

# Technical Specifications for PV Lighting Systems Virgin Island Energy Office

## Request for Quotation

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# 1. Introduction

This request for proposals presents requirements for PV lighting systems and equipment to be installed on the islands of St. Croix, St. Thomas and St. John in the U.S. Virgin Islands. The intent of this specification is to detail project requirements, and to give the bidder a clear understanding of customer expectations and overall requirements of this bid. Forms and instructions for submitting bids and required information are also included.

## 1.1 General Project Requirements

- Provide and install complete photovoltaic-powered outdoor lighting systems
- Specify layout and location of the systems at each site
- Deliver, assemble and install the systems
- Provide required documentation and on-site operator instructions during installation
- Conduct acceptance testing on each system and a minimum of one-hour training for each design on the operation and maintenance of the systems
- Meet or exceed the lighting requirements both in the amount of illumination provides, as well as the time of operation
- System should require no regular maintenance except for scheduled replacement of lamps and batteries (3-year minimum)
- Reduce the risk of vandalism, theft and personal injury in the installation and operation of the systems

## 1.2 Schedule

- Installation and operation must be completed within 60 days after contract award.
- Contractor must coordinate installation schedule with the U.S. Virgin Islands Energy Office and those responsible for each site

## 1.3 Proposal Requirements and Award Criteria

The following outlines requirements for responsive proposals. Sufficient detail on these items must be provided for consideration in this quotation. At a minimum, each proposal must include:

- Bidder experience, capabilities and qualifications. Complete form in appendix - experience and qualifications, field experience, references and applicable licenses
- Field experience and reliability of the same or similar designs
- Electrical and mechanical drawings
- Complete documentation package, including product literature and specifications for complete system and major components, and operating and maintenance instructions
- Photometric performance of lighting fixtures and projected illumination levels
- System sizing and design estimates for PV array, battery and lighting load
- Total price for equipment and installation. Any or all of the individual applications may be bid, however, bids for each site must be listed separately. Bids for warranty service shall be itemized separately.
- Contractor's proposed schedule for completing installation and acceptance testing.

Evaluation criteria for proposals shall be weighted according to:

- Quality of the design in meeting the performance requirements and in reducing the risk of vandalism, theft, storm damage and personal injury (20%)
- Prospects for minimizing maintenance and maximizing reliability (20%)
- Total price (20%)
- Capability of the bidder to satisfactorily implement the project (20%)
- Aesthetics (20%).

Proposals must be delivered no later than 10 May 2002.

## **2. Site and Application Descriptions**

This request for quotation calls for the turnkey installation of stand-alone PV lighting systems at facilities on the islands of St. Croix, St. Thomas and St. John in the U.S. Virgin Islands. Prevailing conditions at these sites should be considered in any bids, including system locations, shading, accessibility, and potential for vandalism or theft of components. Each site has acceptable solar access and mounting locations for the systems. The contact individual responsible for site operations will work with the contractor to determine specific locations for PV lighting system installations. Appendix section 7.1 provides details and information about the sites and systems to be installed at each location.

## **3. Equipment Requirements**

### **3.1 Photovoltaic Modules and Array**

Array surface area must be limited due to mechanical and wind load constraints on the pole mounted arrays. For these reasons, higher efficiency modules are strongly desired to minimize array surface area requirements. The PV modules used in these systems must also meet industry-accepted standards for performance, reliability, safety and other considerations as outlined below:

- Photovoltaic modules must be UL-listed and meet or exceed IEEE Std. 1262 or equivalent standard.
- Either crystalline or polycrystalline silicon flat-plate PV modules are required; thin-film PV modules are not acceptable for these applications due to their lower efficiencies and larger surface areas required.
- Due to expected high wind loads, and subsequent potential for damage from flying debris, all PV arrays must be installed and mounted in a horizontal orientation. This provision also eliminates the need to orient the array or installation of the system in a south-facing position required for tilted array.
- Backing plates on the underside of the PV array may be provided for vandalism and damage protection, however, these apparatus should be designed as to not severely restrict air circulation beneath the array, and must not allow module temperatures to exceed 75 degrees C under an ambient temperature of 35 degrees C.

## 3.2 Batteries and Charge Control

The batteries used for these applications must be capable of sustained operation in a warm, tropical climate, and must be sized to deliver at least three (3) years of service while maintaining at least 50 percent of their initial rated capacity. Batteries should not require routine maintenance during their three (3) year service life. Due to cost constraints, it is expected that most bids will offer sealed lead-acid (VRLA) batteries, however, flooded lead-acid types will be considered if the bidder can clearly demonstrate that these batteries will not require any maintenance over a three (3) year service life.

All systems must include battery charge control to protect the battery from overcharge and overdischarge, with appropriate control set points for the type of battery used. A controller or function to turn the light on and off at dusk and dawn is also required, and may be part of the battery charge control. Specifications and sources of batteries and controls needed for replacement must be identified in any proposal.

Following are additional requirements for the batteries and charge control:

- Nominal battery and system operating voltage shall be either 12 or 24 volts DC
- Size of the battery should be at least enough to supply three (3) days of the lighting load from fully charged state while receiving no additional charge from the PV array.
- Maximum allowable depth of discharge should be no more than 80 percent of the nominal battery capacity for the given discharge rates. The specification of the low voltage load disconnect set point of the battery charge controller should be consistent with the maximum allowable depth of discharge for the battery.
- Battery enclosures should be designed to minimize large temperature variations of the battery. Shading from direct sunlight, and surface coating of battery enclosure should minimize direct solar gain to battery subsystem. Battery subsystem design and location should minimize the risk of vandalism, theft and personal injury, and be reasonably accessible to maintenance and service personnel.
- Charge controllers are required and the voltage set points must be properly matched with batteries. Proposals must include manufacturer, model number, charging algorithm and set points for charge controllers. Proposals that do not provide this information will be rejected.
- Any type of charge algorithms are acceptable, however constant voltage or PWM type controls are preferred. Either series or shunt type switching is acceptable, and the regulation switching elements must be solid-state (not electro-mechanical relays). The charge regulation set points must be specified, and be consistent with the type and size of battery used.
- Battery charge voltage temperature compensation must be provided as part of the charge controller, either on board or via an external probe. The temperature compensation coefficients must be specified in the proposal.
- The lighting load controller must activate the light each evening, and operate until dawn unless a low-voltage condition is reached. If this condition is experienced, the lighting controller shall not allow the light to reconnect again that night – and must remain disconnected until the battery has received at least one full day of charge from the PV array. The load reconnect set point must be specified, and should ensure that the battery reaches at least 50 percent state of charge before the lighting load is allowed to reconnect.

## 3.3 Lamps, Ballasts and Fixtures

Lamps, ballasts and fixtures must be suitable for outdoor application in a condensing, corrosive marine climate. All systems will be designed for area lighting and for pole mounting, with the exception of one system that will be used for sign lighting. Specifications and sources of lamps and ballasts needed for regular replacement must be identified in any proposal.

- Lighting fixtures and PV arrays should be mechanically integrated on the pole, at a height no greater than 25 feet above grade, and a height of no less than 18 feet above grade.
- Compact fluorescent lamps are required, operated from either 12 or 24-volt electronic DC ballasts.
- Lamp and ballast lifetimes must meet at a minimum the required three (3) year service life.
- Light fixtures (and lamps) must be designed and selected to meet the minimum required illumination levels of 0.4 footcandle over a 400 square foot area for the area lighting systems. A minimum illuminance of 0.8 footcandle is required over the given area for the sign lighting system.

### **3.4 Light Poles and Support Structures**

Specifications for light poles and support structures used to mount the batteries, PV arrays and light fixtures must be contained in the quotation. Light poles can be made from aluminum, galvanized steel or fiberglass, and must be capable of supporting the entire weight and mechanical loads of all PV lighting system equipment. Evidence of a structural certification, or evaluation by a test lab or structural engineer must be provided with any quotation, for each type of system and mounting configuration offered.

For each pole-mount system, the pole must be directly buried in the ground to a suitable depth and compacted, or the pole must be rigidly attached to a concrete base, footer or other permanent structure. Imbedded in the ground. Suitable augers, and lifting equipment may be required.

### **3.5 System Monitoring**

All PV lighting must include a simple, low-cost elapsed time (hour) meter to record nightly time of load operation. This meter must be installed between the lighting load and battery, and record (in hours), time that power is delivered to the load. This meter must be weather sealed, and visually accessible for operators to take the readings as required, without the need to disable or open up any cabinets or components in the system.

### **3.6 Replacement and Spare Parts**

All system components must be clearly specified as to the type, manufacturer, and model number for later needs for replacement and service as required. Sources for this equipment should also be identified in any proposal. Each system will be supplied with at least one set of replacement lamp(s). These extra lamps will be left with the system manuals supplied to the owner/operators of each system.

## 4. System Documentation and Design Requirements

### 4.1 System Documentation Requirements

It is paramount that the system supplier provides a complete documentation package to the buyer and operator of the system at the completion of these projects. At a minimum, the following items must be supplied as part of the system documentation package:

- Specifications for the overall system and individual components.
- Electrical schematics and mechanical drawings.
- Description and requirements for installation, operation and safety
- Acceptance test, troubleshooting and maintenance procedures.
- Specifications and list of all parts and components supplied with systems, including PV modules, batteries, controllers, lamps, ballasts, fixtures and poles. Special emphasis is placed on anticipated replacement items including batteries, lamps and ballasts.

### 4.2 Electrical Design Requirements

Safe and reliable electrical practices must be adhered to in the design and installation of these PV lighting systems. All system designs and installations must conform to the 1999 National Electrical Code (NEC), including Article 690 and all other relevant sections. A product listing from Underwriter's Laboratory (UL) for the complete systems is desirable, but not required.

The following items will be evaluated as part of the electrical designs for all proposals:

- Use of approved or listed (UL) equipment for the intended application. Especially, all circuit breakers, fuses and disconnects must be listed or recognized for use in DC circuits. Equipment only rated AC circuits will not be accepted. Evidence of these component ratings must be provided in the system design documentation. For example, a fuse manufacturer and part/model number is sufficient to verify proper listing of these components.
- All wiring (conductors) must be properly sized and rated for the application, including ampacity (including temperature deratings), location/application (exposure to elements, enclosure) and voltage drop. Voltage drops between array, battery and ballasts should be less than five (5) percent.
- Specifications and appropriate ratings for required disconnect and overcurrent protection devices such as switches, fuses and circuit breakers. In all cases, some means of isolating the battery should be provided.
- Specifications for electrical system grounding and surge suppression. All PV systems, regardless of operating voltage, must have an equipment ground connecting the exposed metal frames and enclosures to earth. It is not required that a current-carrying conductor in the system be grounded as long as the maximum system voltage is less than 50 volts DC. Surge suppression may be specified to provide some level of lightning protection for ballasts, controllers and other sensitive system components. A ground rod must be installed at each system with a preferred maximum earth resistance of 25 ohms.

### **4.3 Mechanical Design Requirements**

All PV lighting systems shall be mounted to a pole, with the exception of the sign lighting system. The following items will be evaluated as part of the mechanical designs for all proposals:

- Verification that the overall system and mounting system are capable of withstanding wind loads, including compliance with applicable standards and building/structural codes as applicable. Mechanical loads due to the weight of the array, wind forces on the array, the array attachment to the poles and the footings for the poles should be computed in accordance with ANSI/ASCE 7-98. Calculations or certifications from a licensed professional engineer or test lab must be provided verifying that the system can withstand hurricane winds of Category 4 or greater (140 miles per hour).
- Use of appropriate and compatible materials to avoid corrosion and degradation. Direct contact between dissimilar metals must be avoided. Untreated wood or steel and corrosion/weather susceptible materials will not be accepted in any part of the system design.
- Use of appropriate enclosures for batteries, controls and lighting equipment to protect from the elements and to minimize temperature variations
- Ease of installation and access for maintenance (personal lift devices may be required to access batteries, controls, PV array and lighting fixtures)
- Array mounting and orientation should maximize solar gain, and avoid any excessive shading of the array.

### **4.4 Lighting Operation, Illumination and Control Requirements**

- Systems should be adequately sized to operate the lighting load from dusk to dawn, year round, while maintaining acceptable battery state of charge and required three (3) year lifetime.
- The lighting controller must be capable of operating the lighting load from dusk to dawn, or any lesser period as required by the operator. A load timer control is required for operators to change duty cycle as needed.
- Provision for turning the lights on during the day must also be provided for maintenance and check out.
- A minimum illuminance of 0.4 footcandle is required over a 400 square foot area for the area lighting systems. A minimum illuminance of 0.8 footcandle is required over the given area for the sign lighting systems.
- A uniformity ratio (average to minimum illuminance) of 5:1 should not be exceeded over the specified area for either area or sign lighting systems.

## 5. System Commissioning and Warranties

### 5.1 Acceptance Testing, Performance Monitoring and User Training

- A third-party agent will work closely with the vendor/installer to conduct acceptance testing and ensure that all project specifications have been met. The system installer will be required to be available and present for the acceptance tests. In addition, final contract payment will be tied to successfully completing acceptance testing.
- Measurements may include array performance, verification of proper charge control operation and light control function, ground-level illuminance, and nightly time of operation.
- System will be monitored using the elapsed time meters specified and required above to document average daily performance (time of light operation).
- The contractor is required to provide a minimum of one hour of training to the buyer for each individual model of designs installed. Training topics will include component descriptions and specifications, theory of operation, maintenance requirements and schedule, instrumentation and test points, diagnostics and troubleshooting, safety precautions and record keeping.

### 5.2 System and Component Warranties

The supplier/installer must provide warranties on both the complete system and individual components. The methods for implementing a warranty provision must be clearly established in the proposal documentation, and handled by the system supplier/installer as the single point-of-contact for warranty service with the buyer. At the buyer's discretion, additional service contracts may be required and will be negotiated in the final contract for purchase.

At a minimum, the following warranty information is required in proposals:

- Two-year, complete system-level warranty for the no-cost replacement of any defective component.
- Individual warranties for major system components such as PV modules, batteries, and controls.\
- PV modules must have a minimum ten-year limited manufacturer's warranty on modules to maintain at least 80 percent of initial rated output.
- Batteries, lamps and ballasts must have a minimum of three (3) year warranties. Batteries must deliver at least three (3) years of service life while maintaining at least 50 percent of initial rated capacity.
- Supplier/installer may provide extended warranty or service contract beyond baseline warranties offered by the system supplier. Extended warranties should be handled by the system installer, and should be based on a per hour charge for additional labor required plus equipment.

## 6. References and Resources

All reference documents and resources are available on the Internet in Adobe PDF format:

1. Photovoltaic Lighting Systems - A Decision Maker's Guide, Volume 1: Photovoltaic Lighting Applications  
<http://www.fsec.ucf.edu/PVT/RESOURCES/pdf/tbs/FSEC-PV-RR-54-1998-1.pdf>
2. Photovoltaic Lighting Systems - A Decision Maker's Guide, Volume 2: PV Lighting Components and System Design  
<http://www.fsec.ucf.edu/PVT/RESOURCES/pdf/tbs/FSEC-PV-RR-54-1998-2.pdf>
3. Photovoltaic Lighting Systems - A Decision Maker's Guide, Volume 3: Technical Specifications and Case Studies  
<http://www.fsec.ucf.edu/PVT/RESOURCES/pdf/tbs/FSEC-PV-RR-54-1998-3.pdf>
4. Photovoltaic Lighting Systems - A Decision Maker's Guide, Volume 4: Lighting Fundamentals and Equipment  
<http://www.fsec.ucf.edu/PVT/RESOURCES/pdf/tbs/FSEC-PV-RR-54-1998-4.pdf>
5. Fundamental and Applications of Batteries and Charge Control in Photovoltaic Systems  
<http://www.fsec.ucf.edu/PVT/RESOURCES/pdf/tbs/PVBatteryFundamentals.PDF>
6. Photovoltaic Power Systems and the National Electrical Code: Suggested Practices  
<http://www.NMSU.Edu/~tdi/pvandnec.htm>

## 7. Appendix

### 7.1 Site and Application Information

Site/ Location	Number/Type of Systems to be Installed	Application Information	Contact Individual	Links to Images and Photographs of Installation Site
<b>St. Croix</b>				
VI Government Property & Procurement Administration Offices	2 pole mounted lighting systems and 1 sign lighting system	Security lighting. Pole lighting is required for parking area approximately 50 feet by 80 feet in area. Sign lighting is required for sign on building, approximately 30 feet long and 2 feet high		<a href="http://www.fsec.ucf.edu/pvt/vieo/VIEOPICS/STCROIX/PV/PROCUREMENTOFFICE_PV_LIGHTS/">http://www.fsec.ucf.edu/pvt/vieo/VIEOPICS/STCROIX/PV/PROCUREMENTOFFICE_PV_LIGHTS/</a>
VITEMA Emergency Management Center	5 pole mounted lighting systems	Lights are required for entry of building on the south side, parking lot on the north side, and near the entrance to the building on the east side, illuminating the stairway leading down the hill		<a href="http://www.fsec.ucf.edu/pvt/vieo/VIEOPICS/STCROIX/PV/VITEMA_PV_LIGHTS/">http://www.fsec.ucf.edu/pvt/vieo/VIEOPICS/STCROIX/PV/VITEMA_PV_LIGHTS/</a>
Red Cross	5 pole mounted lighting systems	Security lighting. Lights are to be installed from parking area to entrance of emergency shelter, from the south side of the building to the parking area on the east side of the building	School principal, Red Cross coordinator	<a href="http://www.fsec.ucf.edu/pvt/vieo/VIEOPICS/STCROIX/PV/REDCROSSSHELTER_PV_LIGHTS/">http://www.fsec.ucf.edu/pvt/vieo/VIEOPICS/STCROIX/PV/REDCROSSSHELTER_PV_LIGHTS/</a>
<b>St. Thomas</b>				
Seaview Nursing Facility	3 pole mounted lighting systems			<a href="http://www.fsec.ucf.edu/pvt/vieo/VIEOPICS/STTHOMAS/PV/SEAVIEW_PV/">http://www.fsec.ucf.edu/pvt/vieo/VIEOPICS/STTHOMAS/PV/SEAVIEW_PV/</a>
Red Cross Facility				No images available
<b>St. John</b>				
John Folly's Institute	2 pole mounted lighting systems	Security lighting. PV lighting systems are required for lighting in the parking area and entrance to emergency management facility		<a href="http://www.fsec.ucf.edu/pvt/vieo/VIEOPICS/STJOHN/PV_DHW/JOHN_FARLEY_INSTITUTE_PV_DHW/">http://www.fsec.ucf.edu/pvt/vieo/VIEOPICS/STJOHN/PV_DHW/JOHN_FARLEY_INSTITUTE_PV_DHW/</a>

## 7.2 Photovoltaic Lighting System Request for Quotation Form

Vendor Name \_\_\_\_\_

Date \_\_\_\_\_

Site	No. of Systems per Site	System Manufacturer and Model No.	Manufacturer, Model and No. of PV Modules	Manufacturer, Model and No. of Batteries	Manufacturer and Model of Controllers	Manufacturer, Model, Number and Lamps/Ballasts	Equipment and Hardware Cost (\$)	Installation Labor Costs (\$)	Total Installed System Cost (\$)

### Applicant Check List

The following information is requested of the bidder:

- \_\_\_\_\_ Request for Quotation Form
- \_\_\_\_\_ Contractor Information Form
- \_\_\_\_\_ PV Lighting System and Component Warranty Information
- \_\_\_\_\_ Copy of U.S. Virgin Islands "Contractors License" or "Installation of Equipment" License
- \_\_\_\_\_ Copy of Workmen's Compensation Certificate of Insurance
- \_\_\_\_\_ Statement of experience and abilities relative to performing described statement of work
- \_\_\_\_\_ Statement describing the firm's current projects and ability to complete quoted work in reasonable time frame



## 7.4 Contractor Information Form

### Contractor Identification

Company Name	
Address, Street	
City, Zip, Island	
Telephone Numbers	
Fax Number	
E-Mail	
Contact Individual	

### Contractor License Information

All contractors must possess a current U.S. Virgin Islands "Contractor's License", or "Installation of Equipment" license qualifying them to install PV lighting systems in the Territory. Contractors shall provide the information requested below and submit a copy of their current license(s).

License Number	Licensing Authority	Expiration Date

Service Area: \_\_\_\_\_ St. Croix      \_\_\_\_\_ St. Thomas      \_\_\_\_\_ St. John

### References

Please provide four (4) references for prior work with solar or photovoltaic systems:

Name	Address	Telephone Number	Types of Systems Installed	Installation Date

Submitted by \_\_\_\_\_ Signature \_\_\_\_\_ Date \_\_\_\_\_