SECTION 16900 – PHOTOVOLTAIC POWER SYSTEM
(REVISED W/ Addendum #1 DATED 03/21/2013)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1. Section 06100 "Rough Carpentry “for wood nailers, curbs, and blocking.

1.2 SUMMARY AND GENERAL REQUIREMENTS

A. Section Includes:

1. PV modules (laminates in mounting frames).
2. Inverters.
3. Mounting structures.
4. Electrical requirements.
5. Mechanical requirements.
6. Engineering, drawings, installation and testing.

B. Provide an alternate price to mount the PV panels in a parking lot mounting location on a shade structure.

B. These specifications cover the procurement of design, equipment, hardware, documentation, labor and supervision required for the installation of a maximum of *four (4)* nominal *10 kWp* grid-connected PV systems, for a total nominal rated **40** KW, minimum, for an annual energy production of approximately 50,000 KWh per year. There will be *no* energy storage devices (e.g. batteries) used in these systems. System shall have an output to the grid at 208 volt, 3phase.

C. All systems should be designed for outdoor installation in the Collier County area. Florida is subject to long-term high humidity and temperature conditions. Annual ambient temperatures can range from *30° F to 100° F*. Supplied equipment must be rated and warranted to withstand and operate under these conditions.

D. Contractors should be aware of all the documentation and procedural requirements required by the local authority having jurisdiction, the local utility company, the Owner, and the architect, prior to submitting bid.

E. The Contractor shall have a Florida Solar Contractor's License and will have taken the course, "Installing Grid-Connected Photovoltaic Systems," conducted by the Florida Solar Energy Center, or similar training.

F. The Contractor shall be listed as certified by the Florida Solar Energy Center. (http://www.fsec.ucf.edu/en/certification-testing/PVsystems/certified_systems/index.php)

1.3 CODES AND STANDARDS

A. Florida Building Code, 2010

B. National Electrical Code, 2008

1.4 DEFINITIONS

A. CEC: California Energy Commission.

B. ETFE: Ethylene tetrafluoroethylene.

C. FEP: Fluorinated ethylene propylene.

D. IP Code: Required ingress protection to comply with IEC 60529.

E. MPPT: Maximum power point tracking.

F. PTC: USA standard conditions for PV.

G. PV: Photovoltaic.

H. STC: Standard Test Conditions defined in IEC 61215.

1.5 BID SUBMITTAL REQUIREMENTS

A. Bid submittals must include (at a minimum) the following information for the bid to be considered responsive:

1. The bid shall include a total turnkey design-build price, including costs for all required professional engineering (drawings signed and sealed by a Florida registered professional engineer for structural, electrical, architectural).
2. The bid shall include the required lead-time in delivery of equipment.
3. A letter stating that the bid is in compliance with these specifications and that a complete shop drawing submittal, in compliance with paragraph 1.5 below, will be provided within 21 days of award.
4. Proof of Florida Solar Contractor's License and Florida Solar Energy Center certification.
5. Overview of major system components and principles of operation.
6. Complete list of all equipment, components, electrical components, mechanical hardware and other equipment required for installing the systems (must include description and make for all the equipment provided, model/part number and source are also required for the PV modules and the inverter).
7. Diagram indicating proposed layout of entire system, including PV array, and location of equipment hardware and control equipment with respect to the array.
8. Show coordination compliance with the building construction documents, including equipment location, roof area required and location for array mounting, and system circuit breaker size in building panelboard.

9. Summary performance data calculation of the total AC energy production (KWh) per month for the system, plus the annual AC energy production for the system.

1.6 SHOP DRAWINGS AND SUBMITTALS

A. Product Data: For each type of product.

1. Overview of major system components and principles of operation.
2. Complete list of all equipment, components, electrical components, mechanical hardware and other equipment required for installing the systems (must include description and make for all the equipment provided, model/part number and source are also required for the PV modules and the inverter).
3. Catalog cut sheets of all equipment, components, electrical components, mechanical hardware and other equipment required.
4. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for PV panels.
5. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
6. Summary performance data calculation of the total AC energy production (KWh) per month for the system, plus the annual AC energy production for this specific system in this specific location and building orientation.

B. Shop Drawings: For all PV system equipment and modules.

1. Include plans, elevations, sections, and mounting details.
2. Diagram indicating proposed layout of entire system, including PV array, and location of equipment hardware and control equipment with respect to the array.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
4. Details of fabrication and assembly.
5. Include drawings for power, signal, and control wiring, including power riser diagram.
6. Electrical schematics and diagrams showing all 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 control panel, and the control panel interface with the utility grid.
7. Mechanical drawings showing details of module/array mechanical support.
8. Warranty information on individual components as required in this bid document.
9. Proof of solar or electrical contractors license, with license number, type of license and expiration date.

10. Complete assembly and installation instructions for mounting array, junction boxes and enclosures, routing conduit, wiring arrays, and terminating conductors at array, combiner boxes and system control panel.
11. Procedure for commissioning, operating, disconnecting, servicing and maintaining complete system and individual components.

C. Provide complete system building permit and construction drawings, including electrical drawings as required for permit and construction. All drawings shall be submitted in an electronic format, both PDF and AutoCAD (DWG), and shall be made available to the Owner, Architect/Engineer, Contractor and related sub-contractors. Drawings shall be coordinated with the building construction documents. Provide all required hard copies, signed and sealed by the required Florida registered professionals (electrical, architectural, structural) as necessary for permit and construction.

D. A copy of the interconnection agreement between the owner and the utility must be provided.

E. Warranty: Copy of manufacturer's special materials and workmanship warranty and minimum power output warranty. Copy of supplier/contractor/installer warranty. Include warranty for inverters, disconnects, cabling, and all other system equipment and hardware.

1.7 ACCEPTANCE AND CLOSEOUT SUBMITTALS (PRIOR TO FINAL ACCEPTANCE)

A. Operation and Maintenance Data: For complete system equipment and devices, including PV modules shall be included in operation and maintenance manuals. Provide two complete copies of all installation, operations and maintenance manuals

B. Field quality-control reports.

C. As-built drawings indicating overall layout of entire system, including PV array, and location of equipment hardware, controls, etc.

D. A copy of the interconnection agreement between the owner and the utility must be provided.

E. An acceptance test must be performed on the system once the installation is complete and a report provided at substantial completion. This includes measuring the short circuit currents and open-circuit voltages on all source circuits while measuring irradiance and module temperature. This also includes measuring the instantaneous DC input and AC output of the system to determine its efficiency. The acceptance test form submittal shall be as provided for on the Florida Solar Energy Center web site for PV system Acceptance Testing, or a similar test report.

F. A copy of the permit obtained from the appropriate authority having jurisdiction for system installation.

G. A copy of the system warranties including parts and labor.

1.8 WARRANTY

A. Manufacturer's Special Materials and Workmanship Warranty: Manufacturer agrees to repair or replace components of PV modules and all other system components and hardware that fail in materials or workmanship within specified warranty period.

1. Manufacturer's materials and workmanship warranties include, but are not limited to, the following:

    a. Faulty operation of PV modules.
    b. Degradation of performance.
    c. Mechanical failure of components or mounting hardware.
    d. Electrical failures or faulty performance.

2. Warranty Period: Each PV module shall be warranted by the manufacturer for at least *90%* of its rated power for *10* years and *80%* of its rated power for *20* years from date of Substantial Completion.

3. Include 10 year warranty for inverters, disconnects, cabling, and all other system equipment and hardware.

B. Installer's warranty: Installer agrees to repair or replace components of the system, including PV modules and inverters, which fail due to the installer's workmanship within a period 1 year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS – PV MODULES

A. Basis-of-Design Product: Subject to compliance with requirements, provide MX Solar USA Suncase MX60 or comparable product by one of the following:

1. Aleo Solar.
2. BP Solar USA.
3. Evergreen Solar, Inc.
4. GE Energy; General Electric Company.
5. Mitsubishi Electric Corporation.
6. REC Solar US LLC.
7. Sanyo North America Corporation.
8. Sharp Electronics Corporation.
9. SunPower Corporation.
10. Suntech Power.
11. Trina Solar Limited.
12. United Solar Ovonic LLC.
13. Other Manufacturers tested and certified by the Florida Solar Energy Center.

2.2 PERFORMANCE OTHER GENERAL REQUIREMENTS

A. NRTL (Nationally Recognized Testing Laboratory) Listing: Entire assembly shall be listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for electrical and fire safety, Class C, according to UL 1703.

B. FM approved for NFPA 70, Class 1, Division 2, Group C and Group D hazardous locations.

C. The PV modules should be framed flat-plate crystalline silicon modules. Thin- film modules will not be considered for this project

D. The PV modules shall meet or exceed the requirements of Underwriter Laboratories (UL) Standard 1703 Standard for Safety for Flat-Plate Photovoltaic Modules and either IEEE Standard 1262-1995 IEEE Recommended Practice for Qualification of Photovoltaic (PV) Modules and Panels or IEC 1215 Crystalline Silicon Terrestrial Photovoltaic (PV) Modules- Design Qualification and Type Approval.

E. Each PV module shall include bypass diodes installed in the module junction box.

F. The system must use a single inverter(s), designed specifically for utility grid interconnection of photovoltaic arrays and be capable of automatic, continuous, and stable operation over the range of voltages, currents, and power levels for the size and type of array used.

G. Shall be compliant with IEEE Std. 929-2000 (Recommended Practice for Utility Interface of Photovoltaic Systems) and have UL1741 (Standard for Static Inverters and Charge Controllers for Use in Photovoltaic Power Systems). Shall also comply with IEEE Std. 519 (Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems) and the latest applicable ANSI and FCC standards and addenda dated prior to the award of the purchase order for this procurement.

H. Shall have an automatic visual indicator showing whether the system is on-line or not.

I. The controls, inverter, AC and DC disconnects, and any other required electronics shall be installed near the array, where they are be exposed to weather and possible vandalism. The contractor will provide a suitable *pad-mountable*, lockable enclosure for housing these components. This enclosure shall provide any venting and weather sealing required by the electronics enclosed. All electrical enclosures shall be rated as NEMA 3R or better and have superior strength and corrosion resistance properties.

J. PV system shall be installed at site. Provide for roof mounting the array in a manner that is acceptable with the Owner, Architect and Structural Engineer. The array shall be mounted on the structure at the optimal fixed tilt plane, be mounted parallel and perpendicular to roof, and shall be oriented either to the South or the West or both, as local conditions dictate.

2.3 SYSTEM DESCRIPTION

A. Grid-Tied PV System:

1. Connected via a utility meter to the electrical utility.
2. An array to generate a total nominal rated **40** KW, minimum. The PV array should be sized to achieve a nominal *40 kWp* DC STC output for the entire system under peak sun conditions and 50,000 KWh per year.
3. System Components, but not limited to:

    a. Cell materials.
    b. PV modules.
    c. Array frame.
    d. Inverter.
    e. Overcurrent protection/combiner box.
    f. Mounting structure.
    g. Utility meter disconnect.
    h. Other components as required.

2.4 MANUFACTURED UNITS

A. Cell Materials: Polycrystalline

1. c-Si.
2. Gallium arsenide (GaAs).

B. Module Construction:

1. Nominal Size: 38 inches wide by 64 inches long.
2. Weight: 48.8 lb

C. Insulating Substrate Film: Flexible or Rigid. Polyester or polyimide.

D. Conducting Substrate Film: Flexible or Rigid. Fluoropolymer, ETFE, orFEP.

E. Encapsulant: Ethyl vinyl acetate.

F. Front Panel: 0.125-inch-thick glass.

G. Backing Material: 0.125 inch - thick glass;

H. Bypass Diode Protection: Internal.

I. Junction Box:

1. Size: As required.
2. Fully potted, vandal resistant.
3. Flammability Test: UL 1703.

J. Output Cabling:

1. 0.158 inch diameter minimum.
2. Quick, multiconnect, polarized connectors.
3. Two-Conductor Harness: No traditional return wire is needed from the end of a row back to the source combiner.

K. Series Fuse Rating: As required.

2.5 CAPACITIES AND CHARACTERISTICS

A. Minimum Electrical Characteristics:

1. Rated Open Circuit Voltage (V_{oc}): 37 V dc
2. Maximum System Voltage: 600 V dc
3. Maximum Power at Voltage (V_{pm}): 29.8 V dc
4. Short-Circuit Temperature Coefficient: 2.39 mA/deg C
5. Rated Short-Circuit Current (I_{sc}): 8.45 A.
6. Rated Operation Current (I_{mp}): 7.68 amps.
7. Maximum Power at STC (P_{max}): 235 Wp.
8. Tolerance of Pmax: +/- 2 percent.
9. Series Fuse Rating: 15 A

10. Module Efficiency: 13.7 percent.
11. Wind Loading or Surface Pressure: 50 lbf/sq. ft.

B. Normal Operating Temperature Characteristics (NOTC):

1. Temperature at Nominal Operating Cell Temperature: 42 **C**
2. Temperature Coefficient (NOTC P_{max}): -1.1 watts per deg C
3. Temperature Coefficient (NOTC V_{oc}): -0.138 V/deg C
4. Temperature Coefficient (NOTC l_{sc}): 2.39 ma/deg C

2.6 MODULE FRAMING

A. PV laminates mounted in anodized extruded-aluminum frames.

1. Entire assembly UL listed for electrical and fire safety, Class C, according to UL 1703, complying with IEC 61215.
2. Frame strength exceeding requirements of certifying agencies in subparagraph above.
3. Finish: Anodized aluminum.

a. Alloy and temper recommended by framing manufacturer for strength, corrosion resistance, and application of required finish.

2.7 ARRAY CONSTRUCTION

A. Framing:

1. Material: Extruded aluminum.
2. Maximum System Weight: Less than 4 lb/sq. ft.
3. Raceway Cover Plates: Galvanized steel.

B. Flat-Roof Mounting:

1. No roof penetrations.
2. Self-ballasting.
3. Rated for wind load for the specific location, as required by the Florida Building Code.
4. Service Life: 20 years.

2.8 INVERTER

A. Basis of Design: SMA Sunny Boy 10000TL-US

B. Control Type: Maximum power point tracker control.

C. Inverter Electrical Characteristics:

1. Maximum Recommended PV Input Power: 12500 W.
2. Maximum Voc: 600 V DC
3. PV Start Voltage: 360 V DC
4. MPPT Voltage Range: 345 V DC
5. Maximum Input Current: 35 A.

6. Number of String Inputs at Combiner: 6
7. Number of Independent MPPT Input Circuits: 1
8. CEC Rated Power: 10,000 W
9. Nominal Output Voltage: 208 V AC
10. Maximum Output Current: 48.1 A
11. Peak Efficiency: 98.6 percent.
12. CEC Weighted Efficiency: 97.5 percent.

D. Operating Conditions:

1. Operating Ambient Temperatures: Minus 40 to plus 140 deg F
2. Relative Humidity: 0 to 100 percent, noncondensing.

E. Enclosure:

1. NEMA 250, Type 3R.
2. Enclosure Material: Galvanized steel
3. Cooling Methods:

a. Passive cooling.

4. Protective Functions:

a. AC over/under voltage.
b. AC over/under frequency.
c. Ground over current.
d. Overtemperature.
e. AC and dc overcurrent.
f. DC over voltage.

5. Standard liquid crystal display, four lines, 20 characters, with user display and on/off toggle switch.

F. Disconnects:

1. Low-voltage disconnect.
2. Low-voltage reconnect.
3. High-temperature disconnect.
4. High-temperature reconnect.

G. Regulatory Approvals:

1. IEEE 1547.1.
2. IEEE 1547.3.
3. UL 1741.

H. Characteristics:

1. Inverter Dimensions: Arrange enclosure to fit in the area allocated for the system equipment, per building construction documents.

2.9 SYSTEM OVERCURRENT PROTECTION

A. Combiner Box:

1. Fuses: Sized (amperage) as required for the system protection per NEC.
2. Circuit Breakers: Sized (amperage) as required for the system protection per NEC.

2.10 MOUNTING STRUCTURES

A. Roof Mount: Extruded aluminum, including all required rails, tilt legs, and roof standoffs.

2.11 COMMUNICATIONS INTERFACE

A. Provide for seamless communications with the PV system to the building energy management system (Niagra) to allow for system monitoring by the Owner. Provide for ModBus or BacNet compatibility and provide communications ports as required for the necessary connections and interface. Provide any software and licensing agreements to allow for owner's connections and communications.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrate areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Do not begin installation until mounting surfaces have been properly prepared.

C. If preparation of mounting surfaces is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

D. Examine modules and array frame before installation. Reject modules and arrays that are wet, moisture damaged, or mold damaged.

E. Examine roofs, supports, and supporting structures for suitable conditions where PV system will be installed.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections with the assistance of a factory-authorized service representative.

C. PV module will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports by manufacturer's field service rep and submit at substantial completion, and include in final closeout documents.

3.3 PV SYSTEM ELECTRICAL REQUIREMENTS

A. The electrical design and installation instructions for the PV systems shall conform to the 2008 National Electric Code (NFPA 70). Article 690 of the NEC shall apply specifically to the photovoltaic system safety, protection, control and interface with other sources. Other articles of the NEC also apply. The PV system electrical design shall also comply with the IEEE Std. 1374-Current Edition (Guide for Terrestrial Photovoltaic Power System Safety).

B. All electrical components, including overcurrent protection, disconnect, 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. All wiring shall be listed for a minimum operation of 600 volts and temperature rating of 90° C in wet locations, but sized using the 75° C current rating. All current carrying conductors shall be enclosed in conduit, including module interconnections.

D. Ampacity calculations must take into account appropriate de-ratings as required. All conductors in the system are subject to a 125% NEC de-rate, and all DC source circuit conductors and overcurrent devices must include an additional 125% de-rate for solar radiation enhancement. Appropriate temperature de-ratings for conductors used in module junction boxes must be considered for peak module operating temperatures, as well as de-ratings 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 five percent (5%), including losses in conductors and through all fuses blocking diodes and termination points.

F. All overcurrent devices shall have trip ratings no greater than the de-rated ampacity of the conductors that it protects.

G. All series connected strings of modules (also known as panels, or source circuits) must include a series fuse as required by UL and NEC to prevent to wiring or other system components. 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. All series connected strings of modules (source circuits) shall also include a blocking diode to prevent reverse currents. 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. Array ground-fault protection devices should be included as required by the NEC. These devices must be capable of detecting array ground faults, shunting the fault current to ground, and disabling the array until the fault has been cleared.

J. All 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 all of the required field connections.

K. All module frames, panel/array support structures, metal enclosures, panel boards and the system cabinet should be provided with connections for bonding to a common grounding conduc-

tor and terminating at the ground rod at the utility service entrance point. In addition, provisions for grounding the neutral of the system output shall be provided. The DC negative circuit may be common to the AC neutral in the system design and under no circumstances should multiple connections to ground be provided for current carrying conductors in the system.

L. Contact local utility and identify and provide all work required by the utility for connection to the system.

M. Loss of Line: The system shall not operate without the line voltage present. The system shall sense a "loss of line" (utility) condition and shall automatically disconnect from the line. In the event of multiple PCSs and/or balanced load on a common line, the system shall contain circuits (such as Sandia Voltage Shift and Sandia Frequency Shift) that will cause the system voltage or frequency to drift downwards under loss of line conditions and cause it to cease energizing the grid within two seconds after loss of line. The system restart shall occur automatically after restoration of line voltage and frequency for at least five minutes.

3.4 PV SYSTEM MECHANICAL REQUIREMENTS

A. Provide the all mounting hardware for mounting the photovoltaic arrays. Provide all other hardware required for assembling the photovoltaic modules and panels and structurally attaching them to the base support structure/roof.

B. The PV array, including modules, hardware and attachments shall be designed to withstand wind loads as indicated on the building construction drawings and as required by the Florida Building Code, and shall comply with all local and state codes.

C. Array mounting hardware supplied by the bidder should be compatible with the site considerations and environment.

D. Special attention should be paid to minimizing the risk from exposed fasteners, sharp edges, and potential damage to the modules or support structure. Stainless steel fasteners and an aluminum support structure, or similar non-corrosive materials shall be provided. The use of ferrous metals, wood or plastic components will not be accepted.

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

F. The array layout should be consistent with the ordering (and labeling) of source circuits in the array combiner boxes.

G. Ease of access for array troubleshooting and maintenance shall be provided by allowing access to the back of the array for module junction box servicing, and removal/replacement of individual source circuits (panels) and modules.

H. The array shall be mounted on stand-offs three (3) to five (5) inches off the roof, to allow array ventilation. This prevents excessive temperatures that decrease output and increase module degradation.

I. Provide alternate price for mounting the array on a shade structure for cars in the parking lot.

END OF SECTION 16900