



ALBUQUERQUE PUBLIC SCHOOLS

Facilities Design & Construction / Maintenance & Operations

SOLAR PHOTOVOLTAIC SYSTEM DESIGN GUIDELINES

Including:
Design Parameters
Sheet Notes

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INTRODUCTION:

This APS Solar PV Guideline has been developed to:

- 1) Identify the criteria for Solar Photovoltaic (PV) installations at APS facilities and
- 2) Provide guidance to designers and installers of our PV projects.

It outlines the key attributes of, and expectations for, PV systems on APS projects.

It is the District's intent to incorporate solar power whenever and wherever practical, and to maximize production on the available space. In most cases, this is with roof-mounted ballasted systems, though other strategies will also be considered. It is further our intent to have the solar firm provide a *turn-key project*, with both design and installation services, and to incorporate their work with the overall design of the building(s).

Architectural/Engineering Firm's Responsibilities:

Design Development stage: The Architectural/Engineering Design Professional (A/E) is responsible for providing a DD level Roof Plan, showing available roof area (or other available space on select projects), to be used by solar firms in determining solar production targets.

Construction Documents stage: The A/E shall accommodate/incorporate solar PV in its electrical, structural and layout considerations, and shall coordinate/collaborate with the selected solar firm to achieve a successful PV element within the project.

Solar Photovoltaic Firm's Design Responsibilities:

50% Construction Documents stage: The Solar PV Design Professional (**PVD**) shall provide a preliminary drawing labeled "PV-100" showing the proposed location and layout for both PV panels and inverter(s). Layout must address fall protection provisions and walkways as required by the AHJ for fire protection. The PV-100 is to include a one-line electrical diagram for the PV system and its interface to the local electrical utility, as well as the Sheet Notes referenced by this Guideline. The drawing shall also identify the target capacity in kW for the project.

The PVD is expected to coordinate with the A/E Team, and adjust their PV design as necessary throughout the design process to meet the overall needs of the project.

95% Construction Documents stage: The PVD shall provide complete wiring and component details, panel and inverter locations, 1-line and 3-line electrical diagrams, and details about required signage, placards, monitors, dashboards, etc. If data drops are needed, they must be specifically identified on the drawings. Any equipment requiring a dedicated data drop must also be listed on the architectural sheet "DD-100" with specific identifying features.

100% Construction Documents stage: Stamped permit drawing set must be submitted to CID for permitting. In addition, application process for Interconnection Agreement with PNM is to be initiated by PVD (up to and including final inspections and approval). See additional information in Contract Instructions below.

CONTRACT INSTRUCTIONS:

- PV is to be provided as a turn-key (design-build) Bid Lot item until further notice by APS.
- Solar Contractor is responsible for processing interconnect agreement with PNM, as well as providing all information required to pursue Renewable Energy Credits (RECS) for the Owner. Coordinate with Owner to obtain required signatures on application(s).
- Energy monitoring
 - Dashboard & sub-metering equipment with data-recording capability shall be included in the Bid Lot.
 - Monitoring shall include irradiance as well as power output. (Irradiance data may be derived from separately-installed weather station.)
 - Monitoring for large systems should be available at the combiner or inverter level, in order to monitor sub-system performance.
 - APS has an in-house Energy Team, and requests permanent lifetime access to monitoring of each installed PV system.
 - Educational graphics and dashboard monitoring screen in the school building are requirements of each PV system
 - Contract must include providing and installing this monitor
 - Monitor can be wired or wireless Smart-TV, placed in public area
 - Identified data drop(s) are provided by General Contractor and APS

PV ARRAY GOALS:

1. Maximize onsite renewable energy generation based on available space, targeting up to 100% of project's electrical energy use.
2. Minimize penetrations through the roofing structure to support future roof maintenance and repair.
3. Integrated battery storage systems are being explored, and may be requested as part of the solar design.

Roof-mounted grid-tied systems are preferred (versus ground-mounted) to minimize vandalism, reduce first costs, provide protection to roof membranes, and allow for ease of maintenance.

KEY ARRAY ATTRIBUTES:

The following attributes shall be used to plan new PV systems. A supporting document with Sheet Notes for construction drawings, attached below, is integral to this Guideline. The Sheet Notes must be included in the Construction Documents, outlining the requirements for equipment selection, installation, maintenance, and other considerations.

- Panels (Modules)
 - Minimum Panel Efficiency: 16% (Year 1 – see degradation requirements below)
- Panel Performance Degradation
 - Minimum 90% original capacity at Year 10
 - Minimum 80% original capacity at Year 25
- Spacing and parapet clearance requirements must comply with the City of Albuquerque's Fire Department PV Guidelines (separate document) and OSHA regulations regarding parapet heights and safety tie-offs.
- Shading by objects (structure, trees, etc.) shall be managed so that shade on modules is minimized or eliminated during the hours of 9:00 am and 3:00 pm all days of the calendar year.
- Refer to and follow APS Roofing Design Guidelines and Specifications
- Flat Roof Mounting
 - Ballasted racking system, tilted at a minimum of 10° from horizontal
 - Unirac® as Basis of Design – Use Unirac's RM tools or similar process to size structural loads and determine gear associated with the array.
 - Coordinate ballasted wind-load with structural engineer.
 - ⊖ IMPORTANT: Coordinate PV ballast specification with roof warranty provisions for PV, especially regarding prescribed sacrificial padding layers. In no way may the PV installation jeopardize the roof warranty.
 - Ideal orientation is South, though SE or SW variations are allowable where building orientations dictate.
- Sloped Roof Mounting
 - Schletter "Standard Flush-Mount" clips & racking as Basis of Design or similar
- Inverters – *Based upon system size*
 - Minimum inverter efficiency: 96% (year 1).
 - Inverter capacity must be \geq 105% of array DC Standard Test Conditions (STC) wattage.
 - Consider string inverters where possible, to reduce need for combiner boxes.
 - No single inverter to exceed 30 KW.

- Indoor or protected (shaded) outdoor inverter placement is preferable. Do not place exterior-rated inverters on south or west facades.
- If inverter is not equipped with integral fused string combiner, provide switched combiner box(es) with integral DC disconnect, surge suppression device, and NEMA 3R enclosure (Eaton® #ESC series or approved equal). Provide fused inputs as indicated (Littelfuse® SPF series or approved equal). Fuses shall be sized based on final solar panel selection in accordance with the NEC.
- PV circuit breakers in electrical panel shall be rated as suitable for backfeed. Circuit breakers shall be sized based on final inverter selection and total PV output in accordance with the NEC.
- Minimum Component Warranties
 - PV Panel Performance – 25 Years
 - PV Panel Components (hardware, conductors, etc.) – 10 Years
 - Inverter(s) – 10 Years
 - Racking – 10 Years
- Training
 - APS Maintenance & Operations personnel shall be thoroughly trained by the installing PV Contractor and/or manufacturer on the following:
 - System components
 - Maintenance
 - Trouble-shooting
 - Monitoring
 - Training shall be video-taped and coordinated with APS commissioning agent

OTHER CONSIDERATIONS:

- We recognize that the photovoltaic and energy storage industries are advancing and changing very rapidly. While these Guidelines give information about how APS is currently employing solar energy, they can't possibly anticipate all the scenarios we'll encounter as we continue to build in the coming years. We're counting on you -- the industry professionals -- to keep us up-to-date on trends and technology. Please make suggestions and recommendations that can benefit the school district, and help us make good decisions to keep our solar energy strategy viable and sustainable.

APPENDIX 1

SOLAR PHOTOVOLTAIC SYSTEM SHEET NOTES

Special Sheet Notes for General Contractor:

1. Base Bid for project (General Contractor's scope) shall include two (2) 3" conduits from main electrical room to penthouse or other inverter location for PV use. Label both conduits at stub-out locations with "Rooftop Solar."
2. Back-feed breaker must be sized appropriately as part of Base Bid for anticipated rooftop solar.

PV System Sheet Notes:

1. All material and labor for installation of the roof-mounted photovoltaic array and associated monitoring system shall be included as a turn-key package.
2. Shop drawings shall be submitted to and reviewed by the Owner and commissioning agent (CxA) for comments prior to the installation of any equipment. Shop drawings shall include general configuration of the system, wire and fuse sizes, proposed monitoring system software platform and display screen, and cut-sheets for PV-related equipment.
3. Contractor must hold a current NM EE-98 electrical license. Installer(s) should carry North American Board of Certified Energy Practitioners (NABCEP) certification.
4. Design-build system shall be in compliance with minimum requirements listed for solar panels, inverters, and energy production as outlined in APS Solar PV Design Guidelines. PV panel installation must be coordinated with Structural, Roofing, and other disciplines. Any revised layout of equipment or panels must be approved by the project's Electrical Engineer and/or Architect, be coordinated with other trades, and cause no additional cost to the Owner.
5. Contractor shall provide a detailed system performance and life-cycle cost summary with their bid (including all soft-costs such as metering, monitoring, etc.), to demonstrate expected payback schedule.
6. Photovoltaics shall be an included system for overall project commissioning. PV Contractor shall coordinate their commissioning/startup activities with Owner's commissioning agent (CxA).
7. Prior to installation, each module (panel) shall be confirmed to have a production tolerance within 0% to +3% of the module's nameplate rating (to reduce "module mismatch").
8. All electrical components including overcurrent protection, disconnects, conduit, wiring and terminals must have UL or equivalent listing, and have appropriate voltage, current and temperature ratings for the application. All wire management materials (cable ties, etc.) utilized outdoors must be of UV-resistant material.
9. All wiring shall be listed for a minimum operation of 600 volts and 90° C temperature rating. All current-carrying conductors must be enclosed in conduit, with the exception of module interconnections protected underneath panels within the same grouping.
10. Cable trays and cross-path conduits between arrays shall be clearly marked and caution-colored to minimize trip-hazard.

11. Exposed wall-mounted conduit shall be routed to minimize visibility and painted to match surrounding structure. Conduit shall be mounted parallel and perpendicular to structural elements.
12. PV system circuit breaker at point of interconnection to be provided by project Electrical Contractor. Confirm sizing of breaker at Main Switch Board (MSB) with final configuration of PV system.
13. Equipment shall be labeled to indicate usage, voltage, and all safety/hazard warnings as required by National Electric Code (NEC) section #690.
14. Installation shall meet setback requirements and clearances per Albuquerque Fire Department guidelines, and any other provisions per directives from local utility company and Authority Having Jurisdiction (AHJ).
15. All framing members, boxes, metal enclosures, panel boards, inverters, and conduit must be properly grounded and terminated at appropriate grounding rod connection point. Modules shall be bonded to support racks using stainless steel hardware (nuts, lock washers, and threaded bolts or other UL listed clamps).
16. Refer to and follow APS Roof Design Guidelines and Specifications. DO NOT BEGIN PV INSTALLATION BEFORE ROOF UNDERGOES INITIAL INSPECTION.
17. Provide all necessary components to give a complete and operable system in compliance with the National Electric Code. Ensure that PNM interconnection requirements are met.
18. Provide necessary equipment for web- or server-based monitoring of inverter output. Any required data drops must be indicated clearly on the drawings and coordinated with A/E Team. Equipment requiring a dedicated IP address must be listed in detail and tracked on Sheet DD-100 (included in A/E's bid documents).
19. Provide Smart TV or suitable computer with separate flat-screen monitor in building lobby or other area approved by Owner. Coordinate exact location with A/E. Computer/smart monitor must have all necessary monitoring system software pre-installed. Provide written instructions for how to access and navigate PV data at this terminal as part-of commissioning training. Data network access provided by Owner.
20. Comprehensive training on PV system by the installer and/or manufacturer's rep, including PV components, maintenance, monitoring and trouble-shooting, shall be provided to the APS M&O staff and verified by the Owner's commissioning agent. See APS Solar PV System Design Guidelines.