Oregon Solar Photovoltaic Project

Appendix A

Technical Specification

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Appendix A: Technical Specification

A-1 Introduction and Bidder Responsibilities

PacifiCorp is seeking a firm (“Bidder”) to provide comprehensive design, construction, startup and commissioning services for a nominal 500 Kwac to 2 MWAC solar photovoltaic facility (“Project”).

The Bidder shall provide all required services and materials for the successful completion of the Project. Bidder shall include environmental permitting, site acquisition, design, engineering, procurement of equipment, site prep work, foundations, installation of all equipment, bulk material and commodities supply and site finishing work. The Bidder shall also include project management, construction management, start-up and commissioning, as well as testing of work.

The following sections describe the technical requirements for the photovoltaic plant. This document sets forth the Scope of Services required for Bidder to fulfill such obligations. The project division of responsibility (DOR) is attached in Appendix 7.

A-2 Site and Facility Description

The Bidder shall prepare a detailed Site and Facility description to meet the following specifications:

Area map (State-level view) indicating development location, including state, county and local coordinates.

Local view (e.g., artists concept, Google® map image, site pictures) indicating development, topography, highways, major roads, transmission lines, substation, 100 year flood-plain, adjacent structures, existing paved roads, existing gravel/dirt roads, as well as other features such as lakes, rivers, creeks, and rail lines.

Site plan including the following and as applicable:

- Array Field
- Inverters and/or inverter building(s)
- Underground electric cable trenches
- Switchgear
- Communications building
- Electrical metering point (if not in communication building)
- Proposed electric utility interconnection
- Operation and maintenance building(s), parking, viewing locations, etc.
- Entrance road(s)
- Fencing
- Main gate
- Maintenance roads
- Construction entrance
- Construction staging and laydown area(s) and footprints
- Site perimeter dimensions

Inverter building floor plan and elevations, as applicable.

Detailed view of the proposed sub-array (i.e. the portion of the PV array feeding a single inverter, or inverter building).

Detailed top view of the proposed PV mounting system (including module dimensions, and row-to-row spacing).

Detailed side and/or front view of the proposed PV mounting system and footer. Include dimensions of height, depth of penetration, and method for installing ground posts.

Electrical building/substation floor plan and elevations.

Cross-section of electrical trench for wiring from combiner boxes to inverter building.

Typical cross-section of maintenance roads indicating road design, materials. Denote the intended vehicle type(s) for the road (e.g. heavy equipment, pickup, or four-wheeler).

Elevation of fencing.

Communications building floor plan and elevations

Operations and maintenance building floor plan and elevations

A-3 Site Acquisition and Development

Bidder shall demonstrate site control of a suitable project location by providing the following:

(1) evidence of site ownership,
(2) an option to purchase the site, or
(3) an option for a long-term lease or easement.

Land rights control shall include, but not be limited to:

(1) provision for installation and operation of a PV system;
(2) provision for installation and operation of a meteorological tower;
(3) Provision for interconnection with either electricity distribution or transmission system:
(4) provision for installation and operation of a medium or high voltage substation;
(5) provision for access rights from any entity who may need to be required to grant access through their land holdings, such as surrounding land owners, for the purpose of the installation and operation of the project; and
(6) any other land related agreements. Bidders shall demonstrate that there are no prevailing land usage agreements, such as subsurface or water rights assignments, which will impinge on
the installation and operation of the Facility. Long-term lease agreements and easements shall be assignable to PacifiCorp.

Studies required for successful completion of site development, including geotechnical analytic results of the site, must be provided to PacifiCorp for review and approval before physical site development activities commence. Bidder must provide these documents to PacifiCorp and allow for ten (10) business days for PacifiCorp review and comment. The following is a list of site acquisition and development activities required of the selected Bidder.

Provide geotechnical report for the selected site, including soil conditions, and recommendations.

Clear, grub, and otherwise prepare the site as necessary to accommodate and complete the project in accordance with PacifiCorp guidelines.

Construct all roads, foundations, electrical systems, ancillary structures, storage facilities, and fencing and erect and commission the PV system in the locations and orientations set forth in the site plan and site layout drawings and in accordance with the design specifications.

Provide for adequate site access – all road features shall be designed and constructed to allow delivery, access and egress of all project components and construction equipment to their respective design and working locations.

Ensure all roads, storage areas, and other project civil design features meet all county, state and local and federal design and environmental requirements.

Maintain dust compliance in accordance with state or county requirements until Final Acceptance is achieved.

Install all control, monitoring, communications, security systems (fencing) and equipment in accordance with the engineering and design documents.

Bidder shall utilize sustainable practices where practical, such as recycling shipping containers; pallets, etc. All materials that are not reasonably recyclable shall be disposed in a PacifiCorp approved landfill.

Clean up any spill or contamination that may occur on site in accordance with approved standard procedures.

Coordinate all required interaction with the site owner or designated authority, if applicable.

Provide all other required site maintenance, such as mowing or other site-specific activities.

Submit a Phase I Environmental Assessment for the Site and all access roads in accordance with ASTM standards, for PacifiCorp review and acceptance.

A-4 Design and Engineering

Bidder is responsible for all engineering for the project. All design drawings, specifications and calculations shall be signed and sealed by a professional engineer of record registered in the state of Oregon. Bidder shall submit to PacifiCorp 90% complete design drawings, data and
documents for review and comment. These engineered design drawings, data, and documents must be submitted to PacifiCorp for review and approval before construction is to begin. PacifiCorp will have ten (10) business days to review and comment. Construction shall not commence until drawings and specifications are signed, sealed, and issued for construction also known as “approved for construction” documents.

Any third party or independent engineering reviews shall be provided to PacifiCorp for information and review.

Certain equipment must comply with PacifiCorp specifications. Refer to Appendix 8 PacifiCorp Specifications.

**A-4.1 Site Layout, Maps, Line Drawings**

Prior to beginning construction or procuring equipment, Bidder will submit to PacifiCorp site layout design drawings, data, and documents for review and approval. The drawings, data, and documents will be submitted to PacifiCorp when they are ready for review.

**A-4.2 Structural Engineering**

The Bidder shall design the PV arrays’ mounting systems, foundations, and piers. The design shall be based upon standard industry practice, including the requirements of applicable codes, standards, and permits, as well as the information/specifications provided by the module, inverter, transformer, switchgear, racking, and all other vendors.

**A-4.3 Civil Engineering**

The Bidder shall design all systems in accordance with local codes and standards. Bidder shall design necessary road improvements to meet State of Oregon Transportation or local codes, standards, Conditional Use Permit stipulations and conditions, and requirements presented by construction equipment, delivery vehicles and operation and maintenance traffic. The design will include vehicle access roads to provide maintenance/cleaning access with a thirty (30) year service life and the appropriate surfacing material, which shall comply with Oregon or local county surface material requirements.

**A-4.3.1 Erosion Control**

The Bidder will submit a location specific erosion control plan for PacifiCorp approval prior to construction.

The Bidder will be responsible for constructing and maintaining erosion control in accordance with all the conditions set forth in its National Pollution Discharge Elimination System (NPDES) Permit, including arranging for the required inspections.

The Bidder will plan and execute construction of earthwork methods to control surface drainage from cuts and fills and prevent erosion and sedimentation.

The Bidder will pay for all fines and damages resulting including any and all NPDES permit violations.
A-4.3.2 Weed Control
The Bidder will prepare and provide PacifiCorp with a plan to prevent the transportation of noxious weeds to the site from vehicles and materials entering the construction area.

The plan shall be in effect before any materials will be allowed to be transported to the site.

The Bidder will also prepare and provide to PacifiCorp a soil treatment plan to prevent weed growth on the site. This plan shall include the application of a soil sterilizer or long term pre-emergent in areas occupied by the equipment footprint, and in those areas required for operation and maintenance of the Facility. The weed control plan shall comply with local and permit requirements. The soil treatment plan shall be submitted to PacifiCorp for review and approval. PacifiCorp shall have ten (10) days to review and approve weed control plan. Weed control application shall meet local environmental code requirements.

All areas of temporary soil disturbance are to be graded and re-vegetated in a timely manner to limit erosion.

A-4.3.3 Grading and Drainage
The grading and drainage plan shall be designed and installed in accordance with local code and permit requirements. All structures required for the drainage plan shall comply with Oregon standard specifications for drainage facilities.

A-4.3.4 Dust Control
The Bidder shall apply dust control materials to minimize raising dust from construction operations and traffic, including haul routes. Use only dust control mixtures approved by the local jurisdictions.

A-4.3.5 Fire Prevention/Protection
As part of its Safety Plan, the Bidder shall include a fire prevention and response plan.

The Bidder shall perform all work in a fire-safe manner.

The Bidder shall supply and maintain on site and on each piece of equipment, adequate fire fighting equipment capable of extinguishing incident fires.

The Bidder shall comply with all state, federal, and local fire prevention regulations.

A-4.3.6 Construction Facilities
Prior to moving onto the site, the Bidder will submit the location and layout of intended staging areas, parking areas, storage areas, security fence, office areas, workshops and other temporary facilities.

A-4.3.7 Roads and Construction Access
Bidder shall provide cross sections of proposed roadways, including widths and pavement sections.

A.4.3.7.1 Construction Access
The Bidder shall abide by all load limits established by the Oregon Department of Transportation (ODOT).
The Bidder shall be responsible for providing, operating and maintaining equipment, services, and personnel with traffic control and protective devices, meeting the requirements of the Manual of Uniform Traffic Code Devices (MUTCD) as required to allow traffic flow on haul routes and on site access roads in a safe manner and pay all associated costs.

The Bidder is responsible for construction of temporary access around areas of excavation and other construction activity, as required. Temporary construction roads and staging areas shall be completely removed in their entirety after construction is complete and restored in strict accordance with all permit requirements.

The Bidder shall be responsible for making necessary improvements to state, county and other roads outside the project area, as required, to allow delivery of the components.

**A.4.3.7.2. On-Site Roads**

Bidder shall provide a minimum set back of twenty feet (20') between the perimeter fence line and any equipment or as directed by local code authorities if more distance is required. This set back space shall be used as a perimeter road.

For interior service roads as necessary, allow a minimum road width of twenty feet (20') between PV array blocks. Pathways between rows of modules and circuit blocks may be less than 20 feet, however, the designer should consider procedures required for accessing all modules and array equipment for maintenance and repairs.

Road surfacing shall meet local fire and emergency vehicle access requirements.

**A.4.3.7.3. Site Access Roads**

Site access roads are those off-site roads used to access the Facility. The Bidder shall design all site access roads with a thirty (30) year service life to satisfy the loading requirements of the equipment vendors and to provide all-weather access for operation and maintenance of the Facility. This design shall be based on sufficient soils and subsurface investigation by a qualified professional to ensure that the constructed road will meet its intended purpose.

Site access roads pavement sections shall be designed in accordance with geotechnical requirements and have access suitable for construction, operation and maintenance of the Facility, as well as emergency access. Site access roadway design shall comply with local permit requirements.

Surfacing shall be provided to meet the requirements for a fire access road, as described by the ODOT or the fire authority, or as required to support the heaviest transportation vehicle planned for delivery.

Shoulders are to be compacted native or engineered soil suitable to accommodate heavy equipment travel.

Temporary shoulders not required for operation and maintenance are to be reclaimed and vegetated by the Bidder at the conclusion of the installation that affects a given access road in accordance with ODOT standard specifications.
A-4.4 Earthwork

A-4.4.1 General

Earthwork includes, but is not limited to:

Site clearing.

Rough and finish grading.

Excavating (including rock excavation), filling and compacting to attain required grades and densities.

Trench excavation (including rock excavation) and backfill for underground utilities.

Excavation and backfill (including rock excavation) for footings.

Installation of granular fill and surfacing around concrete structures, within roadways, drainage facilities, towers, and related site structures.

The Bidder shall make its own estimate of the types and of the extent of the various materials to be encountered or required to accomplish the work.

A-4.4.2 Excavation

The Bidder shall be responsible for making all excavations in a safe manner and consistent with the requirements of the Occupational Safety and Health Administration (OSHA)

The Bidder shall provide adequate measures to retain excavation side slopes to ensure that structures, equipment, and persons working in or near the excavation are protected.

The Bidder shall protect all above grade and below grade utilities.

A-4.4.3 Site Work Materials Requirements and Uses

Fill Material is to be onsite excavated material or imported material as required by the geotechnical investigation.

A-4.4.4 Compaction Requirements

In areas where compaction is necessary or required per the geotechnical analysis, a minimum compaction of ninety-eight (98%) of standard proctor, ASTM D-698 (AASHTO T-180) within 2% of optimum moisture, will be required for all sub and finish grade materials.

A-4.4.5 Culverts

Bidder shall size and install culverts at all locations where cross flows would lead to erosion of the roadway. Culvert sizing and installation shall be in conformance to local authority requirements. Culvert sizing shall be based on engineering calculations performed by a registered civil engineer. All culverts shall conform to ODOT or local county requirements.

A-4.4.6 Construction Signage

Bidder shall provide temporary signage for local traffic control in accordance with ODOT or local county requirements and in accordance with the Agreement.
A-4.4.7  Fencing and Cattle Guards

The Bidder is to supply and install cattle guards at locations where new site access roads cross existing fence lines. In areas where site Access roads cross existing fence lines, Bidder shall coordinate design and installation of fencing and cattle guards with all affected land owners. Bidder shall submit proposed fencing and materials to affected land owners for approval prior to installing any fencing.

The Bidder shall utilize temporary fencing whenever an existing fence is removed and as necessary to maintain security and prevent the movement of livestock.

A-4.4.8  Site Finish Grade

The Bidder shall leave the site in a finished and clean condition upon completion of the work. Efforts shall be made to restore area to a clean and finished condition as soon as practical. The Bidder shall remove all trash, debris and stockpiles and leave the area graded to facilitate proper drainage. The site access roads shall be returned to condition to meet the original specification by repairing road damage, such as ruts, gouges and weather damage that may have occurred during the course of construction.

Site finish grade within the equipment footprint and in areas required for operation and maintenance of the Facility shall be fully stabilized with a dust palliative that meets or exceeds local county requirements. Bidder shall submit finish grade stabilization application plan to PacifiCorp for review and approval. PacifiCorp shall have ten (10) days to review and approve.

The Bidder will seed and mulch all areas of the project, which have been disturbed beyond the permanent portion of the site and access roads. Areas that were originally agricultural use that will return to agricultural use will be scarified and left in a graded condition ready to return to agricultural use. Provisions of the stormwater pollution prevention plan (SWPPP) for final stormwater drainage will be implemented.

A-4.5  Project Design and BETC requirements¹

Bidder’s design shall conform to all requirement of the State of Oregon “Business Energy Tax Credit” (BETC) program. The Bidder shall be responsible for verifying the requirements for participating in BETC. However, Bidder shall be aware that the minimum requirements set forth in this document shall supersede any specifications by BETC should the requirements of this document be more stringent. The general requirements are, but not limited to the following:

As set forth by BETC all qualifying installations must meet the following minimum PV system specifications:

1. The facility must be designed to last at least 25 years (with minimal maintenance) and deliver or exceed performance expectations of a well designed facility.

¹ Refer to the following website for current information regarding BETC:
http://www.oregon.gov/ENERGY/CONS/BUS/BETC.shtml
2. Installation must meet industry standards.
3. Facility must be permitted and in compliance with all applicable building and electrical codes.
4. All facility equipment must be rated for the temperature and exposure conditions in which it will operate continuously for twenty-five (25) years or more.
5. All facility components must be new (modules, inverter, batteries, mounting hardware).
6. Array mounting must not reduce the expected life or durability of the structure on which it is located.
7. The facility must be designed for optimal performance without sacrificing good aesthetics.
8. The facility must include all code required signage and a customer manual.
9. A customer manual must contain the following information:
   a. Facility documentation
      i. As-built drawings that accurately describe the components installed and the wiring design, including wire sizes, and estimated length of wire runs
      ii. Facility site plan that indicates array, inverter, and all disconnect locations
      iii. The sun chart used to determine facility total solar resource fraction
      iv. Operation and maintenance requirements including the name and phone number of person(s) or company to call in the case of a facility failure
   b. Warranties and installation documentation
      i. Minimum two-year Bidder warranty for materials and workmanship
      ii. Manufacturer’s warranty for PV modules and inverter
      iii. Permit documentation
   c. Manuals and data sheets
      i. Bill of material listing all primary facility components including part model numbers or designation
      ii. Inverter Owner’s Manual
      iii. Manufacturer data sheets for major components, including but not limited to: inverters, modules, charge controller.
10. All facilities must include one or more meters that are capable of recording the facility’s total energy production. Meters must be equivalent to American National Standards Institute (ANSI) certified revenue meters with a 0.5 or better accuracy class and, if digital, it must have non-volatile data memory.
11. Array must be sized to operate within the current, voltage and power limits approved and warranted by the inverter manufacturer. The temperature-adjusted voltage must remain within the inverter limits at the historical record low temperature for the location in which it is installed.
12. Wires must be sized to keep the total voltage drop below 2 percent on the direct-current (DC) conductors from the array to the inverter including the existing wire whips on the
PV modules, and/or 2 percent on the alternating-current (AC) conductors from the inverter to the point of interconnection (total not to exceed 4 percent).

13. Voltage mismatch caused by practical shading of the array, different orientations of string and localized shading events are minimized.

14. Bidder must provide a minimum 24-month full warranty on parts and labor to PacifiCorp.

15. System Total Solar Resource Fraction (TSRF) must be greater than 75 percent.

**A-4.6 Electrical Engineering**

Bidder shall provide all electrical engineering design services. Electrical engineering design shall be based upon a thirty (30) year service life, meeting applicable codes and standards and the requirements of the interconnecting utility.

The engineering and design shall include the appropriate sizing and cabling (above and below ground) that will connect all applicable equipment to the point of interconnection. The project electrical system shall be designed for electrical system losses on the DC wiring system shall have no more than 2 percent and losses on the AC wiring system no more than 2 percent.

All protection equipment used throughout the system shall be sized and specified to reduce damage to all components and to the interconnection point in the event of electrical failure.

The above ground portion of the electrical systems shall be neatly routed to facilitate access, troubleshooting, maintenance, etc.

The electrical design shall include the design of equipment grounding and lightning and surge protection for the entire PV Plant site.

Bidder shall design and specify all communications hardware and software required for system protection and remote monitoring and control. All monitoring and communication supplemental equipment and cabling shall be designed and specified, subject to PacifiCorp approval.

Bidder shall design and specify any necessary power, communications, and internet facilities required for PV Plant operation and control, remote monitoring, and the Facility security system.

Bidder shall provide a comprehensive statement on the overall power factor control strategy for the entire field from inverter output to MV system to substation delivery to grid. The power delivered to the Grid must at all times meet the interconnect requirements for power factor. A one-line drawing is required to illustrate the power factor control strategy.

Bidder shall provide provisions to isolate equipment to facilitate panel/inverter maintenance and minimize impact to Facility production.

**A-4.7 Communication System (Fiber Optic Cable)**

The Bidder shall procure and install the fiber optic cable in accordance with the PV specifications. Fiber cable is to generally be placed in the trench with the collector system cables.
This work consists of furnishing and installing all materials and equipment necessary to complete the communication (data collection) cable installation. This includes, but is not limited to the fiber optic cable, conduit, pull boxes, terminations, connectors, panels and other equipment as necessary to provide a complete installation that meets the intended use and that meets the requirements of the Bidder.

A-4.7.1 Fiber Optic Cable

The fiber optic cable shall meet or exceed the applicable provisions of:

- CFR 1755.900, RUS Specification for Filled Fiber Optic Cables
- TIA/EIA-455-27A, Method of Measuring (Uncoated) Diameter of Optical Waveguide Fibers
- TIA/EIA-455-28B, Method For Measuring Tensile Failure Point of Optical Waveguide Fibers
- TIA/EIA-455-34, Interconnection Device Insertion Loss Test
- TIA/EIA-455-95, Absolute Optical Power Test for Optical Fibers and Cables
- TIA/EIA-455-103, Buffered Fiber Bend Test
- TIA/EIA-568-B, Commercial Building Telecommunications Cabling Standard
- TIA/EIA-569-B, Commercial Building Standard for Telecommunications Pathway and Spaces
- TIA/EIA-758, Customer-owned Outside Plant Telecommunications Infrastructure Standard
- TIA/EIA-526, Measurement of Optical Power Loss of Installed Fiber Cable Plant
- TIA/EIA-598-A-1, Special Colors for fiber optic cordage
- TIA/EIA-598-B, Color Standard for Optical Fibers
- NFPA 70, National Electric Code

Fibers shall contain no factory splices. All fibers shall be free from imperfections and inclusions that would prevent them from meeting the transmission and mechanical requirements of this application. Anomalies shall not exceed 0.20 dB. The maximum dispersion at 68°F shall be 2.6 ps/nm-km over the range of 1225 to 1330 nm. The cutoff wavelength shall be 1200 nm nominal, and shall have no variation greater than 70 microns.

A-4.7.2 Installation

Double jacket, double armor direct burial fiber optic cables shall be installed in continuous lengths without intermediate splices or as approved by PacifiCorp. The Bidder shall comply with the cable manufacturer’s specifications and recommended procedures including, but not limited to the following:

1. Installation.
2. Proper attachment to the cable strength elements for pulling during installation.
3. Bi-directional pulling.
4. Cable tensile limitations and the tension monitoring procedure.
5. Cable bending radius limitations.
The Bidder shall use the fusion method with local injection and detection for all fiber optic splicing. The average splice loss of each fiber shall be 0.15 dB or less per splice. The average splice loss is defined as the summation of the attenuation as measured in both directions through the fusion splice, divided in half. No individual splice loss measured in a single direction shall exceed 0.20 dB.

The Bidder shall seal all cables where the cable jacket is removed. The cable shall be sealed per the cable manufacturer’s recommendation with an approved blocking material. All below ground splices shall be contained in waterproof splice closures. All splices shall be contained in splice trays utilizing strain relief, such as heat shrink wraps, as recommended by the splice tray manufacturer. Upon sealing the splice closure, the Bidder shall show that the closure maintains 10 psi of pressure for a 24-hour period.

All fusion splicing equipment shall be in good working order, properly calibrated, and meeting all industry standards and safety regulations. Splices shall utilize two half shells bolted together with stainless steel bolts and be fitted with a neoprene gasket. Cable preparation, closure installation and splicing shall be accomplished in accordance with accepted and approved industry standards.

The Bidder shall protect the loops from tangling or kinking. At no time shall the cable’s minimum bending radius specification be violated. To accommodate long, continuous installation lengths, bi-directional pulling of the fiber optic cable is permitted.

**A-4.7.3 Communications System Testing and Warranty**

The Bidder shall test the installed communication system to demonstrate its ability to meet the requirements of its intended use. Testing shall be done twice: when the cable is installed and when the final system interconnections have been made. Testing shall be done using Optical Time Domain Reflectometer (OTDR) testing method.

The Bidder shall submit one hard copy and one electronic copy of the fiber test results to PacifiCorp for approval. The Bidder shall take corrective actions on portions of the fiber installation determined to be out of compliance. Upon acceptance of the cable installation and test results, the Bidder shall submit three hard copies and one electronic copy of the fiber test results to PacifiCorp. The Bidder shall provide an unconditional warranty on all installed cable for a period of two years.

**A-4.7.4 Communications System Documentation**

The Bidder shall provide all documentation pertaining to the materials provided, cable schedules and the installation methods. PacifiCorp approval is required prior to commencement of any work. Bidder will also test the fiber loops and provide loop functional check sheets for each communication circuit to be used.
A-4.8 Security

Bidder shall design the security system for all ground mounted equipment, which shall include the following guidelines:

Perimeter fencing shall be designed and installed in accordance with PacifiCorp specifications.

Spot/flood lights triggered by motion sensors powered by station power with backup battery power shall be installed as follows: two (2) at each entry gate, two (2) in the parking area outside the gate, and two (2) at each building, if applicable.

Perimeter signage shall be provided in accordance with PacifiCorp Standards (see Appendix 11) and shall be installed every 200 feet along the perimeter fence approximately 24” wide and 10” high, in two color stating, in both English and Spanish:

- Danger
- Keep Out!
- Hazardous Voltage Inside
- Will shock, burn or cause death.

A-5 Equipment

Installed equipment and materials shall be new, of good quality and suitable grade for the intended purpose, and not a lower grade or quality than specified in the design and engineering plans or in manufacturers’ recommendations. Where applicable, utility-grade equipment shall be used – commercial or residential grade equipment shall not be acceptable. No equipment shall utilize polychlorinated biphenyls (PCB’s).

If the Bidder proposes to use equipment that is non-utility grade it is the responsibility of the Bidder to identify the equipment.

It is the responsibility of the Bidder to identify any equipment using SF6 gas.

It is the responsibility of the Bidder to identify any proposed batteries, quantities and associated data sheets.

It is the responsibility of the Bidder to provide data sheets and quantities on any proposed chemicals used on Project.

The Bidder shall provide a list of all major equipment and buildings to be purchased, constructed and installed as part of the project. The list shall identify both the item and quantities.

The following is a list of Company Preferences for Major PV Components.

Photovoltaic Modules

- Canadian Solar (Crystalline)
- Kyocera (Crystalline)
- LDK (Crystalline)
SunTech (Crystalline)
SunPower (Crystalline)
Solar Frontier (Crystalline)
SolarWorld (Crystalline)
Solarfun (Crystalline)
Sharp (Crystalline and Thin Film)
Trina (Crystalline)
Yingli (Crystalline)
First Solar (Thin Film)

Single-axis Tracking Systems

Array Technologies
RayTracker
SunPower

Inverters

AE SOLARON
- 250 kW 600 (±330 to ±600 V)
- 333 kW 600 VDC (±330 to ±600 V)
- 500 kW 600 VDC (±330 to ±600 V)

SATCON PowerGate Plus
- 250 kW 600 and 900 VDC
- 375 kW 600 VDC only
- 500 kW 600 and 900 VDC
- 1 MW 600 and 900 VDC

SMA SUNNY CENTRAL
- 400HE
- 500HE
- 630HE
- 500HE-US 98% CEC efficiency - 600 VDC

SIEMENS SINVERT
* multiple models (300MS, 350M, 400MS, 420M, 700MS, 850M, 1000MS, 1300MS, 1400MS, 1700MS)
* Transformerless (500M TL, 100 MS TL, 1500 MS TL, 2000 MS TL)

Bidder shall submit completed forms in Appendix 2 Technical Specifications for all major equipment.
A-5.1 Buildings and Enclosures
Buildings or enclosures with critical and temperature sensitive equipment shall have redundant HVAC systems to support Facility operation.

A-5.2 Coating Specification
All material not naturally corrosion-resistant shall be treated or finished to protect surface and functional integrity under the ambient conditions similar to those expected at the site. Coatings shall be designed for a minimum service life of ten (10) years. Bidder shall provide PacifiCorp with proposed surface coating specification for review and approval. PacifiCorp shall have ten (10) days to review and comment.

A-5.3 Photovoltaic Modules
There are several flat-plate PV module technologies that the Bidder may use including crystalline and thin film type. However, the modules technology shall be proven and used extensively in the field. Experimental or beta type modules are not allowed. Concentrating Solar PV (CPV) systems are not being considered for this RFP.

Multiple PV modules shall be installed in sufficient quantity to form a complete PV solar power generating system to generate the projected mega-watts, alternating current (MWac).

Bidder shall submit a Handling Plan for PV modules that includes recycling and disposal requirements.

PV modules shall be listed by Underwriter’s Laboratories (UL), or another recognized Laboratory.

PV modules shall, at minimum, have the performance specifications identified in Table 1.
<table>
<thead>
<tr>
<th><strong>PV MODULE</strong></th>
<th><strong>REQUIREMENTS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency</td>
<td>Minimum 10% at standard test conditions (STC)</td>
</tr>
<tr>
<td>Maximum DC System Voltage</td>
<td>1000V</td>
</tr>
<tr>
<td>Sustainable Wind Pressure</td>
<td>3,000 Pa or local wind loading requirements, whichever is greater.</td>
</tr>
<tr>
<td>Resistance to Water / Damage</td>
<td>PV modules shall be capable of resisting damage/water penetration when subject to varying weather conditions including dust, rain, washing fluids, and similar intermittent external conditions.</td>
</tr>
<tr>
<td>Resistance to Hail Damage</td>
<td>The modules shall be capable of resisting damage when subjected to hailstorms of a maximum diameter of 28 mm with impact speed of 86 km/h.</td>
</tr>
<tr>
<td>Expected / guaranteed performance degradation factors over 25 years</td>
<td>90% of minimum power at the end of 10 years; 80% of minimum power at the end of the 25 years</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>- 40°F (-40°C) to +176°F (+80°C)</td>
</tr>
</tbody>
</table>

The following is a list of relevant bodies that develop standards for photovoltaic modules and systems (specific standards are included in Table 2):

ANSI (American National Standards Institute)

NIST (National Institute of Standards and Technology)

ASTM (originally American Society for Testing and Materials, now International ASTM)

IEEE (originally Institute of Electrical and Electronics Engineers, now just IEEE)

UL (Underwriters Laboratories, independent product safety certification organization)

SEMI (Semiconductor and Equipment Materials International, non-profit industry group)

CENELEC (European Committee for Electrotechnical Standardization)

IEC (International Electrotechnical Commission)
<table>
<thead>
<tr>
<th>STANDARD</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL 1741</td>
<td>Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources</td>
</tr>
<tr>
<td>UL 1703</td>
<td>Flat-Plate Photovoltaic Modules and Panels</td>
</tr>
<tr>
<td>ANSI C37.90</td>
<td>IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus –Description</td>
</tr>
<tr>
<td>IEEE 929</td>
<td>Recommended practice for utility interface of residential and intermediate PV systems</td>
</tr>
<tr>
<td>IEEE 1262</td>
<td>Recommended practice for qualification of PV modules</td>
</tr>
<tr>
<td>IEEE 1513</td>
<td>Recommended practice for qualification of concentrator photovoltaic modules</td>
</tr>
<tr>
<td>IEEE 928</td>
<td>Recommended criteria for terrestrial PV power systems</td>
</tr>
<tr>
<td>IEEE 1373</td>
<td>Recommended practice for field test methods and procedures for grid-connected PV systems</td>
</tr>
<tr>
<td>IEEE 1374</td>
<td>Guide for terrestrial PV power system safety</td>
</tr>
<tr>
<td>IEEE 1547</td>
<td>Interconnecting Distributed Resources with Electric Power Systems</td>
</tr>
<tr>
<td>IEC 61173</td>
<td>Overvoltage protection for photovoltaic (PV) power generating systems - Guide</td>
</tr>
<tr>
<td>IEC 61215</td>
<td>Crystalline silicon terrestrial photovoltaic (PV) modules - Design qualification and type approval</td>
</tr>
<tr>
<td>IEC 61646</td>
<td>Thin-film terrestrial photovoltaic (PV) modules - Design qualification and type approval</td>
</tr>
<tr>
<td>IEC 61683</td>
<td>Photovoltaic systems - Power conditioners - Procedure for measuring efficiency</td>
</tr>
<tr>
<td>IEC 61724</td>
<td>Photovoltaic system performance monitoring - Guidelines for measurement, data exchange and analysis</td>
</tr>
<tr>
<td>IEC 61727</td>
<td>Photovoltaic (PV) systems - Characteristics of the utility interface</td>
</tr>
<tr>
<td>IEC 61277</td>
<td>Terrestrial photovoltaic (PV) power generating systems - General and guide</td>
</tr>
<tr>
<td>IEC 61721</td>
<td>Susceptibility of a photovoltaic (PV) module to accidental impact damage (resistance to impact test)</td>
</tr>
<tr>
<td>IEC 61829</td>
<td>Crystalline silicon photovoltaic (PV) array - On-site measurement of I-V characteristics</td>
</tr>
<tr>
<td>IEC/TR2 61836</td>
<td>Solar photovoltaic energy systems - Terms and symbols</td>
</tr>
<tr>
<td>ASTM E 1799</td>
<td>Standard Practice for Visual Inspections of Photovoltaic Modules</td>
</tr>
</tbody>
</table>
**A-5.4 PV Module Mounting**

Bidder shall provide in the proposal a detailed description of its proposed mounting method. Bidder may propose a fixed or tracking mounting scheme.

**A-5.5 Step-up Transformers**

Bidder to provide information on proposed step-up transformers.


Transformers shall be rated for inverter source operation and the environment in which they will operate.

Transformer shall be supplied with a no load tap changer with high voltage taps capable of operating @ 2.5% above and below nominal voltage at full rating.

Transformer shall be supplied with a fused disconnect switch on the transformer high voltage side to isolate the transformer in case of an internal fault. The switch/transformer configuration shall be designed for loop feed.

Transformers shall be either dry-type or less-flammable oil insulating fluid.

Enclosure finish shall be a top powder coat that is designed for a twenty-five year service life.

Accessories to include liquid level and pressure/vacuum gauges, a dial-type thermometer with SPDT alarm contacts, a pressure relief valve, and a drain valve with sampler.

PacifiCorp shall reserve the right to attend factory witness testing of step-up transformers.

**A-5.6 Inverters**

Bidder to provide information on the proposed inverters and any enclosures or shading structures.

Inverters shall be greater than or equal to 250 kW output rated at >0.97 power factor.

High efficiency 600 volts, direct current (Vdc) and 1000Vdc inverters are acceptable.

Inverters less than or equal to 600 Vdc shall be certified to “Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources,” UL1741, including revisions through and including November, 2005.

Inverters shall comply with IEEE 1547, including testing to IEEE 1547.1 and IEEE C62.45 Regulatory standards compliance shall also include IEEE C62.41.2 and CSA107.1-01.1.

Output current harmonics shall contain <5 percent total harmonic distortion (THD) at rated power output.
Inverter efficiency shall be >97 percent without medium voltage step-up transformer.

Inverters enclosed in sheltered buildings are preferred. Skid-mounted package units containing all equipment including DC switches, master fuse boxes, inverters, step-up transformers and other power conditioning system equipment is preferred.

Inverters located outdoors shall be enclosed in lockable, NEMA 3R with coating in accordance with section A-5. Any sensitive electronic equipment associated with the inverter shall be installed in a NEMA 4 rated enclosure. A shading structure, such as a small awning, may be required to keep temperatures below the manufacturer’s recommended operating temperatures and to protect inverter display.

Outdoor inverter display shall be oriented north and protected from the sun.

Enclosure must have a door interlock system to prohibit the door(s) from being opened while energized.

Inverters shall incorporate a no-load, 2-pole, lockable disconnect switch for main DC power disconnect for maintenance personnel safety.

Inverter output shall be protected by a circuit breaker with short and long time adjustable over current protection. This circuit breaker shall be externally operated or the vendor shall furnish an external on/off (start/stop) switch.

Inverters shall be capable of rated output at 50ºC or better.

Inverters shall employ a maximum power point tracking (MPPT) scheme to optimize inverter efficiency over the entire range of photovoltaic panel output for the given site design conditions.

Inverters shall be equipped with all hardware for data collection and communication to the central SCADA server.

Inverter shall be equipped for direct external communication and control to PacifiCorp.

Inverter shall include a fused and disconnectable control power transformer (CPT).

CPT shall be sized and single phase breakers shall be included to supply power to a convenience receptacle, inverter heaters or air conditioners (if required to meet manufacturer recommended humidity requirements), a fluorescent light fixture, HVAC (if required to meet manufacturer recommended operating temperature requirements), and inverter control power.

CPT shall be metered and monitored using an electronic, digital and utility-grade meter.

Inverters shall be equipped with a minimum of thirty (30) fused, disconnectable, DC inputs with built in current and fault monitoring for input to the SCADA system.

A-5.7 DC Fused Combiner Boxes

Bidder to provide information on proposed DC Fused Combiner Boxes.
Combiner boxes shall be rated for maximum system voltage and maximum system continuous and short circuit currents.

Enclosures shall be rated National Electrical Manufacturers Association (NEMA) 4 and shall have integral key lock or provisions for padlocking.

DC inputs shall be fused with finger safe fuse holders for both positive and negative conductors.

Fuses shall have blown fuse indication.

Combiner box output shall be externally disconnectable.

**A-5.8 Meteorological Stations**

Bidder shall provide a sufficient number of meteorological stations (“Met Station”) to provide adequate meteorological data to evaluate Facility performance. The number of stations will be designed based on site terrain and local variability, but no less than two (2) per plant. Stations shall be located at strategic points within the array field. Met Station shall be capable of collecting the data points and sample frequency. Met Station shall have capability of recording and storing environmental conditions without AC power for two (2) days.

**A-5.9 Supervisory Control and Data Acquisition (SCADA)**

Bidder to provide information on proposed SCADA system.

Bidder shall provide an engineering work station providing local control. The SCADA system is composed of an integrated operator human-machine interface (HMI), input/output (I/O) and remote telemetry units (RTU) hardware, firmware, and software. Internal control/communications devices designed to industry standards shall provide for remote monitoring, alarm management, control and historical trending of the monitored equipment. The plant-wide SCADA system shall integrate all monitored devices into a single HMI through which PacifiCorp may monitor all equipment.

Communications shall be transmitted via ANSI-compliant fiber optic or wireless communications infrastructure for web and PacifiCorp interface. All fiber optic cable shall be installed in accordance with standard industry practices.

Bidder shall describe and provide external communications link to provide PacifiCorp access to all data acquisition and real time performance monitoring.

Bidder shall program the control software for the plant on an industry-standard SCADA platform and provide points for a third party web-based data acquisition system (DAS) and a contact block using PacifiCorp-approved communication protocol for PacifiCorp network interface.

Points to be monitored by the SCADA system shall include, at a minimum:

- Meteorological stations
  - Reference Cell Temperature
- Reference Cell Irradiance, Plane of Array (POA) for tracking systems, it shall follow the tracking path;
- Ambient Air Temperature
- Wind Speed
- Wind Direction
- Global Horizontal Irradiation
- Rain
- Back of Module Temperature

- Inverters
  - AC Voltage
  - DC Voltage
  - AC Current
  - DC Current
  - kW
  - kWh

- Metering
  - SCADA System shall monitor and store data from the Project Site meter on an interval from between five (5) to twenty (20) seconds.

- Transformers
- Trackers (if applicable)
  - Tracker control system integration, remote monitoring and control.
- All Buildings/Shelters
- Plant Switchgear

The following will make up the SCADA Calculated Values List:
  - Model vs Actual Performance in kW and kWh
  - Day’s power in kWh
  - Month’s power in kWh
  - Year-to-date power in kWh
  - Total lifetime power in kWh

Performance Ratios
  - Facility Performance Ratio, current value
  - Facility Performance Ratio, day’s average
  - Facility Performance Ratio, month’s average
  - Facility Performance Ratio, year-to-date average
  - Facility Performance Ratio, since commissioning.

Data Storage and Historian
Facility shall have one (1) year minimum onsite storage capacity for high-resolution data.
Networking Infrastructure, an industrial Ethernet LAN is the networking infrastructure for communication to the field devices distributed throughout the Facility.

If necessary, all buildings, in addition to the equipment contained within the building, shall be monitored for:
- Environmental Conditions
- HVAC/Climate Control Status
- Door Position
- Fire/Smoke
- Security/CCTV

All monitored plant electrical generation equipment (e.g. inverters, transformers, switchgear) shall be monitored to capture real time AC and DC electrical characteristics, including:
- Voltage
- Current
- Power
- Frequency
- Power Factor

All monitored plant electrical generation equipment (e.g. inverters, transformers, switchgear) shall be monitored to capture all diagnostic information including:
- Temperatures
- Alarms
- Status indicators
- Fault states

SCADA System Security: The Operator/Engineering stations shall be provided with security access to specific system functions and data. A login session’s security access to system functions and data shall be a combination of the user’s security access and the Operator/Engineering station for the session to have that security access.

A-5.10 Wire, Cable, and Connectors

Bidder to provide information about proposed wire, cables and connectors including all underground facilities.

Cable shall be designed and installed for a service life of thirty (30) years.

DC cable shall be 2kV 90°C (wet or dry) power cable type XHHW with UL 1581, VW-1 rating.

PV Panel interconnect DC cable shall be type USE-2 cable, or approved equal with XLP jacket capable of meeting DC collection system design current requirements.

Externally installed cables shall be sunlight (UV) resistant, suitable for direct burial and conform to NEC 300.5 Underground Installation, Table 300.5 Minimum Cover Requirements, 0-600V.

PV Panel interconnect connectors shall be latching, polarized, and non-interchangeable with receptacles in other systems. Grounding member shall be first to make and last to break contact with mating connector and shall be rated for interrupting current without hazard to operator.
PV Panel interconnect connectors shall be tee tap branch connectors and multi-contact (MC) termination connectors.

Cables shall be listed and identified as PV wire as stated in NEC Article 690.

If a cable tray is utilized, there shall be no self-tapping screws, only a clamping mechanism to secure the top.

All underground cable shall be mapped and identified along their entire run with hazard tape and tracing, 18 inches above the cable elevation and 18 inches below finish grade elevation.

Use rigid steel conduit, galvanized where underground cable is exposed above ground or stubbed up to junctions or poles. All 90 degree bends shall be long sweeps installed in accordance with standard industry practices.

Underground cable shall be direct buried at a minimum of three feet (3’) of below finish grade elevation.

No underground cable splicing shall be acceptable under any circumstance. All cable splices shall be brought above ground and housed in a suitable enclosure or, if below grade, placed in a suitable vault that is clearly marked.

A-5.11 Communications Shelter- if required

Bidder is to provide information about proposed Communications Shelter, if proposed.

When applicable, communications shelter shall be provided by the Bidder designed for local site conditions and may be of steel, brick, or concrete construction to meet local building code requirements.

Communications Shelter shall be lockable and shall be furnished with a door position switch.

A-5.12 Plant Switchgear

Bidder is to provide plant switchgear information.

Switchgear shall be located outdoors. Enclosure shall be NEMA 4 and lockable.

Switchgear shall include an auxiliary compartment containing all instrument transformers associated with the protective relays and the 120/240V control power transformer (CPT) shown in the one-line diagram(s).

Switchgear monitoring and communication hardware shall be included to meet the requirements of A-5.8 of this specification and the metering requirements of PacifiCorp.

Relay current transformers shall be C400 accuracy class.

CPT shall be fused and disconnectable. The CPT shall be sized and single phase breakers shall be included to supply power to a 120V convenience receptacle and a fluorescent light within the switchgear enclosure, switchgear heaters, and the 240/120V AC panelboard within the communications shelter.

Enclosure shall be coated in accordance with A-5.2.
Switchgear main breaker shall have vacuum fault interrupters and shall have provisions for bifurcation.

Medium voltage protective device selection and relaying should be based on the use of Schweitzer Electric Laboratories (SEL) 351 relays.

A-5.13 Emergency DC/Battery System

Bidder is to provide information regarding emergency DC and battery system.

Batteries and chargers location shall be specified in accordance with temperature and shading requirements.

Battery system shall meet the requirements set forth in the PacifiCorp Interconnection Agreement.

Battery system shall be sized to provide DC power to trip, close, and recharge the switchyard 8 hours after a loss of power and to recharge within 12 hours and supply sufficient power to the SCADA and communications systems for 12 hours minimum.

Battery sizing calculation shall be provided by Bidder for PacifiCorp approval.

A-5.14 Grounding and Bonding

Bidder is to provide information about proposed grounding grid for the Facility and Substation.

Facility grounding design shall be done in accordance with IEEE standards for generating stations. Grounding design shall be reviewed and approved by PacifiCorp prior to commencing work.

Substation grounding shall be done in accordance with IEEE standards for substation grounding. Grounding design shall be reviewed and approved by PacifiCorp prior to commencing work.

All ground conductors shall be stranded copper and may be bare if exposed and green insulated if in conduit.

Ground lugs shall be mechanical and rated AL/CU.

All below grade connections shall be exothermic welds.

Step-up transformers and inverters and the Plant Switchgear shall be bonded to the ground ring at opposing corners of the equipment.

Mounting structures shall be grounded with ground rods and/or conductors sized for maximum available short circuit current and lightning current (if required).

Bidder shall submit to the PacifiCorp for approval grounding and lightning calculations for assurance of safe step and touch potentials on the project site in accordance with PacifiCorp approved standards.

Bidder shall conduct a ground resistivity test witnessed by PacifiCorp engineers to verify that the grounding system meets minimum requirements for the overall grounding scheme.

Fences and gates shall be grounded per PacifiCorp standards.
A-5.15 Tracker

Bidder to provide details on the foundation support requirements for the tracker assemblies. If the tracker assembly does not require fixed mounting foundations, then the Bidder shall describe in detail current field experience with this design including details of any assembly or thrust block “support keying”, erosion protection, provisions for potential “Liftoff” during high winds, and methodology for tracking accuracy restoration should the tracker assemblies experience any vertical or lateral displacement during the projected life of the system. Specify the mounting system (clamp/clips or others) that is currently being utilized to mount the proposed PV modules to the tracker assemblies and which complies with the minimum requirements. Provide technical specification, drawings, installation guide, warranty information, materials of construction, and protection systems (paint, coating, galvanizing, other) as part of the submittal. In addition, the Bidder shall provide details of all the support bearings for the tracker including materials of construction, specific bearing loadings, bearing safety factors, lubrication, and monitoring. Bidder shall provide, at minimum, the following additional information and drawings about the trackers:

- Site layout with trackers
- Grade/slope requirements for trackers
- Type of tracker
- Power consumption requirements for motor controller
- Installation manual
- Operation and maintenance requirements
- PV mounting/installation methods/requirements
- Shading calculation
- Tracker SCADA plan and interface requirements
- Controller single and three line diagrams and control schematics
- Performance data
- Reliability data
- Test data

PV systems with tracking shall be designed with the required accuracy to achieve minimum performance standards.

Details of the controller systems and monitoring are to be provided. It is necessary to differentiate and articulate the control protocol (i.e., GPS, passive, time of day, irradiance tracking or other).

The Bidder shall also provide details on “anti-shading” methodology required to be implemented in the layout design.

The tracker system shall be of proven design and shall be based on trackers systems that have been deployed in the field and in production for a minimum of one (1) year. The tracker system may be electrically or hydraulically driven and shall meet all the seismic and wind loading requirements of the applicable local codes and local wind conditions as specified in ASCE 7 05.
If utilizing tracker stowing function shall be independent of a grid supply of power. Mounting support rails or support points shall be located symmetrically under the PV module.

**A-5.16 Equipment Labeling Convention**

The Bidder shall provide a labeling convention to allow identification of all pieces of equipment and the labeling convention shall be consistent from drawings to installed equipment. The labeling convention shall be of uniform nature to include multiple equipment vendors, site locations and equipment applications.

**A-5.17 Other Major Equipment**

Bidder to identify other major equipment such as foundation, transformer, cabling information.

**A-6 Applicable Codes and Standards**

The project’s design, engineering, construction, interconnection, startup, and testing shall follow the applicable codes, standards, and publications that are in effect at the time of project initiation, and which are consistent with industry standards. The codes and standards utilized shall be the latest editions in effect at the project effective date.

Materials manufactured within the scope of Underwriters Laboratories (UL) will conform to UL standards and have an applied UL listing mark. If no UL compliance is available, material and equipment will be labeled or listed by a nationally recognized testing laboratory.

Where codes do not govern specific features of the equipment or system, equipment manufacturer specifications and standard industry standards shall apply. Where local codes or ordinances will have an impact on the design, PacifiCorp and Bidder shall jointly address these with the local authorities having jurisdiction.

**A-7 Project Management**

Bidder shall provide all project management responsibilities for the duration of the work. Bidder shall appoint a single representative as its Project Manager.

Monthly progress reports shall be provided by Bidder by the second Wednesday of every month covering the prior month’s activities and progress. The report shall cover each of the major areas of responsibility as follows: Engineering, Permitting / Environmental, Procurement, Safety, Construction Startup and Testing. For each major area of responsibility (i.e. engineering, permitting / environmental, procurement, safety, construction, startup and testing) and for the completion status of the project in general, Bidder shall provide a progress versus planned report. The reports shall outline areas of concern and plans for corrective action to maintain the project schedule. The reports shall include the total field person-hours worked for the month and from construction start so that OSHA recordable incident rates can be calculated and reported.

Monthly progress reports will commence on the second Wednesday of the month following the month in which Notice to Proceed (NTP) is granted. A weekly status meeting or conference call will be held with PacifiCorp and Bidder to discuss current and planned activities or significant
issues. Bidder shall issue an Agenda and a Weekly Report / Action Items List at least one day prior to the weekly status meeting or conference call.

A-8 Construction and Construction Management

Bidder shall provide all construction management services with an on-site construction management team. Prior to execution of definitive documents, the Bidder will submit a site management organization chart identifying the individuals filling key roles and provide the qualifications and experience of these key individuals for PacifiCorp review and approval. Bidder will not change these key individuals without PacifiCorp approval, not to be unreasonably withheld.

Bidder shall be responsible for construction and construction management activities, including but not limited to the following:

Supply all labor, tools, machinery, equipment, and equipment transportation for all work and a fully functioning Facility.

Supply all temporary office space, temporary power, sanitary facilities, communications equipment, and drinking water for Bidder’s personnel on the site. Bidder shall provide two desks in a separate office trailer for use by PacifiCorp. PacifiCorp’s site representative shall be provided with electrical power, air conditioning, two telephones, internet connection, one bookcase, one file cabinet, and access to sanitary facilities in a manner similar to Bidder’s office trailers.

Provide site security during construction.

Daily housekeeping, to keep the site clean and orderly throughout the duration of construction. All trash and other like material shall be disposed of in accordance with best industry practices and applicable law.

Maintain a copy of all drawings, specifications, permits, and vendor installation manuals at the site.

Provide storage and maintenance of all installed equipment during the performance of work consistent with the recommendations of the equipment Bidders and good practice. Copies of all installed equipment maintenance records shall be kept at the site and included in the turnover packages. Bidder shall be responsible for obtaining any required off-site warehouse space, temporary parking, staging, or laydown areas.

Provide permanent equipment marking, labeling and signage for the project. Warning signs shall be placed at key areas near equipment, at project entrances, along the perimeter fence, and otherwise as specified in the proposal or project design.

Erect temporary construction fences and silt barriers as appropriate for the site and the work and as specified in the applicable permits.

Recognize and respect all properties adjacent to the site and use reasonable efforts to minimize disruption to neighbors (e.g., sediment control, dust control, traffic control, trash control, noise control, etc.) as applicable.
Fully comply with all applicable notification, safety and work rules.

Route all field routed electrical collection systems in a neat and orderly fashion and in accordance with all applicable code requirements. All cable terminations, excluding module-to-module and module-to-cable harness connections, shall be labeled with permanent wire labels showing 'TO' and 'FROM' on each wire end.

Provide all temporary road and warning signs, flagmen or equipment as required to safely execute the work.

Perform continuous monitoring and maintenance of erosion control measures during all construction activities as per the environmental permits, best management practices and project documents.

A-9 Distribution or Transmission Interconnection

The Bidder is responsible for the costs of designing, procuring equipment for, and installing all interconnection and metering facilities required to deliver the project’s electrical output to the proposed delivery point on the PacifiCorp’s electrical system.

Bidder shall fulfill all application, study and testing procedures to complete the interconnection process. All costs associated with the electrical interconnection shall be borne by the Bidder, however Bidder shall itemize the cost of transmission interconnection filing and buildout. During the initial start-up phase, PacifiCorp shall be invited to observe and verify the system’s performance. Bidder is responsible for the following at a minimum:

- Identify and describe the proposed point of interconnection, ownership demarcation and location.
- Describe any additional transmission lines that will be required to connect to the site
- Obtain Interconnection approvals from the owner of the electric transmission system to which the project interconnects
- Provide a definition of grid access and timing
- Provide submittals to PacifiCorp during the interconnection process
- Provide a schedule for interconnect.
- Identify transmission line ownership and operator control

A-10 System Performance

Bidder shall submit a detailed prediction of the hourly performance using TMY3 solar weather data and the preferred computer modeling software titled PVSYST. The Solar Advisor Model (SAM) available from the National Renewable Energy Laboratory is also acceptable.²

Performance measures include the following:

² SAM may be obtained at the following web site
- System initial rating in MWac at project test conditions (PTC)
- Predicted first-year of operation output on an hourly basis (MWh delivered to the PacifiCorp system at the point of interconnection)

Bidder shall submit an estimate of the initial rating of the PV Plant at PTC. Data required for submission is summarized in Appendix 3 Performance Characterization.

A-11 Operations and Maintenance - Manuals and Training

A-11.1 Documentation

Bidder shall provide PacifiCorp with all documentation necessary to enable the successful operation and maintenance of the generating unit. Documentation shall include the following:

A system-wide operations and maintenance document produced by the Bidder that encompasses all generating unit components, interconnections and site facilities, and

All individual operations and maintenance manuals or other documents produced by equipment providers for discreet components of the generating unit.

A-11.2 Training

Bidder shall provide a schedule of recommended operations and maintenance training, accompanied by an estimated cost for each individual training session. Bidder shall differentiate training by categories similar to the following and including a narrative description of the type and level of training:

Bidder on-site training
Equipment vendor on-site training
Equipment vendor off-site training.

Bidder shall also identify where training is offered free of charge to new equipment owners by equipment vendors. Bidder shall produce a comprehensive cost estimate of all training required for an external entity to assume operations and maintenance of the generating unit, prepared under the assumption that this entity does not yet possess any such required training.

Bidder shall provide PacifiCorp with the aforementioned operations and maintenance documents and summary of required training with cost estimate. PacifiCorp will have ten (10) business days to review and comment on this submittal. All Bidder-provided on-site training shall be completed prior to Substantial Completion.

A-12 Spare Parts Inventories

Bidder shall submit a list of recommended spare parts for the proposed facility. This list shall include any requirements for spare parts as defined by any local law or regulation and according to good practices. Bidder shall complete the template provided in Appendix 6 Spare Parts List, detailing the individual spare parts and the number of spare parts.

https://www.nrel.gov/analysis/sam/
As a minimum the list shall include the following:

- Number of recommended on-site spare modules
- Number of spare fuses, breakers and disconnects
- Identification of replacement parts for trackers and tracker motors (as applicable)
- Identification of replacement parts for inverters, transformers, and other power conditioning system equipment
- Other recommended spare parts

Bidder shall specify how the recommended quantities of spare parts were developed and what the anticipated availability of the project will be with the recommended spares inventory. Expected annual usage shall be indicated for scheduled and unscheduled replacements. During the warranty period, as parts and supplies are used from the inventory, they shall be replaced by the Bidder at no cost to PacifiCorp. In addition, if during the warranty period a change in the level of spare parts maintained is required in order to maintain the warranted levels of availability, the spare parts inventory shall be revised, at no cost to PacifiCorp.

A-13 Operation and Maintenance Option

Bidder may provide a pricing option for three (3) years of Operation and Maintenance of the Facility. The narrative description for this option shall include identification of staffing/skill levels, equipment list, hours per year per staff, consumables, and other anticipated capital and/or operating costs associated with operating the facility for three years.

A-14 Quality Assurance/Quality Control & Procedure for Project Acceptance

The procedure for project acceptance and close out is summarized in Table 3.
## Table 3 Procedure for Project Completion

<table>
<thead>
<tr>
<th>Step #</th>
<th>Milestone</th>
<th>Bidder Required Steps</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Construction Completion</td>
<td>QA/QC Report submittal for review from Bidder</td>
<td>Project Construction is complete. Ready for startup.</td>
</tr>
<tr>
<td>2</td>
<td>Start-up and Commissioning</td>
<td>Project is energized and connected to PacifiCorp grid</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Interim Operating Period</td>
<td>Bidder has up to 45 days to de-bug Project</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Capacity Test Letter</td>
<td>Bidder submits letter indicating ready for performance testing</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Capacity Test</td>
<td>Capacity Test (performance testing)</td>
<td>Capacity Testing on-site with PacifiCorp designated engineer</td>
</tr>
<tr>
<td>6</td>
<td>Substantial Completion</td>
<td>Capacity Test is passed</td>
<td>Project is considered substantially complete upon successfully passing the capacity test</td>
</tr>
<tr>
<td>7</td>
<td>Final Completion</td>
<td>Final Completion and Acceptance</td>
<td></td>
</tr>
</tbody>
</table>

### A-14.1 Step 1 - QA/QC

Bidder shall submit to PacifiCorp a copy of its quality assurance and quality control plan for review not later than forty-five (45) days after contract execution for PacifiCorp review and comment. The Project shall be managed in accordance with the program.

The QA/QC program shall include such procedures and systems as the following (but not limited to):

- Road construction
- Rebar and conduit placement
- Concrete placement and testing
- All wire insulation testing – Megger Testing or Very Low Frequency (VLF) testing
- Mechanical system - trackers, mounting structures, tracker controls
- Factory testing of inverters and transformers
- PV source open circuit measurements – Voc at combiner boxes
- Fuse tests
• Termination pull testing
• All visual inspections
• Grounding continuity testing
• Earth ground resistivity testing
• PV module inspection and manufacturer documentation of factory test (STC) of every module
• Metering and instrumentation calibration testing
• Step-up transformer testing
• Inverter phase rotation and matching with utility
• Relay settings at the point of interconnection to PacifiCorp
• And other Bidder prescribed procedures

All QA/QC testing procedures shall be witnessed and documented by a qualified representative of the Bidder. PacifiCorp shall observe and witness QA/QC as necessary and at its will. Qualified engineer of the Bidder shall date and sign documentation indicating completion and acceptance of each QA/QC test procedure.

A-14.2 Step 2 - Startup and Commissioning

Bidder shall provide the proposed startup and commissioning plan for the Project.

Bidder will coordinate with PacifiCorp to develop an acceptable commissioning plan that includes a check-out and start-up procedure. This work will assure that systems are activated in a manner that is safe for personnel as well as for the equipment, that Bidder work is complete and according to the Contract documents, and that the systems perform as required by the Contract documents and are ready to be turned over to PacifiCorp. As the construction and installation of the systems nears completion, Bidder will prepare punch lists and conduct system walk-downs, sub-system and system check-outs, start-ups, testing, and turn-overs.

The final approved Acceptance Test and Commissioning Procedures shall, at minimum include:

• Safety plan during start-up and commissioning
• Review of all QA/QC testing on DC and AC side of inverters
• Detailed procedure for PV Project start-up including switching sequencing
• Test and energize inverters in conformance with manufacturer’s recommended procedures. Note operating voltages. Confirm inverter is performing as expected.
• Under full sun conditions, and after at least 15 minutes of operation, take and record PV facility operating data – such as but not limited to MW_{DC}, MW_{AC}, V_{DC}, V_{AC}, I_{DC}, I_{AC}, Solar Radiation, etc.
• Test the system control and monitoring system to verify that it is performing correctly.
• Test the communication system for offsite monitoring.
• Test the Project metering and protective relaying
• Detailed procedure for interface and initialization with the grid
• Documentation of successful start-up and commissioning procedure
- Bidder shall submit written notification to PacifiCorp that the completion of Acceptance Testing and Commissioning has occurred.

Upon successful completion of energizing, and start-up, the Project will be considered operable. The Project will then move to the Interim Operating Period where the Bidder will make the Project ready for Capacity Testing.

A-14.3 Step 3 - Interim Operating Period

Following the successful completion of the Start-up and Commissioning of the Project, the Bidder will have a maximum of 45 days to resolve any operating issues. The PacifiCorp designated operating and maintenance team will receive training regarding the Project during this period. After the successful execution of the Interim Operating Period the Bidder will perform a Capacity Test Procedure to verify the rated output for the Project. Bidder is not required to use the maximum 45 days – rather it is an allowance of time. For example, Bidder may be ready for Capacity Testing after 10 days.

A-14.4 Step 4 - Capacity Test Procedure

The Bidder shall provide PacifiCorp with a letter indicating the Project is ready for the Capacity Test Procedure.

A-14.5 Step 5 - Capacity Test Procedure

Bidder shall provide a Capacity Test Procedure that will be used to verify the facility rating (i.e., MWac) at Project Test Conditions (PTC) of 20 °C ambient temperature, and 1,000 watts per square meter (W/m²) irradiance as developed by the PVUSA program. The Capacity Test procedure, if different than described in APPENDIX TBD of this document, shall be submitted by the Bidder, for PacifiCorp’s approval, no later than sixty (60) days prior to the date which the Bidder anticipates the commencement of the procedures. A third-party, independent engineering company may be needed to verify the procedure and carry out the Capacity Testing.

The objective of the PV facility Capacity Test Procedure is for the Bidder to demonstrate to PacifiCorp that the PV Project has achieved the Performance Guarantee (in MWac) under PTC. The approved Capacity Test Procedure shall, at minimum, include listing of test instrumentation, calibration procedures, test duration, type of data collected and collection frequency, test data collection procedures, and test reporting.

Bidder shall be authorized in writing by PacifiCorp to begin the Capacity Test Procedure which will be to establish the full power rating of the PV Project at:

- Plane of Array - 1,000 W/m²
- Ambient Air Temperature (Tamb) of 20°C
- Atmospheric air mass of 1.5 or less
- Wind speed of approximately 1 meter per second (m/sec)
- Net power to the grid in MWac at the point of interconnection to the electrical system

The general guidelines for the Capacity Test Procedure include the following considerations:
Bidder shall supply all required labor to execute the Capacity Testing and supply all test and calibration equipment, materials, tools and services necessary to perform all testing. Bidder shall include PacifiCorp designated engineer to witness all Capacity Test procedures or a third-party engineering firm if necessary.

The proposed Capacity Test Procedure shall detail all test activities including:
- Specification “cut-sheets” and calibration certificates for all primary measurement devices.
- Location of these measurements for field verification.
- Field testing procedures (i.e. test duration, frequency, actions in the event of a failed test, etc.)
- List of secondary measurement devices and location.
- Output calculations, methodology, correction factors, equations and procedures
- Sample test calculations.
- Pre-test uncertainty analysis
- The procedures will provide sufficient detail to allow the PacifiCorp to perform independent calculations of test results from the measured data.

Bidder shall determine the test duration and frequency of the Capacity Test Procedure in a mutually agreeable schedule with PacifiCorp.

If the rating falls below the guaranteed output, Bidder shall take measures to bring the Project up to the required rating, or pay Liquidated Damages for performance.

If the Bidder chooses to take corrective measures to bring the power rating up to acceptable level, then retesting may occur following notification of PacifiCorp in writing.

Bidder shall submit preliminary results of the Capacity Testing within twenty-four (24) hours of the conclusion of the test. Upon PacifiCorp’s acceptance of the preliminary test results, Bidder shall submit a detailed test report within ten (10) business days of the completion of the Capacity Test results to PacifiCorp consisting of the following:
- Any agreed upon deviations to the test procedures
- Instrument calibration sheets/certificates
- Test data (manual and data acquisition)
- Corrected test data
- Field notes
- Calculations
- Post-test uncertainty analysis
- Conclusions

**A-14.6  Step 6 – Substantial Completion**

After successful demonstration of the Capacity Test and is in agreement with PacifiCorp, the Project is considered Substantially Complete.
A-14.7  Step 7 - Final Completion

After Substantial Completion, Bidder shall complete all punch-list items, demobilize, clean and clear the site, submit all As-Built drawings and O&M manuals, complete all training, deliver all spare parts on-site, and transfer all permits to PacifiCorp. Upon agreement by PacifiCorp the Project is considered to be at Final Completion.

A-15  Project Work Schedule

The Bidder shall submit a Level 1 milestone schedule for the project in PDF file format. The schedule shall be prepared in Primavera 6.2 or later.

The Level 1 schedule will illustrate major project activities, milestones and key deliverables for the whole project. Representative elements of the Level 1 schedule are identified below.

Notice to proceed from PacifiCorp
Kickoff and regular meetings
Phase I Environmental Assessment
Permit acquisition
Land acquisition rights (e.g., purchase or lease agreement completed)
Resource assessment
Engineering design
Equipment specifications
Construction specifications
Procurement
  - Long lead item equipment supply contract(s) (specify)
  - Major construction contract(s) (specify)
Mobilize to site
Construction start
  - Roads and site improvements
  - Foundations completion
  - Mechanical completion
  - Electrical completion
Construction finish
Training period
Reliability test period
Grid interconnection
Phase I Environmental Assessment – Final
Startup and commissioning
Acceptance testing
Commercial operation date
The successful Bidder will be responsible for preparation of Level 2 and Level 3 schedules, to be submitted to PacifiCorp on the following schedule:

NTP issued to successful Bidder
Thirty (30) days after NTP, Level 2 schedule submitted to PacifiCorp
Sixty (60) days after NTP, Level 3 schedule submitted to PacifiCorp

**A-16 Project Organization Structure**

The Bidder shall submit an organizational chart illustrating management and functional relationships among all project team members including consultants, subcontractors and vendors at each significant stage of the work, such as permitting, design, construction, testing and commissioning, close-out.

The Bidder shall provide a narrative to accompany the organizational management plan, roles and responsibilities and lines of authority. The project organizational structure shall be updated as necessary.

The Bidder shall provide information on key subcontractors and shall address the following:

- Working relationship with each subcontractor (provide contact name and dates/duration)
- Number of projects worked with the subcontractor (provide name and nature of work of each project)?
- Description of process for qualifying subcontractors
- Indication of level of confidence this subcontractor will meet your expectation (quality, timing, and cost)
- Inclusion of subcontractor letter of commitment to support
- Risk mitigation strategy if the subcontractor fails to meet their committed workmanship, schedule, or cost (be specific)

**A-17 Equipment Warranty**

Bidder to provide equipment and system warranties for major components including PV panels, inverters, tracking systems, switchgear and other major components.

The warranty descriptions shall explicitly identify the term of the warranty, what is covered by the warranty, provisions for transfer or assignment of the warranty and any special conditions that are unique to the specific equipment.

For PV modules it is anticipated the warranty will cover a term of at least 25 years with no less than 80% performance degradation.

For inverters it is anticipated the warranty will cover a term of at least 10 years.

For racking or tracking systems it is anticipated the warranty will cover a term of at least ten (10) years.

Other equipment shall carry a warranty of at least two (2) years.
Applicable Permits

The Bidder shall complete a detailed analysis of the potential permits, approvals, and consultation that might apply to the project and use these results to complete all required studies, public review and/or hearings, and pay all application and review fees necessary to obtain federal, state, and local approval of the project. The Bidder shall identify all permit requirements including but not limited to permits identified in Appendix 5 Permit Checklist. Bidder shall provide PacifiCorp with copies of all approved permits and applications for permits still in process on the effective date of contract. In the event it was determined that an approval was not required, then agency consultation letter or other proof shall be required.

Plant Performance Estimation

Bidders shall provide a performance estimate of the PV plant. Bidders shall use one of the following modeling packages to estimate the output of the PV plant:

Solar Advisor Model, Version 2009.10.13, or current
PVSYST Version 4.37, Version 5.06, or current
Performance estimates from both models may be presented if desired. The performance modeling software is available from the locations listed below:

Solar Advisor Model
The current version Solar Advisor Model (SAM), Version 2009.10.13 may be downloaded at:
https://www.nrel.gov/analysis/sam/

PVSYST
PVSYST 4.37 and 5.06 models may be downloaded at:
http://www.pvsyst.com/5.0/purchase.php
(Note: There is a licensing fee for the modeling software)
(Note: PVSYST modeling is NOT required but is the preferred model for Bidders to use for this RFP process)

Performance Estimate Parameters

Bidders should perform a component-based analysis, using information and inputs from the proposed PV hardware.

The analysis should be performed using the TMY 3 weather center of closest proximity to the project site. TMY 3 weather files may be referenced from the National Solar Radiation Data Base

If the responder has site-specific weather data that has been collected at or near the project site for greater than one (1) year, the data should be submitted as a separate exhibit. Performance estimates may be run with both the site-specific weather file and the neighboring TMY 3 weather file.

PacifiCorp may perform performance estimate analysis for comparative purposes.

Bidders shall complete form in Appendix 3 Performance Characterization based on their proposed facility and input parameters.

If the input parameters of the proposed equipment fall outside of the inputs used in Appendix 3 Performance Characterization, describe the equipment and provide guidance for how the performance estimate should be modeled.

A-19.2 Performance Estimate Output

Bidders shall provide the performance estimate data in annual, monthly and hourly output values. Include the performance ratio as listed by PVSYST, and/or the total de-rate factor (multiplied by the inverter efficiency to account for the inverter de-rate factor for SAM). The hourly output values are not required to be printed in the written submission, but shall be submitted digitally. A graphical representation of hourly output over a one year period is desirable.

If PVSYST is used, the Bidder shall provide a copy of the simulation report in PDF file format.

A-19.3 Capacity Test Procedure

Upon notification that the Project is ready for field testing, the Bidder, in the presence of PacifiCorp designated engineers, or a third-party independent engineer shall complete the Capacity Test Procedure. The PV Project will be tested under field environmental conditions (in the field irradiance, temperature, and measured capacity (MW)).

A. Inputs Provided by the Bidder:

Performance Ratio (PR), which is the overall losses for the PV Project before accounting for temperature and irradiance variations - as used in PVSYST or SAM. The PR includes all the system losses from the DC array to the power output (in MWac) to the grid at the point of interconnection including the inverter efficiency, transformers, wire losses, etc.

MWdc at STC, is the PV Project capacity of solar modules at standard test conditions (STC).

Cp, is the temperature coefficient for power output for the PV modules as a function of cell temperature.

MWac is the expected PV Project output at Project Test Condition (PTC) as described by the PG&E program from 1990’s PVUSA, to the electric grid as provided by the Bidder.

B. Field Measurements:

Testing shall be generally performed during the hours of 9 AM to 4 PM when the plane of array irradiance is greater than 750 W/m². Fifteen-minute interval readings will be measured for a minimum of 36 intervals where the following data points are recorded:
- Plane of Array irradiance – w/m² (minimum two locations in array using a 2 % accuracy Precision Spectral Pyranometer (PSP) (Imeas)
- Total facility output to the grid at the point of interconnection – (MWac meas)
- Ambient air temperature at two locations within the array field in °C (Tamb)

Once the data sets have been recorded and logged the following analysis will be used to compare the field measured capacity (MWac meas) rating to the guaranteed capacity in MWac:

An example is presented below to help clarify the procedure. The example here assumes that a Bidder has provided a bid that indicates it would guarantee a particular power plant capacity at PTC. The Bidder has indicated they would guarantee the capacity of 60 MWac at PTC and the modules operate at a temperature power coefficient of Cp = -0.5 %/°C.

Following is the Calculation Procedure for this Example:

A. Inputs supplied by the Bidder

\[ MWac = 60 \text{ MWac from Bidder is the expected (guaranteed) capacity at PTC as submitted in their bid} \]

\[ Cp = -0.5 \%/°C \text{ from Bidder (in this case from module manufacturer) as submitted in their bid} \]

B. Measurements in the field for Capacity Testing - in time interval 1.:

\[ MWac \text{ meas} = 52 \text{ MWac} \]

\[ Imeas = 900 \text{ W/m}^2 \]

\[ Tamb \text{ meas} = 40 °C \]

**STEP 1 - Adjust (MWac meas) for Imeas**:

\[ (MWac \text{ meas}) \times \left(\frac{1000}{Imeas}\right) = MWac \text{ meas A} \]

Example:

\[ MWac \text{ meas A} = 52 \times 1000/900 \]

\[ MWac \text{ meas A} = 57.8 \text{ MWac} \]

**STEP 2 – Adjust (MWac meas A) for Tamb measured in the field**:

Then, \( (MWac \text{ meas2}) = (MWac \text{ meas A}) + (P \% \text{ change})(MWac \text{ meas1}) \)

\[ (P \% \text{ change}) = (20-40) \times (Cp) \]

\[ (P \% \text{ change}) = -20 \times -0.005 = 0.1 \]

Then, \( (MWac\text{-meas B}) \text{ adjusted} = \)

\[ (MWac\text{-meas A}) + (0.1 \times MWac\text{ meas A}) \]

\[ = 57.8 + (0.1 \times 57.8) = 63.58 \text{ MWac} \]
STEP 3 – Compare the (MWac) to the (MWac meas B)

Compare the capacity measured in the field to the capacity guaranteed.

\[ \text{MWac} = 60 \text{ MWac} \]

Compare to 63.58 MWac-meas2  \( \frac{63.58}{60.0} = 1.06 \)

Thus, measured is 5% above the guaranteed capacity - project capacity acceptable.

Repeat the procedure for all 36 data points and compare the average. If average measured capacity is within a 5-percent average value compared to the guaranteed capacity from Bidder, then the Project is considered to have met the guaranteed Project capacity rating.