV communications gateway prior to start of programming.

B. Provide manufacturer supported programming and commissioning services as required for functionality of system as described above. Provide Owner minimum two 2-hour training sessions on separate days with factory support, for use of both internet portal and review installation of communications system. Provide audio/video record of both sessions. Hold either session no less than 30 days from date of substantial completion of the project.

END OF SECTION