

Appendix 2: Technical Specification Forms

PV Modules (flat-plate)	
<i>Attach datasheets</i>	
Manufacturer	
Model #	
Power _{MAX} Rating (Watts DC at STC)	
Technology Type (e.g. thin-film, monocrystalline, etc.)	
Efficiency (at STC) (%)	
Maximum System Voltage (V DC)	
Nominal Operating Cell Temperature (°C)	
Temperature Coefficient for Power (%/°C)	
Sustainable Wind Pressure (Pa)	
Total capacity (MW DC at STC) installed to-date of the proposed PV module	
Manufacturing availability of proposed module over project construction and life of project	
Statement on the selected vendor's factory locations, capacities, labor availability and shift utilization.	
Statement on the proposed transportation chain from point of final manufacture to the Project site. Include a description of handling, packaging, options for reuse of packaging materials or waste volume, and the removal plan for packaging from Project site.	
Control and risk mitigation statement for any compound or chemical in selected panel deemed controlled or hazardous.	
Detailed description of mechanism and effects including calculation of (any) initial light-induced degradation effect for selected panel, including field trial data where available.	
Describe any quality & environmental certification that the proposed module's manufacturing facility has received (e.g. ISO 9001, ISO 140001, or other certifying bodies)	

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DC Wiring and Combiner Boxes	
<i>Attach datasheets</i>	
DC wiring voltage insulation design capability (600V, 1000V or higher)	
List of proposed vendors	
Statement on vendor capability to supply the necessary volumes and meet	

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Mounting	
<i>Attach datasheets</i>	
Single or double-axis?	
# of projects deployed with proposed tracking system	
Stow wind speed	
Type and # of control system used and sources of information source for	
Power consumption requirements for motor controller (estimated daily kWh)	

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Inverters		
<i>Attach datasheets</i>		
Manufacturer		
Rating (Maximum Continuous AC output)		kW
		V
Certification listing if applicable (e.g. UL 1741, ETL or other)		Y/N
Total harmonic distortion		%
Power factor at full power rating		
Efficiency at full power rating		
Total installed capacity of the selected inverter		

Appendix 2: Technical Specification Forms

Step-Up Transformers

Attach datasheets including efficiency curve and loss curve

1	Manufacturer & Model #		
2	Rating		kVA
3	Impedance		
7	Primary voltage		
8	Secondary voltage		
9	Winding insulation ratings		° C rise over
10			° C average ambient
11	Includes fused disconnect switch on high voltage side		Y/N
12	Type (check one)		Dry-type
13			Less-flammable oil insulating fluid
14	Accessories included (check all that apply):		Liquid level gauge
15			Pressure/vacuum gauge
16			dial-type thermoment with SPDT alarm contacts
17			Pressure relief valve
18			Drain valve with sampler

Appendix 2: Technical Specification Forms

Switchgear

Attach datasheets

1	Manufacturer		
2	Ratings		kV
			A
			k AIC
			kV BIL minimum
			Phase
3	Description of metering components		
4	Relay Manufacturer		

Appendix 3: Performance Characterization

	Input	Units	Comment
Climate and Location			
City		-	
State		-	
Latitude		°	
Longitude		°	
Weather File used for performance estimate		-	TMY 3 weather data
Module			
Module Name			Please include detailed information
Maximum Power (P _{mp})		Wdc	
Module Power Output Tolerance			
Module efficiency		%	
Module Area		m ²	
Maximum Power Voltage (V _{mp}) @STC		V	
Maximum Power Current (I _{mp}) @STC		A	
Open Circuit Voltage (V _{oc}) @ STC		V	
Short Circuit Current (I _{sc}) @ STC		A	
Temperature Coeff. of I _{sc}		%/°C	%/°C or A/°C
Temperature Coeff of Voc		%/°C	%/°C or V/°C
Temperature Coeff of P _{max}		%/°C	
Module structure		-	Glass/Cell/Polymer Glass/Cell/Glass Polymer/Cell/Steel Other
Normal Operating Cell Temperature (NOCT)		°C	
Inverter			
Inverter Manufacturer and Model			Please include detailed information
Nameplate AC Power		kWac	
AC Voltage		Vac	
Max DC Input Voltage (V _{dcmax})		Vdc	
Maximum Input Current		Adc	
MPP Input Voltage Max		Vdc	
CEC Weighted Efficiency		%	
Array			
Modules per string		-	
Strings in Parallel		-	
Total Modules		-	
Total Array Power		kWdc	
Number of Inverters		-	
Total Inverter Capacity		kWac	
Tracking and Orientation			
Specify: FIXED, 1-axis tracking, 2-axis tracking, etc		-	
Manufacturer and Model of Mounting/Tracking Unit			
Tilt		°	
Min/Max rotation (if tracking)		°	
Azimuth		°	0 = true south; 90 = west, -90 = east
Ground Reflectance			
Backtracking enabled		-	Yes/No
Ground Coverage Ratio		%	
System Derates			
Mismatch		%	
Diodes and Connections		%	
DC Wiring		%	
Soiling		%	If using monthly derate factors, please list in the comment field
Sun Tracking		%	Use this value to simulate shading losses and/or backtracking losses
AC Wiring		%	
Transformer		%	
Total Derate Factor (Pre-Inverter)		%	Use value and significant digits as calculated by SAM
Expected Annual Degredation Factor		%/yr	

Appendix 5: Permit Checklist

Regulatory Authority	Statute	Permit/Approval	Description	Triggers
FEDERAL				
Lead Agency varies by project Council on Environmental Quality Regulations (CFR 1500-1508) and supplemental regulations from lead agency	National Environmental Policy Act (42 USC 4321)	Record of Decision or FONSI or Categorical Exclusion	Establishes national mandate for federal agencies to review environmental impacts of proposed actions. Process can be combined with state and local environmental reviews	<ul style="list-style-type: none"> Federal permit or approval required Siting on federal lands Accessing federally owned land transmission line Receipt of federal grants
Advisory Council on Historic Preservation (ACHP), Tribal Historic Preservation Office (THPO) and State Historic Preservation Office (SHPO) (36 CFR 60 and 800)	National Historic Preservation Act (16 USC 470)	Section 106 Consultation	Requires federal agencies to review impacts to historic and Tribal resources and allows ACHP to provide comments. Consultation authority delegated to SHPO and THPO.	<ul style="list-style-type: none"> Federal permit or approval Required Activity may impact property listed in or be eligible for listing in the National Register of Historic Places (NRHP) Activities may impact tribal places
Bureau of Land Management (BLM)	43 U.S.C. 1761 43 U.S.C. 2801	Site Specific Grant	Authorization for individual meteorological towers and instrumentation facilities	<ul style="list-style-type: none"> Placement of short-term (less than 3 years) facilities with minimal impacts on BLM lands

Appendix 5: Permit Checklist

Regulatory Authority	Statute	Permit/Approval	Description	Triggers
Federal Aviation Administration (14 CFR 77)	49 USC 44718	Notice of Proposed Construction (Form 7461-1) Hazard Determination	Notifies FAA of proposed structures that might affect navigable airspace. Form requires proposed markings and lighting. FAA must review possible impacts to air safety and navigation, as well as the potential for adverse effects on radar systems.	<ul style="list-style-type: none"> Construction or alteration of structures standing higher than 200 feet above ground level Construction or alteration of structures near airports Siting within radar line-of-sight of an air defense facility
U.S. Army Corps of Engineers (USACE) (33 CFR 320-331 and 40 CFR 230)	Clean Water Act (33 USC 1251 et seq) Section 404 (33 USC 1344)	Individual, general, and nationwide permits	Regulates discharge of dredged or fill materials into waters of the United States	<ul style="list-style-type: none"> Activities that may impact federal waters, including wetlands
USACE (33 CFR 320-331)	Rivers and Harbors Act of 1899 (33 USC 401 et seq) Section 10 (33 USC 403)	Section 10 Permit	Regulates obstructions to navigable waters of the United States	<ul style="list-style-type: none"> Building or replacing bridges
U.S. Fish and Wildlife Service (USFWS) (50 CFR 13 and 17)	Endangered Species Act (16 USC 1531-1544)	Endangered Species Act Consultation and Incidental Take Permit	Regulates activities affecting threatened and endangered species: Section 3 (16 USC 1532) defines terminology Section 7 (16 USC 1536) establishes federal interagency consultation	<ul style="list-style-type: none"> Consultation with FWS under Section 7 Activities that may result in take or harm to species and their habitat, such as site clearing and wind turbine operation

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Regulatory Authority	Statute	Permit/Approval	Description	Triggers
			Section 9 (16 USC 1538) establishes prohibited actions Section 10 (16 USC 1539) establishes permits and exceptions Section 11 (16 USC 1540) describes penalties and enforcement	
USFWS (50 CFR 13 and 21)	Migratory Bird Treaty Act (16 USC 703-712)	Consultation	Prohibits harm, possession, or take of migratory bird species, nests, and eggs. Strict liability statute.	<ul style="list-style-type: none"> • Potential impact to migratory bird species protected by the act
USFWS (50 CFR 13 and 22)	Bald and Golden Eagle Protection Act (16 USC 668-668d)	<ul style="list-style-type: none"> • Consultation • Golden Eagle Nest Take permit 	Prohibits harm, possession, or take of bald and golden eagles. Strict liability statute.	<ul style="list-style-type: none"> • Potential impact to bald or golden eagle • Necessity for moving golden eagle nest
United States Forest Service (USFWS)	36 CFR 251.50	Special Use Permit	Authorization for use of project area for construction of all facilities necessary for a long term, commercial wind energy project, including construction of turbines, access roads, distribution lines, and associated facilities	<ul style="list-style-type: none"> • Required to occupy and use National Forest System lands and related waters
LOCAL				
Counties	Varies by county	Non Title V air quality permit	Required for facility emissions that are below the Title V emission thresholds and that are not considered exempt or insignificant	Check with county.

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Regulatory Authority	Statute	Permit/Approval	Description	Triggers
County Air Quality Department	Varies by county	Fugitive Dust Control Permit	Required for activities that will disturb a surface area equal to or greater than 0.1 acre or the demolition of buildings.	Threshold varies by county. Check with county air quality department.
County Floodplain Department	Varies by county	Floodplain Use Permit	Construction with a FEMA or county designated floodplain.	Check with county.
County Planning or Development Department	Varies by county	Construction, Grading, and Building Permits	Grading, construction, and building facilities	Check with county.
County Planning or Development Department	Varies by county	Conditional Use Permit (CUP)	Required when use is not allowed under the zoning code, but can be specially permitted.	Check with county.
County Planning or Development Department	Varies by county	Comprehensive Plan Amendment	Required when use is not allowed under current county general plan and plan must be amended to allow for use.	Check with county.
County Planning or Development Department	Varies by county	Rezoning	Required when current site zoning does not allow for use, but the Comprehensive Plan does allow for rezoning of the site.	Check with county.
County Transportation Department	Varies by county	County Road Encroachment Permits	Encroachment in to a county road for utilities, driveways, etc. general requires an encroachment permit.	Check with county.

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Regulatory Authority	Statute	Permit/Approval	Description	Triggers
County Transportation Department	Varies by county	Oversize and Overweight Vehicle Permit	For movement of specific oversize and/or overweight loads with exact dimensions, and exact weights.	Check with county.
County Wastewater Department	Varies by county	Wastewater Sewer Connection Permit	Required to connect to the county sewer system.	Check with county.
OTHER				
Railroad		Encroachment Permit	Process varies by railroad.	Required for all utility and road crossings and parallel installations with the RR ROW.

C = Contractor
O = Owner
T = Transmission Provider

Appendix 7: Division of Responsibility

Activity Description	Conceptual Engineering	Detailed Design	Equipment Procurement	Construction	Comments
PROJECT FINANCING/Ownership	O	O	O	O	
SITE ACQUISITION	C	C	C	C	
ENGINEERING AND DESIGN SERVICES					
Plot Plan & Arrangement Drawings	C	C	C	C	
Solar Optimization	C	C	C	C	
One-Line Drawings	C	C	C	C	
Drawing Schedule	C	C	C	C	
Commissioning, Start-up & Operating Manuals	C	C	C	C	
Maintenance Manual	C	C	C	C	
Spare Parts Manual	C	C	C	C	
Design Criteria	C	C	C	C	
Construction Support Services, Resident Eng.	C	C	C	C	
Functional Specification of Major Equipment	C	C	C	C	
Corrosion Protection Concept	C	C	C	C	
Fire Protection Concept	C	C	C	C	
Design Plant	C	C	C	C	
Calculations Plant/Drawings Plant/PE Stamp	C	C	C	C	
As-Built Drawings	C	C	C	C	
Purchasing Support/Equipment and Material Specification	C	C	C	C	
Vendor Quote Recommendations	C	C	C	C	
Review and Approval of Vendor Drwgs.	C	C	C	C	
Procurement Schedule	C	C	C	C	
Design Reviews	C / O	C / O	C / O	C / O	Owner may review design per contract
PERMITTING & DEVELOPMENT RELATED					
Local Mandates Social Benefits For Labor	C	C	C	C	
Federal Permits, Licenses and approvals	C	C	C	C	
State Permits, Licenses and approvals	C	C	C	C	
Environmental Assessment	C	C	C	C	
Zoning Board Approvals	C	C	C	C	
Building & Construction Permits	C	C	C	C	
Coordination of the Local Building Inspector's Site Inspections	C	C	C	C	
Transmission Interconnection Request & Studies	C	C	C	C	
Permanent Water Supply	C	C	C	C	if required
Permanent Sewer Connection	C	C	C	C	if required
Permanent Plant Phone System	C	C	C	C	if required
SITE WORK					
Site survey/access right of way & easements	C	C	C	C	
Geotechnical Study and recommendations	C	C	C	C	
Clearing and Grubbing	C	C	C	C	
Earthwork	C	C	C	C	
Roads/Paving/Surfacing/all required surfaces	C	C	C	C	
Fencing/Gates	C	C	C	C	
Final Landscaping	C	C	C	C	
Grading and Drainage	C	C	C	C	
Sedimentation and Erosion Control Plans	C	C	C	C	
CIVIL WORK					
Building Foundations	C	C	C	C	
Infrastructure	C	C	C	C	
Misc. Foundations	C	C	C	C	
Trenches, Duct Banks & Manholes	C	C	C	C	
Piers	C	C	C	C	
Footings	C	C	C	C	
Pads	C	C	C	C	
RACK MOUNTS/TRACKING					
Steel Support Posts	C	C	C	C	

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Activity Description	Conceptual Engineering	Detailed Design	Equipment Procurement	Construction	Comments
All single-axis tracking system (motors, mounting, drives, etc.)	C	C	C	C	
Wiring and associated controls for tracker motors and drives	C	C	C	C	
EQUIPMENT PROCUREMENT AND SUPPLY	C	C	C	C	
Solar Modules	C	C	C	C	
DC Wiring	C	C	C	C	
Combiner Boxes (includes DC fuses, ground lugs, lightning arresters, etc.)	C	C	C	C	
DC Disconnect Switches	C	C	C	C	
Master Fuse Boxes for collection of Main DC Source Circuits to enter inverters	C	C	C	C	
Inverters	C	C	C	C	
AC Wiring	C	C	C	C	
Tracker interconnection	C	C	C	C	
Cable, Conduit, Bus, Tray & Grounding	C	C	C	C	
Main Step-up Transformer(s)	C	C	C	C	
Auxiliary Transformer(s)	C	C	C	C	
Substation / switchyard	C	C	C	C	
Transmission line from substation / switchyard to	C	C	C	C	
Low Voltage Switchgear	C	C	C	C	
Station Grounding system	C	C	C	C	
Outdoor Lighting	C	C	C	C	
UPS System	C	C	C	C	
DC Station Battery	C	C	C	C	
Station Battery Charger	C	C	C	C	
Cathodic Protection	C	C	C	C	
Ground Fault Protection System	C	C	C	C	
Revenue Metering	C	C	C	C	
System Protection - Relays	C	C	C	C	
Grid Interconnection	C / T	C / T	C / T	C / T	Contractor to coordinate with Transmission Provider
CONTROL/DATA ACQUISITION					
Array Data Acquisition and SCADA	C	C	C	C	
Tracking Control	C	C	C	C	
BOP Data Acquisition	C	C	C	C	
PROJECT SERVICES					
Project Management	C	C	C	C	
Project Master Schedule	C	C	C	C	
Drawing Schedules	C	C	C	C	
Equipment Delivery Schedules	C	C	C	C	
Construction Schedules	C	C	C	C	
Overall Project Status Reports	C	C	C	C	
Factory Tests Reports	C	C	C	C	
Performance Test Procedure And Final Report	C	C	C	C	
Transportation Risk Insurance	C	C	C	C	
Operating and Maintenance Personnel Training Program	C	C	C	C	
Quality Assurance/Quality Control	C	C	C	C	
MISC					
Security System	C	C	C	C	
BUILDINGS					
Structural steel	C	C	C	C	
Roofing	C	C	C	C	
Siding	C	C	C	C	
HVAC	C	C	C	C	
Building Insulation	C	C	C	C	
Doors and Windows	C	C	C	C	
Building finishes	C	C	C	C	
Architectural items	C	C	C	C	
Office equipment, furniture	C	C	C	C	
Specialties (Toilet Accessories, Lockers, etc.)	C	C	C	C	

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Activity Description	Conceptual Engineering	Detailed Design	Equipment Procurement	Construction	Comments
Misc. Building Plumbing	C	C	C	C	
Potable Water Supply	C	C	C	C	
Wastewater system	C	C	C	C	
PAINTING, COLOR CODING AND					
Prime Coating of Equipment	C	C	C	C	
Prime Coating of BOP	C	C	C	C	
Final Painting	C	C	C	C	
SPARE PARTS					
Commissioning Spares	C	C	C	C	
Operational Spares	C	C	C	C	
TEMPORARY FACILITIES					
Construction Facilities for Labor such as Toilets, Shelters, Change Rooms, etc.	C	C	C	C	
Laydown Area, (establish, Control & restore)	C	C	C	C	
Site Construction Office, Including all furniture, supplies, etc.	C	C	C	C	
First Aid Station, Safety and health facilities	C	C	C	C	
Site Security	C	C	C	C	
Fire Prevention and Fighting	C	C	C	C	
Temporary Water and Elec. Supply & Distribution	C	C	C	C	
Temporary Site Telephone/Communications	C	C	C	C	
Temporary Sewage Collection, Treatment and	C	C	C	C	
Dirt and Mud Control (temporary graveling of site	C	C	C	C	
Housekeeping for On-Site Facilities	C	C	C	C	
Clean-up and Removal of Temporary Facilities	C	C	C	C	
Training Facilities (on site or off site)	C	C	C	C	
Site Warehouse and Storage for all equipment and materials	C	C	C	C	
LOGISTICS					
Transportation of Equipment to Construction Site	C	C	C	C	
Preparation and Arrangement for Receiving Unloaded Equipment & Materials (including Warehouse Craneage, etc.)	C	C	C	C	
Local Registration Fee, Licenses, etc., if required	C	C	C	C	
Rights of Ways/Clearance for special shipments	C	C	C	C	
Equipment Unloading and Handling	C	C	C	C	
Equipment and Materials Receiving, Inspection, Inventorizing, Shipment Damage Claim	C	C	C	C	
Comprehensive General Liability Insurance	C	C	C	C	
Automobile Insurance	C	C	C	C	
Insurance of Temporary Facilities, Tools, Construction Equipment, Etc.	C	C	C	C	
Builder's All Risk (BAR) Insurance Coverage	C	C	C	C	
Bonding	C	C	C	C	
Construction Equipment, Tools, Instruments &	C	C	C	C	
Construction and Erection Tests	C	C	C	C	
Technical Advisors (TAs)	C	C	C	C	
Supervision and Labor Reports	C	C	C	C	
START-UP AND COMMISSIONING:					
Lead Organization	C	C	C	C	
Start-up & Initial operations mgt. & scheduling	C	C	C	C	
Start-up Advisor	C	C	C	C	
Consumables	C	C	C	C	
Craft Labor	C	C	C	C	
Reports	C	C	C	C	
Standard Test Instruments, Tools & Equipment	C	C	C	C	
Special Test Instruments, Tools & Equipment	C	C	C	C	
Documentation, Test and Data Records	C	C	C	C	
Equipment, Component, System Walk-throughs & Turnovers	C / O	C / O	C / O	C / O	Owner to participate in walk-throughs and may review

Appendix 8: Owner Specifications

Specification	Title
GEN-ENG-RELAY-0001	Protective Relaying Standard
GEN-ENG-RELAY-0002	Arc Flash Hazard Standard
ZS-013	Substation Equipment - Power Circuit Breaker - Nominal 345kV and Above
ZS-003	Substation Equipment - Power Circuit Breaker - Nominal 46kV to 230kV
6B.6	Substation Grounding
6B.5	Fence Application and Construction
ZS-001-2007	Substation Equipment - Power Transformer, All Ratings
<i>no number</i>	Facility Connection Requirements for Transmission Systems (46kV and Above)