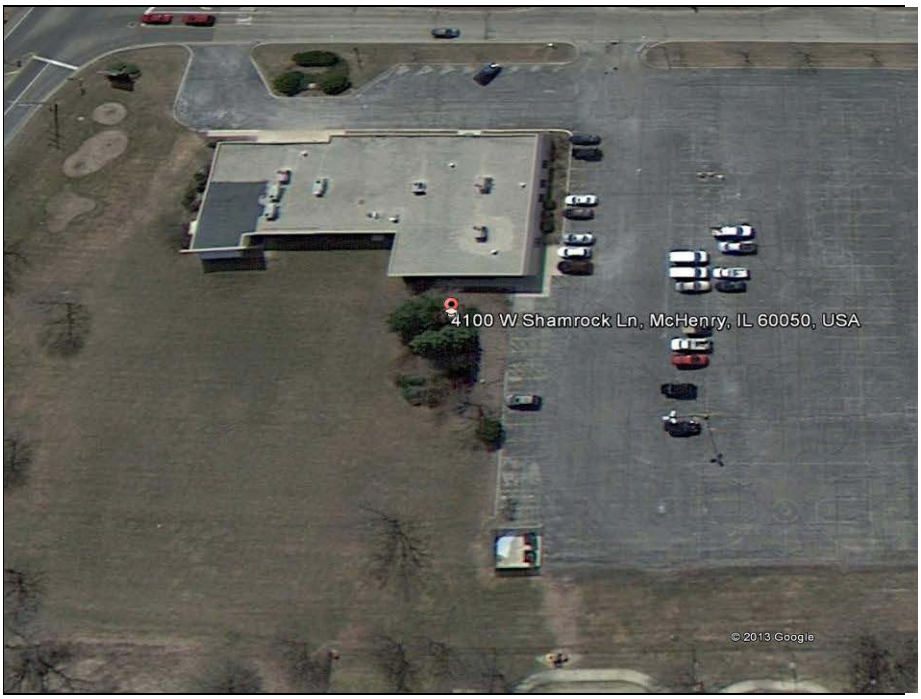
Invitation to Bid & Project Manual
Construction Services for
Solar Photovoltaic (PV) System
Shah Center, McHenry, IL



McHenry County College

8900 U.S. Highway 14
Crystal Lake, IL 60012-2761
815-455-8770

Owners Agent:
J. T. Katrakis & Associates, Inc.
Barrington, IL Chicago, IL

May 22, 2014

McHenry County College Shah Center
Solar Photovoltaic System
Design-Build Project

INVITATION TO BID
May 22, 2014

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PROJECT OVERVIEW

Statement of Purpose: McHenry College is inviting bids in order to select a vendor to design and build a 91.26 kW Solar Photovoltaic (PV) system at McHenry College's Shah Center at 4100 Shamrock, McHenry, IL. This PV system is estimated to generate 110,000 kWh, or about 50% of the annual energy used by the Shah facility. It will also provide the McHenry County citizens with an annual CO2 reduction estimated at 80 tons.

Background: McHenry County College (MCC) is fully committed to integrating sustainable principles into college operations. Currently, a third of MCC's carbon emissions are from purchased electricity. Obtaining energy from a renewable source is a primary goal. In 2011 the College conducted and energy audit to identify priority activities for energy consumption. As a result, MCC began to evaluate the feasibility of renewable energies such as wind, solar or geothermal. It was decided that a project be conducted using photovoltaic solar panels at the College's Shah Center located in McHenry, IL, approximately 9 miles from the main MCC campus.

The proposed renewable energy project will build organizational capacity to support the College's effort to be a model of sustainability and environmental stewardship, as identified in MCC's Principles and Strategic Priorities, and will align with the College's mission of sharing knowledge and resources to support the College community's educational, social, cultural and economic vitality.

There are multiple issues that influence the College's approach to sustainability. As an educational institution, MCC needs to educate the public and provide training to individuals so they will be successful in achieving their academic and career goals. As a community member , MCC wants to position itself to be a model of sustainability in the McHenry County area for residents, businesses, and other government entities.

Local, Regional, and State-Wide Impacts: The Shah Center will be a photovoltaic demonstration project that will reveal to our community that solar power generation is a viable energy option in northern Illinois. It will demonstrate to our taxpayers and students that the College is implementing significant infrastructural changes that will allow it to achieve the goals outlined in our Sustainability Strategic Plan.

Through the job training courses currently offered at Shah, and the large number of guests that visit the building, the solar project will receive high visibility in the county and region.

Bidding & Contracting Conditions: This Invitation to Bid (ITB) does not obligate McHenry County College (MCC) or its Board of Trustees to award a contract or complete the proposed project, and each reserves the right to cancel this ITB if it is considered to be in its best interest. Proposals must be clear and concise. Bids that are difficult to follow or that do not conform to the ITB format or binding specifications, may be rejected. Responding vendors must include the required information called for in this ITB. MCC reserves the right to reject a proposal if required information is not provided or is not organized as directed. MCC also reserves the right to change the evaluation criteria or any other provision in this ITB by posting notice of the change(s) on MCC's Bid website, www.mchenry.edu/bid. For this ITB, posting on the captioned website above constitutes written notification to each vendor. Vendors should check the site daily and are expected to review information on the site carefully before submitting a final bid.

INSTRUCTIONS FOR BIDDERS

The scope of work for the ITB requires the respondent to provide information for the construction, and installation of a Solar PV System.

Qualifications: The Bidders must meet the following requirements and provide the following documentation:

1. Bidder has been in business and offering the proposed equipment/solution for three years or more and is a state-of-Illinois certified installer of distributed generation systems according to Title 83 Public Utilities; Part 468 Distributed Generation Certification Requirements.

2. Provide proof that at least one project team member is a NABCEP Certified PV Installation Professional.

3. Provide an abstract on the company, its history and organization and description of any subcontractor relationships for this project. Specify how long the company submitting the proposal has been in the business of providing supplies and services similar to those requested in this ITB and under what company name. Provide a complete description of any relevant past projects, similar in size and scope to this ITB.

4. At least four (4) references that are using or have used supplies and services of the type proposed in this RFP. The references may include state or municipal governments, universities, colleges, or businesses, for which the respondent, preferably within the last three years, has successfully provided the same service solution. The College will contact the client references for validation of the information provided in the Client Reference Form. If the College finds erroneous information, the proposal may be rejected.

5. Proof that Bidder has designed, permitted, installed (currently providing the full/rated solar generation capability) a minimum of three (3) solar PV Projects in the United States that have a minimum of 40 kilowatts (kW) or more within the last five (5) years. One of the above or an additional project must be a minimum of 80 kW or larger in order to demonstrate capability with larger systems. These should be the same four references as requested above in number 3. Provide names, addresses and contact information for each of these projects.

6. Proof that Bidder has staff that are NA

Approach:

1. Respond to the design described in this ITB;
2. Any missing components necessary to complete the project;
3. Any potential problems/risks that need to be addressed;
4. Management plan including identifying the primary contact and their contact information, team members, sub-contractors. Provide resumes with pertinent experiences for the primary members of the team.

Cost Proposal: Provide your stipulated price for the complete construction of the project per the design documents and specifications. The Owner is a tax-exempt organization. Use the bid

summary sheets on pages 5-7 to record all itemized, add alternate and unit pricing, answers and other pertinent information.

Submittal Deadline: Bids are due no later than 10:00 AM on Monday June 9, 2014 in pdf format using electronic media (DVD or flash drive) and hard copy to Owner:

Owner :	Owner's Agent and Engineer:
Jennifer Jones	John Katrakis
jjones@mchenry.edu	john@jtkatrakisassociates.com
McHenry County College	J. T. Katrakis & Associates, Inc.
8900 U.S. Highway 14	418 North Avenue
Crystal Lake, IL 60012-2761	Barrington, IL 60010
815-455-8770	o: 847-382-1877 cell:847-212-5348

Any questions about the Bid Documents are to be submitted in writing to the Owner's Agent, John Katrakis, of J. T. Katrakis & Associates, Inc. Responses will be posted via addendum at www.mchenry.edu/bid.

PROJECT SCHEDULE

In the attached BID SUMMARY SHEETS (pages 5 to 7) please confirm the feasibility and your ability to perform according to the following project schedule:

	Milestones	Completion Date
1.	Bid Invitation Date	05/22/2014
2.	Pre-bid Meeting at Shah Center (10:00 AM)	05/27/2014
3.	Deadline for Submitting Questions	05/29/2014
4.	Responses to Questions posted to www.mchenry.edu/bid	06/02/2014
5.	Bid Due Date/Time	06/09/2014
6.	Bid Opening (10:00AM Bldg A Board Room 217)	06/09/2014
7.	Review by MCC Evaluation Team	06/10/2014
8.	Contract awarded/Notice-to-Proceed to Contractor	06/11/2014
9.	Permits Obtained	06/16/2014
10.	All Submittals and Shop drawings delivered to Owner & Engineer	07/07/2014
11.	Construction Completed	08/15/2014
12.	Commissioning & Training Completed	08/15/2014
13.	Public Education Displays Completed	08/15/2014

McHenry County College Shah Center
Solar Photovoltaic System
BID SUBMISSION FORM (1 of 3)

Bid Submitted By:

Company Name: Date:

Address:

Signature: Title:

Print Name: Phone:

E-mail: Fax:

Items	Materials & Equipment	Labor & Overhead	Total
1. Solar PV Modules			
2. Module Racks			
3. Site Preparation & Foundations			
4. Security (Fencing)			
5. Landscaping			
6. Balance of System			
6.1 DC Power Distribution including Combiners			
6.2 Inverters			
6.3 Transformer			
6.4 AC Power Distribution			
6.5 Grounding, Lightning Protection			
7 Interconnection & Metering			
8 Commissioning & Training			
9 Education Components			
10 Design/Engineering of PV System			
12. Fees (Permit, Net Metering Interconnect, etc.)			
13. Extended Product Warranties			
STIPULATED TOTAL BASE BID			
Performance Bond ($)			
TOTAL OF BASE BID + Performance Bond			

BID SUBMISSION FORM-Continued (2 of 3)

Items	Materials & Equipment	Labor & Overhead	Total
ALTERNATES (Indicate whether each Alternate is additive or subtractive)			
ALTERNATE#1 Optimize & Monitor Modules in Row #1			
ALTERNATE#2 Optimize & Monitor Modules in Rows #2 to 4			
ALTERNATE#3 Various PV Modules			
ALTERNATE#4 Building Energy Meter			
ALTERNATE#5 Five Year Contractor Warranty			
ALTERNATE#6 Site Evaluation, Commissioning Tools & Training			
ALTERNATE#7 Simulation & Design Software			
ALTERNATE#8 Web-cam			
TOTAL OF ALTERNATES			
GRAND TOTAL (Base Bid +Alternates)			

ANNUAL SERVICE CONTRACT ($/yr)			

UNIT PRICING	Add-Alternate	Deduct-Alternate	
To move the PV Array Northward—20 feet maximum ($/linear foot)			
Labor Rates (Provide Attachment for Various Trades) Standard Overtime			
Overhead & Profit Rate (% of Labor)			

BID SUBMISSION FORM-Continued (3 of 3)

Checklist of Required Bid Attachments (The following items are included in the Bid Response):

1. ____Qualifications
2. ____References for Other Solar PV Projects
3. ____Projected Energy Use (kWh/yr)
4. ____Sketches including Electrical Single-line Diagram (Include proposed DC Voltage) with accompanying narrative.
5. ____Cut-sheets
6. ____Bid Submission Form (3 pages)plus any attachments

Expected Date to Start Mobilization: _____

Expected Date of Project Completion: _____

Comments on Ability to Meet Project Schedule: _____

_____

_____

_____

GENERAL CONDITIONS & REQUIREMENTS

The Contractor is responsible for:

1. Documenting that they certified by the State of Illinois to be installers of distributed generation systems according to Title 83 Public Utilities; Part 468 Distributed Generation Certification Requirements.

2. Visiting the site and verifying all existing field conditions prior to submission of his Bid. The Contractor shall be responsible for determining the actual location, routing and sizing of the components. No extra charges will be accepted for work that has to be performed due to the contractor's failure to adequately verify existing conditions.

3. Coordinating this construction work with any other construction projects occurring at the same time at this site.

4. Selecting and installing components in compliance with all pertinent codes, standards and certifications including but not limited to: 2014 NEC including Articles 250, 310, 690, 705; IEC 61215 and 61646. Use Solar PV modules, Inverters and associated equipment that are UL-Listed per the pertinent UL safety standards. All materials and equipment shall be UL listed where available.

5. Equipment, materials and construction procedures shall adhere to sustainable principles.

6. Obtaining all Licenses, Approvals, and other Arrangements for the work required at the Contractors expense.

7. Coordinating with utilities for the meter replacement and interconnection between the solar PV system and the utility grid.

8. Shipping and Handling of all materials & Equipment

9. All details and costs not mentioned and associated with this scope of work. Notify Owner's Agent of non-functioning related systems necessary for the proper completion of the scope of work; for example non-functioning web-based interface needed for remote monitoring of building performance.

10. Providing SUBMITTALS that include the following shop drawings to the Engineer and Owner's Agent:

    10.1 Project Schedule—to be updated weekly.

    10.2 Drawings and submittals for obtaining construction permit

    10.3 Drawings showing placement of all new equipment, electrical wiring diagram complete metering interface.

10.4 Design calculations and performance projections

10.5 Interface agreement with utility

10.6 Shop drawings on all equipment

10.7 One copy of all completed equipment start-up forms, the final commissioning report to the Owner's Agent and Engineer.

10.8 Sample web-based displays of system performance and energy flows

10.9 Draft training agenda for review by Owner and Owner's Agent, prior to training the Owner's staff

10.10 Four (4) copies of bound Operation & Maintenance manuals with a section that includes all warranty documents, and completed manufacturer's start-up and testing checklists for all systems.

10.11 Prepare As-Builts. All drawings shall be in pdf format and provided on DVD disks or flash drive (4 copies). Disks shall be presented to the Owner.

11. Maintaining legal and acceptable building temperatures and electrical power during the construction work. The building is to be notified in advance of any system curtailments related to this scope of work.

12. All wall, roof and floor penetrations, coring, cutting, patching, and fire stopping as necessary for the work. Existing equipment pads may be re-used or extended if of appropriate size and location.

13. Temporary protection of interior furnishings, carpeting, and interior finishes.

14. Obtain approval from Owner for path to transport materials and equipment from the street to the work site.

15. Maintaining work site in a safe and clean manner. Daily clean-up of contractor's work is necessary to allow routine maintenance and normal building activities.

16. Final cleanup of work areas after contractor's activities are completed. Restore all landscaping damaged by deliveries and construction.

17. Provide security as necessary to protect contractor's activities and property.

18. Provide on-site storage or lock boxes as necessary for contractor's activities.

19. All demolition, dumpsters, hauling and waste disposal in compliance with local ordinances.

20. Cranes, rigging and lifting for all required equipment including the pre-ordered products.

21. Arranging for storage and safe-keeping of all supplies and equipment for this job.

22. Coordination of necessary field inspections with City Department of Buildings.

23. Complying with the scope of work, specifications and general conditions and requirements in this document.

24. Implementing all work in a workmanlike manner according to industry accepted manner.

25. Verifying voltages, frequency, number of phases for all equipment prior to ordering. All final power (line voltage) wiring of all equipment will be done by the contractor's electrical sub-contractor.

26. Repairing/replacing any fireproofing removed in order to install, repair, or remove any items included in the Contractor's scope of work.

27. Arranging for the responsible contractor to conduct all final inspections and tests in the presence of Owner's Agent and Engineer and to provide at least two completed and signed copies of all manufacturer supplied test and start-up forms. All new equipment shall be cleaned and adjusted as required to operate satisfactorily and witnessed by building personnel.

28. Complying with the following McHenry County Colleges Conditions.

MCHENRY COUNTY COLLEGE GENERAL TERMS AND CONDITIONS

1. **Applicability:** These general terms and conditions will be observed in preparing the bid proposal to be submitted.

2. **Purchase:** After notice of the award, purchase will be put into effect by means of purchase orders or suitable contract documents executed by the Director of Business Services.

3. **Right to Cancel:** MCC may cancel contracts resulting from this ITB at any time for a breach of any contractual obligation by providing the contractor with thirty-calendar day's written notice of such cancellation. Should MCC exercise its right to cancel, such cancellation shall become effective on the date as specified in the notice to cancel.

4. **Proprietary Information:** Bidder should be aware that the contents of all submitted bids are subject to public review and will be subject to the Illinois Freedom of Information Act. All information submitted with your bid will be considered public information unless bidder identifies all proprietary information in the proposal by clearly marking on the top of each page so considered, "Proprietary Information." The Illinois Attorney General shall make a final determination of what constitutes proprietary information or trade secrets. While MCC will endeavor to maintain all submitted information deemed proprietary within MCC, MCC will not be liable for the release of such information.

5. **Retention of Documentation:** All bid materials and supporting documentation that is submitted in response to this proposal becomes the permanent property of MCC.

6. **Indemnification:** The Contractor shall protect, indemnify and hold MCC harmless against any liability claims and costs for injury to or death of any person or persons and for loss or damage to any property occurring in connection with or in any incident to or arising out of occupancy, use, service, operations or performance of work in connection with the contract, resulting in whole or in part from the negligent acts or omissions of the Contractor.

7. **Substitutes to Specifications:** Specifications listed in the IFB are the basis for the bid submissions and requirements.

8. **Disclosure:** Contractors shall note any and all relationships that might be a conflict of interest and include such information with the bid.

9. **Terms of Payment:** MCC operates under terms of payment for work completed and product delivered within Net 30 days from date of invoice. All payments of invoices need to be approved on a monthly basis. In no case will MCC agree to late fees prior to 60 days before payment is received, this is based on State Statutes for State funded entities.

10. **Compliance with Law:** Seller will comply with all valid federal, state and local laws and all ordinances and regulations applicable to the manufacture, sale delivery and labeling of the goods ordered and in the performance of any work pursuant hereto. Seller also certifies that the merchandise supplied meets both Illinois Life Safety Code and OSHA regulations.

11. **Equal Employment Opportunity:** To the extent that Vendor is subject to governmental orders, rules or regulations pertaining to Equal Employment Opportunity and/or to the maintenance or Non-segregated Facilities. Vendor hereby certifies that it is complying therewith, including where applicable, the submission and/or filing of Equal Employment Opportunity Compliance Reports and/or Certificates and/or filing of Certificates on Non-segregated Facilities. Compliance with the rules and regulations of the F.E.P.C., Article III, Section 3.1, Equal Employment Opportunity clause is required.

12. **Prevailing Wage Law:** The Illinois Prevailing Wage Act, 820 ILCS 130/01 et.seq. shall be mandatory for all contractors and subcontractors who are hired by the College for construction or construction related services. The Act requires contractors and subcontractors to pay laborers, workers, and mechanics performing services on public works projects no less than the prevailing rate of wages in the county where the work is performed. The Illinois Department of Labor periodically determine what rate is in various locales throughout the State, Illinois Prevailing Wage Act, June 26, 1941, as amended, being Section 39A-9 of Chapter 48 of the Illinois Revised Statutes, 1977.

13. **Insurance Requirements:** If fabrication, construction, installation, service or other work is specified to be conducted on MCC's premises, supplier shall maintain in force during the period of such work the following coverage's: (a) worker's compensation, as required by the laws of the State of Illinois; (b) commercial general liability for bodily injury and/or property damage in an amount of not less than $1,000,000 single limit, per occurrence; (c) automobile liability for bodily injury and/or property damage in an amount of not less than $1,000,000 single limit, per occurrence. **The successful bidder shall provide a certificate of insurance naming McHenry County College as additional insured.**

14. **Performance and Payment Bond:** For every construction or construction related project greater than Fifty Thousand Dollars ($50,000), Contractor shall procure a performance and payment bond for the full amount of the contract price (Public Construction Bond Act, 30 ILCS 550/1). Prior to commencement of any work on the Project, Contractor shall submit insurance and bonds. Any provisions contained within the bonds creating a condition precedent for Owner, or abrogating Owner's rights or remedies otherwise available in contract or law, are void.

15. **Material Safety Data Sheets:** In compliance with the "Toxic Substance Disclosure to Employees Act" (P.A.83-240) vendor must provide Material Safety Data Sheets (MSDS) within 30 days of shipment of any and all hazardous substance ordered on this purchase order. All MSDS sheets must be sent to the Purchasing Office.

16. **Recycled Materials:** McHenry County College is required to purchase products incorporating recycled materials whenever technically and economically feasible. Contractors are encouraged to offer products with recycled content which meet specifications conforming to Illinois State Statute 415 ILCS 20/3.1 pertaining to public community colleges.

17. **Contractor Certification:** The Seller certifies that the Seller is not barred from bidding on governmental contracts as a result of a conviction for either bid-rigging or bid-rotating under Article 33E of the Criminal Code of 1961.

18. **Web Accessibility Law:** As required by Illinois Public Act 095-0307, all information technology, including electronic information, software, systems, and equipment, developed or provided under this contract must comply with the applicable requirements of the Illinois Information Technology Accessibility Act Standards as posted at http://www.dhs.state.il.us/iitaa

19. **Department of Employment Security Law**: By entering into this contract, Vendor agrees to either (1) link its employment vacancies with the IllinoisJobsLink.com System or successor system, or (2) provide an online link to its employment vacancies so that this link is accessible through the web page of the IllinoisJobLink.com System or successor system, as required by Illinois Public Act 098-0107 (20 ILCS 1005/1005-47). ***NOTE***: Vendors who are parties to a collective bargaining agreement with a bona fide labor organization for the performance of construction or construction-related services are exempt from this requirement.

STANDARDS AND SPECIFICATIONS

SCOPE

The required annual energy output of the solar PV system will be at least 110,000 kWh/year based on the following performance specifications. Provide calculations, including all assumptions and measurements to verify the projected annual energy output of the proposed system.

1. Solar PV Modules

1.1 Performance Criteria

a. Solar Power Capacity of the Installed System: minimum 91.26 kW peak DC
b. Modules characteristics include:
   i. minimum efficiency of 16.4% at STC, mono-crystalline Silicon, Tier 1 rated
   ii. Maximum annual degradation in performance: 0.7%
   iii. Temperature coefficient: -0.30%/^{o}F for voltage or -0.35%/^{o}K for power.
   iv. 25 year production (performance) warranty and 20 year product warranty on solar modules

1.2 Location & design summary

a. Location of array: on the lawn north of the Shah Center building per Drawings
b. Guidance on array configuration and dimensions: Four rows of panels with a footprint of approximately 114 ft (north to south) by 110 to 121ft (east-west). Optimal pitch of all modules is 25^{o}; Minimum module pitch is Allowable Annual Shading:
   - among the modules: 1%
   - from neighboring trees and other obstacles: <10%

2 Module Racks

Per the Drawings the PV array includes four sub-arrays or rows of fixed-pitch racks. Also, included is one rack at the east end of Row #1—the southmost row—that can be manually adjusted for various tilt angles from 15^{o} to 65^{o}. This rack will be separate from the fixed angle racks of Row#1 to minimize mutual shading between the racks when at different tilt angles.

3. Rack Foundations

Per the design documents the foundations shall be helical screw piles. The written results of the four soil boring tests results will be available by end of May to confirm the depth of the foundations. Any plant and tree trimming or removal must first be approved by the Owner.

4. Security (Fencing)

Install a permanent fence, minimum 8-foot high, around the array. Assume the fence will be of chain link construction. Ensure the entire fence is properly grounded. The south, east and west fencing shall be located at least 12 feet away from the nearest PV panel; the north fence shall be at least 9 feet away from the nearest PV panel or racking system. Provide extra spacing to ensure the south fence does not shade the nearest row of modules. If feasible and approved by the Owner, the fencing can be used to secure the site during construction. Confirm with the

Owner the location of the gate in the fencing and coordinate it with the access path to be used for bringing equipment and materials to the site.

5. Landscaping Upgrade

After installing the rack foundations, replace the remaining lawn covering the planned footprint of the arrays with graded and compacted washed 2-inch stone gravel, 6-inch base course with filter fabric underlayment under arrays.

6. Balance of System (BOS)

6.1 Inverters. For the fixed-tilt Main Array Use utility-interactive inverters that are UL listed, are certified for EMI under FCC Part 15, comply with IEEE 519 for harmonics control and have a minimum rated CEC weighted efficiency of 96%. The four string inverters, SMA Sunny Tripower 20000TL-US, will be located outside at the east end of each of the four rows mounted on the racking in the shade of the PV modules. The inverters will each have two Maximum Power Point inputs to optimize string performance. The inverters will be located outside at the east end of each row fastened to the rack under the PV modules for protection from direct sunlight.

For the adjustable tilt rack with four PV panels use one enPhase 250 micro-inverter per PV module. with the Envoy Communications Gateway to enable web-based performance monitoring of each module and micro-inverter.

6.2 Transformer. The new indoor transformer for interfacing the PV system to the building electrical service, will be dry-type K, UL listed, with a minimum impedance of 1.5%, sized and selected to operate at minimum average efficiency of 98%.

6.3 Power Distribution. The existing electrical service at the Shah Center is 208V, 3-phase. which requires new transformer located indoors near the existing main switchboard to step down the voltage of the solar PV-generated electricity. Design and install the DC and AC distribution systems with a maximum line voltage drop of less than 0.5% on the DC Side and 2% on the AC side with all copper conductors. The maximum combined line voltage drop of the entire system (from PV module output to interconnection point at existing switchgear) shall be 2.5%. The Voltage drop (%) for the DC and AC distribution systems, and for the combed total will be verified by calculations included the shop drawings.

6.4 Grounding and Surge Protection. Provide for equipment grounding on the DC and AC distribution systems per NEC Articles 250 and 690. Include provisions to maintain grounding continuity when panels are temporarily removed. Provide surge protection from utility service or other on-site electric power generators.

7. Interconnection & Metering

Provide and arrange for utility-approved interconnection based on the present net-metering arrangement offered by ComEd and by the corresponding electricity commodity provider for the Shah Center. Application for net-metering being is being submitted by the Owner's Engineer

8. Performance Monitoring

8.1 System performance.

See DWG E-2 for an overview of the monitoring systems architecture. The system provides for the following monitoring approaches:

a. **By String Inverter.** Provide for continuous monitoring of measured performance at each of the four string each inverter and compare to projected performance for this site, design and equipment. Parameters to be monitored include but are not limited to: interconnection status; AC output voltage, power and power factor; DC input voltage and amperage; MPPT (Maximum Power Point Status) status; error codes; fault conditions and other parameters. Monitoring will be done using the SMA Sunny Cluster Controller and Router that feed through the Shah Center Data Port to the SMA Sunny Portal web-based display.

b. **By Micro-inverter.** For the adjustable tilt rack with four PV panels with the enPhase 250 micro-inverters use the Envoy Communications Gateway to enable web-based performance monitoring of each module and micro-inverter.

8.2 IGEN Energy Monitoring. Furnish, install and confirm operation of the systems needed to provide IGEN continuous data on the energy output of the solar PV system and the energy purchased from the utility and used by the Shah Center. This includes:

a. Install the data-logger provided by IGEN that will receive data from the either the new utility net-metering meter, M_u or building meter $M_{B,}$ and from the new meter M_{PV}, that meters energy produce by solar PV array. Coordinate with MCC IT and IGEN IT staff to ensure the new data logger can communicate 15-minute interval data via the Shah Center data portal with the IGEN servers;

b. If authorized by the utility, establish a real-time data link between the new bi-directional utility meter with the IGEN data logger to enable IGEN to continuously monitor energy purchased from the utility for consumption at the building;

   OR, if the new utility bi-directional meter is not accessible for real-time data monitoring;

   (ALTERNATE #3) Install a new revenue-grade meter, Shark 200 V2 by Electro Industries/Gauge Tech to monitor true energy use, power and power factor of the energy delivered from the utility grid for use by the building. Use properly sized split core current transducers and voltage taps for each phase and neutral at the new panel as necessary for maximum accuracy.. Establish a real-time data link between meter M_B and the IGEN data logger;

c. Install a new revenue-grade meter, M_{PV}, also the Shark 200 V2 by Electro Industries/Gauge Tech, to monitor the true energy, power and power factor produced by the Shah solar PV system Main Array. Use properly sized solid core current transducers and voltage taps for each phase and neutral at the existing switchboard as necessary for maximum accuracy. Establish a real-time link between meter M_{PV} and the IGEN data logger.

d. Provide a real-time data link between the IGEN data logger and the Envoy system that monitors the output of the four PV modules on the adjustable tilt rack, M_{PVA}.

IGEN will be responsible for:

i. totalizing the metered solar PV output from the Main Array and the Adjustable Tilt Array to obtain the Total PV output, M_{PVT};
ii. totalizing the output from the building meter, M_B or M_U, and the total PV output, M_{PVT}, to determine the virtually metered total building energy use, M_{BT}.

DWG E-1 shows the location of these meter monitoring points. The meters shall have an accuracy of +/- 0.5% or better. Calibrate the meter M_B with respect to the new utility net-metering meter and provide Owner with the documented variance between the two metering systems when there is no power generated by the PV system.

Archive and display the above energy and power flows per the MCC faculties required format.

8.3 Environmental Parameters. Furnish and install the SMA Sunny Sensor box which includes an insolation sensor and module temperature sensor in the monitoring package. Trend the resulting data and make it available for use to assess actual PV array performance and compare it to designed performance.

Provide the necessary customized O&M manuals and training for MCC staff for the various monitoring systems.

9 Commissioning, Training & Warranty

9.1 Commissioning. Assist MCC staff and consultant to confirm the installed PV system is working at its expected level of performance and document it. This includes measuring actual I-V characteristics of 5% of the modules and of each of the strings and deriving the total system I-V characteristics. Provide documentation of torque spec compliance and documentation of thermal scan compliance.

9.2 O&M Documents & Training. Provide bound O&M manuals and any required customized O&M procedures for MCC staff. In addition, a maintenance plan for the PV array must be included. Prepare a training agenda for review by Owner and Owner's Agent and facilitate a one day training for MCC Facilities staff .

9.3 Warranty Period. The Contractor shall provide warranty information covering repair or replacement of any defective parts associated with the solar system equipment. Product warranties shall be a minimum 20 year warranty on the solar panels, string and micro inverters, and the rack PV-module rack systems.

The Contractor will provide a two-year warranty on the installation. The warranty is to commence the date the system is completed, commissioned and delivering energy to the building as per design. The Contractor is to provide all necessary servicing for the solar PV system during the two year Warranty on Labor & Workmanship required by MCC. Contractor will visit and inspect the project site at least every six months for the first two years and correct any issues.

10 Education Components

10.1 Education Liaison. The vendor must provide an education liaison that will be a partner and contact person for faculty as he/she documents and builds a record of the PV system install for existing and future classes, as well as forthcoming public presentations about the Shah Center. Please provide the experiences of the liaison with regards to projects such as this. Liaison 's responsibilities include but are not limited to:

- Answering questions about the install
- Answering questions about the industry
- Answering questions about project finances

10.2 Construction Documentation. Allow (and suggest) photographs and/or video content of the install process, procedures and equipment that will be incorporated into existing and future classes, as well as forthcoming public presentations. Facilitate MCC staff photo-documentation of construction-in-progress and interview of the construction manager during construction. Provide final schedule of values itemized costs of project including itemized hard and soft costs.

10.3 Identification & Labels. Provide shop drawings of proposed labeling (interior and exterior components) for approval prior to ordering. Outside signage needs to be protected from the elements and UV rays. Install large-format labels and/or signage with explanations of functions and photographs where appropriate of all key solar PV system equipment. Labels and signage needs to facilitate group discussion so font should be large (at least 36 pt). Font must be Avenir light and/or bold and follow typography guidelines explained on pages 24-27pf the MCC Official Brand and Style Guidelines booklet (http://www.mchenry.edu/brand/brfandbook.pdf). All labels and signage must contain the MCC logo and follow guidelines explained on pages 12-23 in the MCC Official Brand and Style Guidelines. Labels and signage need to be rugged, professionally mounted and sturdy enough to last 25 years. Signage, photographs and appropriate content will be determined in consultation with Ted Erski, curriculum coordinator of this project.

11. Fees

Construction. This includes all fees related to construction such as net-metering, interconnection, re-establishing electric service if temporary shutdown is necessary. Describe any additional required fees. The Owner is paying for the soil boring tests and the permit fees.

Annual. This includes any subscription fees associated with the monitoring systems for the two-year Contractor Warranty period.

Annual Service Contract

Contractor to develop and present to MCC staff a proposal for on-going servicing of the solar PV system after completion of the two year warranty period. Scope includes: clean modules; provide I-V curve measurements and comparison to baseline module to ensure module degradation does not exceed 0.7% year-over-year; provide thermal images of opened combiner boxes, inverter connection points, DC and AC disconnects and AC panelboard; check torque settings of key electrical connections. At completion of construction the contractor will meet with

MCC staff to prepare a final scope of their O&M services that complements the O&M tasks for the MCC staff. Annual service fees exceeding $1,000 are not acceptable.

ALTERNATES

1. **Optimize & Monitor PV Modules in Row #1.** Monitor individual performance of all the PV modules in Row #1—the southmost row most likely to be partially shaded during certain times of the year. Monitoring will be done by the Tigo system that includes a Power Optimizer module for every two PV modules. The Power Optimizers wirelessly broadcast to the Tigo Gateway devices which in turn communicate by cable to the Tigo Maximizer Management Unit and then onto the web-based Tigo Module-level Portal. The Tigo system will also optimize the performance of individual PV modules served by the string inverter for the fixed rack part of Row #1.

   The Tigo optimizers for the four panels served by micro-inverters will simply be used to monitor their individual energy performance and compare them to the other modules in the fixed rack part of Row #1.

2. **Optimize & Monitor Row PV Modules in Rows #2 to 4.** Expand the above-described Tigo module optimization and monitoring system to cover all the PV modules in rows 2 to 4.

3. **Various PV Modules.** At the separate adjustable tilt array, install four different PV modules, each with its own compatible enPhase micro-inverter. The four PV panels will include one of each of the following: same SolarWorld model as in the rest of the array; SunPower Commercial X-20 Series (min 20.5% efficiency) 327watt; ReneSola Virtus II 305watt; Universal Solar Universal Solar WXS 240-US.

4. **Building Energy Meter.** If the new net-metering meter provided by the utility cannot be monitored for continuous real-time power and energy use, install immediately downstream of it a separate revenue-grade building utility meter, Shark 200 V2 meter, using split-core CTs and voltage taps for each phase to provide the necessary building energy use (kWh) data to the IGEN datalogger. Also, track power and power factor by phase.

5. **Five Year Contractor Warranty.** Additional cost for extending the Contractor's Warranty on Labor & Workmanship from the two years required by MCC to five years. This also covers the additional cost to provide 5 years of monitoring subscription service.

6. **Site Evaluation, Commissioning Tools & Training.** Provide one instrument and required training each of: Solmetric SunEye to conduct site evaluations of solar access; Solmetric PV Analyzer (for 1000w DC modules) to enable the Owner's staff to periodically check the Current-Voltage (IV) characteristics of selected PV panels and strings of panels.

7. **Simulation & Design software.** Solmetric PV Designer for parametric analysis and design of PV systems. Compare proposed software features to public domain software such as PV Watts-Version 2 (www.nrel.gov/rredc/pvwatts/grid.html)

8. **Web-cam:** View of PV array from camera mounted on Shah Center; signal to be fed into the SMA web-based display.

SPECIFICATIONS SECTION 263100

PHOTOVOLTAIC POWER SUPPLY SYSTEM

PART 1 - GENERAL

1.1 WORK INCLUDES

A. Base Bid

1. Prime Electrical Contractor

B. Section Includes: Requirements for the design, furnishing and installation of a complete photovoltaic power supply systems as follows:

1. Provide and install specified photovoltaic modules, PV racking at a minimum 25 degree tilt angle, meter/monitoring system, fused combiner boxes, conduit, wire and cable on the north lawn of the McHenry County College Shah Center located at 4100 Shamrock Lane, McHenry, Illinois. Connect the PV modules to the new inverters installed next to the existing electrical switchgear in the building as designated by the Owner. The inverter output is to connect to the end of the bus breaker in the main 208-Volt Switchboard located in the main electrical room.

C. Related work described in the Performance Standards including, but is not limited to:
1. Solar PV Module Performance & Certifications
2. Balance of System
3. Transformer
4. Metering and Monitoring
5. Commissioning &Training
6. Security & Fencing

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. 2014 National electrical Code
2. County of McHenry Codes
3. City of McHenry Building Code
4. IEC-61215
5. ANSI 62.41
6. IEEE 519
7. IEEE 929
8. IEEE 1547
9. ISO 9001
10. UL Inc. 1703
11. UL 1743
12. UL 1741 10
13. UL-508A

1.3 DEFINITIONS

A. PVSI: Photovoltaic System Integrator. The PVSI has full responsibility for the,

design, submittals, construction, installation, testing, commissioning and implementation of the Photovoltaic System including all control, monitoring and Internet reporting of system operation.

B. PTC: PV USA Test Conditions. A set of reference photovoltaic device measurement conditions consisting of solar irradiance of 1 k WI m2, air mass of 1.5, 20°C ambient temperature at 10 meters above ground level and a wind speed of 1 meter per second.

C. NOCT: Normal Operating Cell Temperature. The temperature at which the cells in a photovoltaic module operate under standard operating conditions (SOC). These conditions are: irradiance of 0.8 kW/m2, 20°C ambient temperature, and average wind speed of 1 m/s, with the cell or module in an electrically open circuit state, the wind oriented parallel to the plane of the array, and all sides of the array fully exposed to the wind.

D. STC: Standard Test Conditions. A set of reference photovoltaic device measurement conditions consisting of solar irradiance of 1 kW/m2, air mass of 1.5, and 25°C cell temperature.

1.4 SYSTEM DESCRIPTION

A. Design Requirements:

1. The photovoltaic system is to provide a minimum nameplate of 91.26 kW DC. Provide the corresponding necessary inverters. Utilize identical, individual minimum 270W photovoltaic modules mounted on rack systems on the facility roof, connected in series to form photovoltaic strings, which are connected in parallel to form photovoltaic arrays. Provide all required mounting racks and accessories, circuit combiners, inverters, wiring systems, grounding, testing and control and monitoring systems. Install inverters on the roof or in the main electric room as determined. The photovoltaic system monitoring is to include secure on-line metering/monitoring from a public access web site.

B. Performance Requirements

1. Each photovoltaic module is to have a Minimum Peak Power rating of 270 watts minimum at Standard Test Conditions (STC).
2. Each photovoltaic module is to provide a minimum of 83 percent of the specified Minimum Peak Power for a period of 25 years

C. Electrical Requirements:

1. All equipment to be UL Inc. Listed
2. Provide individual photovoltaic modules with a maximum open circuit voltage (Voc) of 42 volts dc.
3. Connect individual modules in series to form a string per NEC requirements including temperature corrections. Combine strings in parallel to form arrays. Utilize fused circuit combiners for all parallel connections.
4. Provide DC-rated fuses and disconnects at the combiner outputs or at the inverter as required by NEC.
5. Provide inverters with continuous power ratings as shown on the drawings and as specified and each with a circuit input combiner and each with an isolation transformer. The output of each inverter is to be a regulated voltage that is coordinated to the design voltage of the modules and strings on the DC side of

the system, three-phase four-wire.

6. Provide the appropriate transformer to step down the voltage to match service switchboard.
7. Provide insulated copper conductors. All wiring for the photovoltaic system, from the individual combiner boxes to the inverters will be insulated and installed in conduit as required by NEC.
8. Wiring for the series connections from individual modules to adjacent modules on the same mounting rack and may be installed without conduit. Utilizing color- coded black, white and green type rated cable. Utilize black UV rated plastic wire ties at not more than twelve inch spacing to support this wiring from mounting racks. All module series connection wiring that is not to an adjacent module but is to a module or connection on the same mounting rack is to be run within recessed channels in the mounting racks and secured at a spacing of not more than twelve inches with black UV rated plastic wire ties. Install all wiring in conduit for cables that extend beyond a mounting rack.
9. Provide conduit for all wiring from combiners to the disconnect switches and to inverters.
10. In every conduit provide an insulated "system"-grounding cable sized in accordance with the Article 690.41 of the CEC.
11. Provide equipment-grounding conductors sized In accordance with the Article 690.43 of the CEC.
12. Limit total voltage drop of the wiring systems (total of DC and AC wiring from field combiner box to interconnection point in building switchgear) to less than 3%. Limit the voltage drop of each of the DC or AC wiring systems to less than 2%.
13. Ensure that at the highest expected ambient and cell temperatures the string voltage—after DC voltage drop to the inverter is considered-is above the bottom end of the MPPT window of the corresponding inverter. Provide the calculations, based on 20 years of depreciated module performance at the maximum rate of degradation specified herein.
14. Ensure that the inverter AC output circuit does not have excessive voltage drop that would cause the inverters to reach the high voltage limit, cause a high-voltage trip and the inverter to go offline with a “high grid voltage” error.

1.5 SUBMITTALS

A. General:

1. Provide all submittals, including the following, as specified in the Scope of Services

B. Design:

1. Submit for review and approval the detailed design of the photovoltaic system with sufficient information to determine conformance with these specifications. Include the following:
   a. Provide calculations demonstrating voltage and amperage of each series and parallel connection of modules, panels and arrays.
   b. Provide calculations of solar availability at the proposed site along with proposed location and dimensions of the solar array. Base the solar availability calculations shall be based on measured shading at the site using instruments such as the Solmetric SunEye 210.
   c. Perform projected annual energy production calculations using a program similar to the NREL PV Watts for total peak wattage and peak and annual

kilowatt-hour output of the system based on PTC, measured solar availability, installation location, angle of installation, number and efficiency of proposed modules and number and efficiency of proposed inverters and transformer, voltage drop, estimated module performance degradation and effect of dirt accumulation after one year.

d. Provide calculations for all wire and conduit sizing including voltage drop calculations for the DC and AC wiring.
e. Provide a detailed block diagram of proposed system showing; modules, panels, arrays, disconnect switches, inverters, circuit combiners, inverters and connections.
f. Provide Manufacturers Calculations based on module weight and wind loading for mounting rack sizes, connections and loading.
g. Provide Attachment and anchoring details for rack connections to roof structure for anchored PV systems and module connections to rack.
h. Provide Electrical one-line diagram of proposed system. Showing system and equipment grounding system diagrams.
i. Provide Calculations to verify sizing of all electrical protective devices such as fuses and breakers.
j. Provide information control, monitoring and Internet reporting system architecture, I/O naming convention and lists, display screens, reports and security methods.

C. Provide Product Data and Information: Provide standard manufacturer's specification data on photovoltaic modules, circuit combiners, disconnect switches, inverters, meters, racks, wiring, wire ways, grounding elements and individual components. Data to include materials of manufacturer, finishes, standard dimensions and weights, mounting requirements including mounting bolt spacing and wire way locations, physical properties, rating data and Listings and Certifications.

D. Shop Drawings:
1. Photovoltaic Modules: Provide drawings detailing electrical terminations, connection diagrams, mounting details and cleaning and maintenance requirements. Also provide specific data on individual solar module materials, connections, efficiency, electrical performance including warranties.
2. Support Racks and Foundations: Provide drawings stamped by licensed professional engineers detailing component dimensions, module mounting arrangements and mounting hardware, method of securing racks to the ground, grounding and calculations for loading including wind loading.
3. Array Location: Provide drawing showing exact location of the array that will produce the calculated annual energy use required in Section 1b above. Identify any trees that will need removal and or trimming to maintain the solar availability over the life of the solar PV system.
4. Circuit Combiners: Provide drawings detailing internal and external views, identification of all components, component dimensions, rating data of enclosures and of all components and nameplate data.
5. Disconnect Switches: Provide drawings detailing internal and external views, rating data of enclosures and of all components and nameplate data.

6. Inverters: Provide detailed drawings showing internal and external views with dimensions and identification of all components, wiring diagrams of all internal and external connections, rating data of all components, efficiency of inverters and isolation transformers, impedance of transformers and safety and electrical protection devices and nameplate data.
7. Wiring: Provide detailed physical drawings showing location and dimensions of all wiring, mounting of wiring and wire ways, termination details and labeling system for all wiring.
8. Security Fencing: Include in the Array Location drawings the code required fencing.
9. Internet monitoring systems: Provide detailed drawings showing internal and external views with dimensions and identification of all components, wiring diagrams of all internal and external connections, rating data of all components, including methods for securing all data and systems.

E. Samples: Submit samples of mounting rack, wire labels and wire conduit for below-grade and above grade wiring.

F. Quality Control & Commissioning: Provide all required and specified test reports, certificates, and evidence of manufacturer's experience. Provide all proposed test and commissioning procedures for review and approval prior to beginning any tests. Commissioning shall include but not be limited to: comparison of measured and predicted power; spot measurement of I-V curves for 5% of the modules, 10% of the strings distributed evenly among the array rows and for each inverter; log of torque measurement at electrical connections; infra-red scan of critical components and junctions. Spot I-V measurements shall be done by Solmetric PVA analyzer with insolation and temperature sensors.

G. Operation and Maintenance Manuals: Provide operation and maintenance manuals, as specified in part d shop drawings. Provide specific information on photovoltaic module
cleaning, maintenance and testing procedures and inverter troubleshooting, calibration, testing and maintenance procedures.

1.6 QUALITY ASSURANCE

A. Codes: Provide each of the photovoltaic power supply systems in accordance with the McHenry County and City Electrical Code.

B. Regulatory Requirements: All components are to be UL Inc. Listed and modules and inverters are to be certifiable under the applicable McHenry County and McHenry City Electric Code

C. Experience Requirements - Photovoltaic System Integrator (PVSI): The PVSI must have demonstrated experience in the integration of at least three photovoltaic systems of 40 KW or larger in size and arrangement similar to that specified. Provide verification and certification of required experience. Electrical license and NABCEP certification and State of Illinois certification required as of January 1, 2014.

D. Experience Requirements - Equipment: Provide photovoltaic modules from a manufacturer that has manufactured modules of the type specified for at least three (3) years. Provide inverters from a manufacturer that has manufactured inverters of

the type specified for at least three (3) years. Provide verification and certification of required experience.

1.7 DELIVERY, STORAGE AND HANDLING

A. General: Deliver, store and handle all products and materials as specified by the manufacturer

B. Provide any special instructions for storage of spare photovoltaic modules

C. If recommended by the photovoltaic module supplier, provide storage racks for spare modules.

1.8 PROJECT CONDITIONS

A. Existing Conditions:

1. The array is to be located on the existing grass lawn north of the existing building.
2. The electrical Interconnection is to occur at the existing switchgear in the basement of the building.
3. All work and the installation of all equipment must not disturb, damage or otherwise compromise the existing trees and other vegetation that the Owner intends to preserve and maintain.
4. All work and the installation of all equipment must not disturb, damage or otherwise inhibit the existing building systems from their designed operation, or void their warranty.

1.9 SEQUENCING AND SCHEDULING

A. Coordinate all work with the requirements of other trades work under this contract.

1.10 WARRANTY

A. Warrant that each PV module shall be free from defects in materials and workmanship for a period of ten (10) years from date of installation.

B. Warrant that each PV module shall provide a minimum of 83 percent of the specified Minimum Peak Power for a period of twenty-five (25) years from the date of installation.

C. Warrant each inverter and isolation transformer for ten (10) years from the date of installation.

D. Warrant the Labor and Workmanship of the entire photovoltaic power supply system for a period of two (2) years.

E. Warrant all other equipment and components for 25 years as required.

1.11 SPARE PARTS (91.26pkW DC SYSTEM)

A. General: Furnish the following spare parts, packaged for long-term storage with easily identifiable labels on each package.

1. 1% photovoltaic modules

2. 1% photovoltaic module and string connectors (male and female)
3. 5% of each type of circuit combiner fuses.
4. Two (2) complete replacement sets of fuses for each inverter

PART 2 - PRODUCTS

2.1 MANUFACTURERS

1. Photovoltaic Modules
   a. Solar World
   b. Sunpower
   ReneSola
   c. Canadian Solar
   d. Wangxiang New Energy

2. Inverters:
SMA Sunnyboy Tri-Power 20000TL-US or approved equal manufacturers listed below meeting the performance and warranty requirements.
   a. SMA
   b. SolarEdge
   c. enPhase
   d. Solar Max

3. Circuit Combiners:
   a. SMA
   b. SolarEdge
   c. SolarBOS
   d. DECK

4. Module Mounting Racks (at a minimum 25 degree module tilt) for the main array shall be Iron Ridge, or approved equal with a 20 year warranty including:
   a. IronRidge
   b. Schletter
   c. RBI

   The adjustable tilt rack for up to 4 modules shall be DPW Power Fab Model (TPM) for top-of-pole mounting or approved equal. Provide the necessary hardware to enable adjusting the tilt from 15 to 65^{o}.

5. Solar Irradiance Sensor
   SMA All-in-one unit includes irradiance sensor, panel module temperature sensor and ambient air temperature sensor or approved equal

2.2 PHOTOVOLTAIC MODULES

A. General: Provide photovoltaic modules designed to meet the specified requirements.

B. Solar World Sunmodule Plus SW 275 Mono rated for maximum 1000V systems, or

approved equal Tier 1 rated modules meeting the following performance requirements.

1. Mono crystalline cells Tier 1 rated
2. Minimum conversion efficiency of 16.4 percent
3. Output power rating must be positive tolerance only
4. Minimum peak power ratings of 270 watts at STC
5. Modules have all factory-installed MC4 connectors

C. Provide modules specifically designed for outdoor, rack mounted installations.

D. Each module is to have weatherproof insulated cable and connectors

E. Provide each module with an anodized aluminum frame, predrilled for mounting.

F. PHOTOVOLTAIC MODULE MOUNTING RACKS

1. Provide mounting racks specifically designed for mounting photovoltaic modules in an inclined position.

2. Rack system to be stainless steel, galvanized steel or aluminum.

3. For anchored systems, provide fixed mounted rack. For ballasted systems, install in accordance with manufacture's recommendations for applications and design loads indicated.

4. All fasteners and mounting hardware are to be from the same manufacturer as the rack system and of material recommended by the rack system manufacturer.

5. Provide a continuous equipment grounding system for all racks with screw type connections to each rack and to each photovoltaic module. (WEEB style ground washers may be accepted upon review) Connect equipment ground systems directly to the building main ground system bus.

2.3 INVERTERS

A. Provide grid connected inverters specifically designed for photovoltaic systems, sized as shown for exterior application mounted and secured to the ground-mounted racking system.

1. String Inverters: SMA-Tripower 20000TS-US

2. Micro-inverters: enPhase M250-60-2LL-S22/S23/S24

B. Inverter to meet IEEE 519 for total harmonic distortion

C. Design of inverters rated for the dc voltage from the photovoltaic array with the following features and components:

1. Internal, input parallel combiner
2. No-load break input dc disconnect switch.
3. DC rated input contactor for back feed protection
4. DC surge and fault protection
5. Three phase, dry type, isolation transformer or solid state technology with 208-volt secondary, 220degree C temperature, flame retardant, insulation materials and copper windings. OR if Inverters complies with IEEE 519 for harmonic distortion without an isolation transformer, voltage matching and additional harmonic isolation can be done by a separate field-installed

transformer.
6. AC-volt rated output contactor
7. Pre-charge circuit to minimize in-rush current and nuisance trips
8. AC surge protection
9. AC-volt rated output circuit breaker
10. Integrated control system with RS 485 Modbus communications
11. Provide a Revenue grade meter integral to the inverter, or with the monitoring system.

D. Interior Inverters to be furnished in a minimum NEMA 1 enclosure

E. Inverter to comply with UL 1741, IEEE 929, IEEE 1547, IEEE 519 and ANSI 62.41

F. Inverter to have efficiency rating of at least 98 percent and average operating efficiency of at least 96%

G. Inverter to have a maximum heat rise of 50 degrees C at an ambient temperature of 50 degrees C

H. Provide provisions for mounting inverter to the wall or acceptable concrete pad.

2.4 CIRCUIT COMBINERS

A. Provide fused circuit combiners with the following features and ratings at each location two or more photovoltaic panels are to be connected together:

1. UL Inc. Listed to UL-508A
2. Up to 1000-volt dc rated with integral lightning protection.
3. Single, dual and triple outputs as required
4. Continuous duty rated
5. Provide each exterior circuit combiner in a NEMA 3R or NEMA 4 enclosure
6. Provide labels for each interior component
7. Provide descriptive label on exterior door
8. All internal and external wiring to be landed on labeled terminal blocks
9. Provide individual fusing for each input
10. Provide brackets for outdoor mounting on the photovoltaic module racks.

2.5 WIRING AND WIREWAYS

A. Provide all interconnecting wiring and wire ways as specified below

B. All wiring for the photovoltaic system is to be insulated per NEC. Conductors are to be sized to limit voltage drop from the circuit combiners to the inverter input to less than 2 percent. Conductor sizing is to also consider CEC requirements for temperature and number of current carrying conductors in a raceway.

C. Conduits within the building and from circuit combiners to the inverters are to be installed in, RGS, IMC or EMT where not subject to Physical Damage. Utilize GRS conduit where subject to physical damage.

D. Provide labeling for each conduit, each wire and each wire way.

2.6 OPERATION, MONITORING AND CONTROL

A. Solar Electric Monitoring System may include the following:

1. 24x7 monitoring service
2. Web-based views showing how the solar electric system is operating.
3. Automatic calculation of reduction in greenhouse gas emissions

4. Automatic email alerts to your system installer or maintenance service provider
5. Communications via locations Internet broadband link
6. Online storage of data and system information, hosted at a data center
7. Revenue-grade metering and reporting for tracking building energy use and total generated renewable energy suitable for quantifying Performance- Based Incentives such as Renewable Energy Credits (REC)

B. Basic Weather Station for measuring insolation, air temperature and solar module temperature

C. Internet-based communications

2.7 SOURCE QUALITY CONTROL

A. Tests: Factory test equipment and provide certified factory test reports as follows:

1. Photovoltaic modules: Provide copies of test reports for tests done on similar modules at PTC Rating and factory test at least I % of actual modules to be provided demonstrating
   a. Peak power output (Pmax)
   b. Maximum power voltage (Vmp)
   c. Maximum power current (Imp)
   d. Open circuit voltage (Voc)
   e. Short circuit current (Isc)
   f. Short circuit temperature coefficient
   g. Open circuit voltage coefficient

2. Inverters: Factory test each inverter to be provided demonstrating the following:
   a. Inverter Efficiency in percent
   b. Total harmonic distortion
   c. Noise level
   d. Temperature rise

3. Monitoring and Control System: Factory test the complete Monitoring and Control System and submit test reports certifying each aspect of the system has functioned properly.

B. Inspections: The Owners and its representatives reserve the right to visit any facility manufacturing components or assembling components and systems for the photovoltaic power supply systems during the manufacture of equipment for this Contract. This includes witnessing any tests specified herein.

PART 3 - PART 3 EXECUTION

3.1 PREPARATION

A. The Installation of the photovoltaic power supply systems must be coordinated with other work done under this Contract. Provide a detailed schedule of all activities as required,

B. Review activities and work schedules of other work on the site.

C. Coordinate site specific information

3.2 INSTALLATION

A. General: Install the photovoltaic power supply systems in accordance with the manufacturer's recommendations and approved shop drawings and as specified

B. Coordinate all work with all other work on the site.

C. Ground Mounting

1. Move material, modules and racking using access paths approved by the Owner.
2. As part of Base Scope of Work, restore any damaged vegetation due to movement of materials and equipment, on-site storage and installation of the PV system.

D. Wiring and wire ways

1. Utilize integral wiring and connectors provided with photovoltaic modules for series connection wiring from individual photovoltaic modules to adjacent modules. Secure this wiring to modules and mounting rack systems with black UV rated plastic wire ties at distances not greater then every twelve inches.
2. Provide up to 1000-volt insulated, copper conductors in conduit for all parallel connections from series connected panel groups to circuit combiners Size conductors for 156 percent of peak current calculated for the circuit.
3. Provide Aluminum, IMC or galvanized steel conduit for all interior exposed conduit. Secure exposed conduit to mounting racks with approved conduit clamps at distances not greater then every three feet. Provide up to 1,000-volt insulated, copper conductors in conduit for all connections between circuit combiners. Provide rigid aluminum, rigid galvanized steel conduit for all exterior exposed conduit subject to damage. Secure exposed conduit to mounting racks with appropriate straps or clamps at distances not greater then every three feet.
4. Size conductors for 156 percent of peak current calculated for the circuit.
5. Provide labels for all conductors, conduits, modules, combiners, boxes and inverters as required by Specifications.

E. Provide complete grounding systems as per Articles 250 and 690 of the CEC

F. Inverters and isolation transformers:

1. Provide all mounting hardware.
2. Install in the locations provided as coordinated with Architect.
3. Furnish, install and terminate all wiring and wire ways for all connections.
4. Provide complete grounding system Per Articles 250 and 690 of the CEC.

3.3 FIELD QUALITY CONTROL

A. Tests: After installation of the complete system and before connection to the unit substation, provide a test of the system to demonstrate:

1. Proper connection of all components
2. kW output of system is as required by these specifications
3. All controls and monitoring function correctly
4. All protective devices function correctly

B. Submit for approval the test procedure prior to beginning these tests.

C. Provide all equipment necessary to conduct all tests.

D. If necessary for the proper operation of the system during testing, provide for temporary connections to the buildings electrical system.

E. Provide for connections to the Internet to demonstrate the on-line monitoring features of the control and monitoring system.

3.4 COMMISSIONING AND OPERATION DEMONSTRATION

A. Perform a complete system commissioning record of all measured data, findings and recommendations.

B. Furnish the services of a qualified representative of the PVSI to demonstrate the proper operation and instruct the owner's staff on the equipment's operation and maintenance, as specified herein.

3.5 TRAINING

A. Following complete installation and field-testing; provide training in the operation, troubleshooting and maintenance of the equipment as specified in This Section.

END OF SECTION