REQUEST FOR PROPOSALS:

On-Site Renewable Energy Project Design
[Photovoltaic Array (PVA) and Wind Energy System]

ASO PVA Project Development Team

Draft RFP Comment Period: 28 June 2023 – 12 July 2023

Final RFP Issued for Bids: 17 July 2023

RFP Bid Period Closes (Proposal Due Date): 25 September 2023
I. Overview and Proposal Process:

1.1 Advanced Simons Observatory (ASO) Renewable Energy System Request for Proposals - Document Overview:

This request for proposals (RFP) document is aimed at providing an overview for firms wishing to provide a proposal (Phase 0), for the design (Phase 1), and implementation (Phase 2) of the Advanced Simons Observatory (ASO) renewable energy project, to consist primarily of a photovoltaic array (PVA) and, possibly, additional supplemental wind energy production capacity. It is organized according to the following sections:

I. Overview and Proposal Process
II. Expected Structure of Proposals
III. Technical Requirements and Statement of Work

1.2 The Simons Observatory (SO) and the Advanced Simons Observatory (ASO) Projects:

The Simons Observatory project (SO) is a new ground-based experimental cosmology telescope facility under construction on a site near the summit of Cerro Toco at an elevation of 5190 meters in the Atacama Desert of Northern Chile (latitude 22° 57’ 37.06” South, longitude 67° 47’ 15.22” West). This location will be referred to as the SO site throughout this Request for Proposal (RFP) document. Figure 1.2.1 provides Google Earth satellite imagery illustrating the location of the SO telescope site near the planned area for deployment of the ASO photovoltaic array system site. More information on the project scope and scientific objectives of SO can be found at https://simonsobservatory.org/.

The Advanced Simons Observatory project (ASO) is aimed at extending the science and operational reach of SO via a National Science Foundation (NSF) Mid-Scale Research Infrastructure 2 (NSF MSRI-2) grant. ASO will include provisions for the deployment of additional telescope hardware, data pipeline infrastructure, and the renewable energy system, which is the focus of this RFP document.

Figure 1.2.1 – Google Earth satellite imagery illustrating the location of the SO telescope site near the planned area for deployment of the ASO photovoltaic array system site on Cerro Toco, a high-altitude site in the Atacama Desert of northern Chile.
1.2 The ASO Renewable Energy System (ASO Photovoltaic Array – PVA):

The focus of this RFP call is for a design, which will enable the integration, deployment, and operationalization of a new, high-altitude renewable energy power plant – primarily a photovoltaic array (PVA) with the potential for supplemental wind-power-generation system deployments – located roughly 0.6 kilometers Southeast of the SO site. This location will be referred to as the ASO PVA site throughout this RFP document. The mid-latitude, high-altitude location coupled with extremely dry annual weather conditions result in the site’s consideration as ideal for efficient PVA operation.

Experimental cosmology telescopes have been working around the location of the SO site for several decades and have been fully reliant on point-of-use diesel power generation requiring costly deliveries of diesel fuel to the remote, high-altitude site, which becomes at times unreachable due to weather conditions in this extreme environment. This can lead to intermittent power supply to the telescope infrastructure, thus reducing the overall energy security of the site, and, ultimately, the operational and scientific efficiency of the telescope instrumentation.

ASO has placed a priority on the development and operation of a new PVA system to ensure the long-term energy security of the entire SO site. Furthermore, the placement of a PVA at a high-altitude site in the Atacama Desert – considered the driest desert on Earth – will reduce the carbon footprint of the SO project by enabling the reduction of on-site diesel use by up to 70% and solidify the position of SO as the first large truly green telescope facility worldwide.

Prioritization of PVA deployment will serve as an important case study for future remote scientific facilities attempting to increase energy security and sustainability metrics and is in line with both global and Chilean energy transition policy goals to mitigate the climate crisis. Additionally, the inclusion of green energy technology will allow SO to demonstrate to both the Chilean government and people that the project prioritizes the ecological respect of the indigenous lands that NSF programs have utilized on and around Cerro Toco for decades.

The development and operation of the ASO PVA site will benefit the operational stability of the project through positive financial and scientific impacts and will serve to make the SO experiment a pathfinder for future large telescope facilities and remote scientific research sites worldwide attempting to mitigate their own carbon emission impacts on the global climate crisis.

1.3 Project Proposals: Requirements and Opportunities:

The development of a design for a renewable energy power generation system of adequate scale for coverage of the ASO telescope site is the baseline scope of this RFP document. However, proposers must also provide design and pricing information for the baseline system and a system that could be expanded by 50% and 100% of the baseline capacity. The beyond-baseline system design must include appropriately sized infrastructure including voltage converters, transformers, and transmission lines, however not batteries or panels (which are needed in the baseline design), which could be added at a later date to accommodate this increase in baseline capacity.

Furthermore, we welcome proposers to include, in addition, alternate details for a project scenario that includes the potential for a hybrid renewable energy system. Specifically, the potential integration of supplemental wind power generation capacity at the high-altitude PVA site that would diversify the renewable energy production capacity of the site is sought as a project opportunity here. While proposers have the option on whether to include the scenario including wind energy infrastructure in proposals, the inclusion of the hybrid scenario including wind infrastructure is encouraged and will factor into the evaluation of project design proposals, if provided.
Proposers will be asked to provide project development, programmatic, and pricing information for these project opportunities as an alternative to the ASO baseline, providing optionality for future expanded power production support and the inclusion of supplemental high-altitude wind power generation systems.

In summary, the required and alternative configurations sought in this RFP which will serve as the basis of proposal evaluation, go as:

1.) **[Baseline Renewable Energy System - Required]** Design and pricing information for the baseline ASO PVA facility, able to reduce the on-site diesel usage by 70%.

2.) **[Baseline+50/100 Renewable Energy System - Required]** Design and pricing information for a system that could be expanded by 50% and 100% of the baseline capacity.

3.) **[Hybrid Renewable Energy System – If Provided]** Design and pricing information for a hybrid renewable energy system capable of meeting baseline requirements, such as the inclusion of a supplemental wind power generation capacity at the high-altitude PVA site.

### 1.4 Definition of Design Proposal, Form of Proposal and Manner of Submission:

This RFP document outlines the scope of work and project requirements for the ASO PVA. **Proposers should take note that this RFP is requesting proposals including details for two distinct phases of the project.**

Phase 1 includes the fully detailed design of the ASO PVA according to the required and optional configurations described in the previous section.

Phase 2 includes details on the implementation of the project, taking the design developed in Phase 1 through the procurement, shipping, integration, deployment, operationalization, and hand-off to the ASO team for nominal operations.

Proposals should include a binding fixed cost for Phase 1 designs, and a nonbinding estimate covering the cost and schedule for the Phase 2 implementation work in the RFP response. That Phase 2 implementation cost and schedule estimate will then be updated to a final, binding fixed-cost cost proposal by the conclusion of the Phase 1 design work, which will aid in guiding the ASO PVA Project Development Team to decide whether to greenlight a given design for Phase 2 implementation work.

Note that the ASO PVA Project Development Team will review the final design produced by the successful proposer(s) at the conclusion of Phase 1. The ASO PVA Project Development Team will then, at its own discretion, decide whether to greenlight funding to one of the successful proposer(s) to proceed to Phase 2 implementation tasks, allowing that successful firm to complete the integration, shipping, deployment, operationalization, and hand-off to the ASO team for nominal operations.

Figure 1.3.1 provides detail on the dates, milestones, review periods, and decisional elements of flow of the ASO PVA Project development path.
Advanced Simons Observatory (ASO) On-Site Renewable Energy Project Design:
Request for Proposal (RFP), Photovoltaic Array (PVA) Design, Implementation Flow Chart

**PHASE 0 [Proposal]**
- **28 June 2023** Draft RFP Comment Period Opens
- **12 July 2023** Draft RFP Comment Period Closes
- **17 July 2023** Final RFP Issued for Bids
- **07 August 2023** ASO PVA Project Team Q&A Session with Proposers (Zoom-based)

**PHASE 1 [Design]**
- **TBD August 2023** Potential for Proposers to Visit SO Chile Site (at proposer expense)
- **25 September 2023** Final RFP Bid Period Closes
- **26-29 September 2023** ASO PVA Project Team Reviews Completed Proposals with Questions Posed to Proposers as needed.
  - Proposal Sections Evaluated:
    - Baseline Renewable Energy System (Required)
    - Baseline +50/100 Renewable Energy System (Required)
    - Hybrid (PVA+Wind) System (If Provided)
  - Cost Requirements:
    - Binding Fixed Cost for Phase 1 Design
    - Nonbinding Estimate for Phase 2 Implementation
- **06 October 2023** Phase 1 Design Study Award(s) Announced (Between 1-3 Firms Selected for Phase 1)
- **02 November 2023** Kickoff System Requirements Review (SRR) – 10% Design Maturity
- **Mid-December 2023** Preliminary Design Review (PDR) – 30% Design Maturity
- **Early-February 2024** Critical Design Review (CDR) – 50% Design Maturity
- **Early-March 2024** Complete Design Documentation (CDD) Submittal – 100% Design Maturity

**Mid-March 2024** Acceptance of Ownership by ASO PVA Project Team of Vendor Design(s) (Includes Binding Fixed Cost for Phase 2 Implementation)

**Late-March 2024** ASO PVA Project Team Reviews CDD Submittals for Phase 2 Implementation Potential

**Early-April 2024** Selection of one of the Phase 1 Vendors as Phase 2 Implementer
- **Early-April 2024** Announcement of Phase 2 Implementation Bidding/Review Process
- **July 2024** Selection of Phase 2 Implementation Firm (One of Phase 1 Vendors or New External Firm)

**PHASE 2 [Implement]**

**Figure 1.3.1** - Detailed overview of the dates, milestones, review periods, and decisional elements of ASO PVA Project development path flow.
One electronic copy of the proposal, in Adobe PDF format, transmitted electronically, shall be submitted. The proposal shall be organized following the content requirements outlined in Section 2. Proposals shall be delivered by the date set forth on the title sheet of this RFP document to:

Professor Mark J. Devlin (devlin@physics.upenn.edu) and
Dr. Benjamin L. Schmitt (bschm@upenn.edu)
David Rittenhouse Laboratories
University of Pennsylvania
209 South 33rd Street
Philadelphia, Pennsylvania, 19104
United States of America

Any proposal received after 5:00PM U.S. Eastern Time on the date stated on the title sheet of this RFP document may be rejected.

Proposals must set forth full, accurate and complete information as required in this RFP document. Proposals which are incomplete or partial in any material respect with respect to the requested information outline in this RFP document may be rejected.

The ASO PVA Project Development Team especially welcomes submissions from firms with a history of renewable energy design, deployment, and operations in Chile, particularly those with a physical presence in the country.

Proposals shall be in the English language and the currency of pricing quotations shall be in US dollars. Proposals submitted in response to this RFP document must remain valid for at least 90 days from the RFP close date.

During the period in which the RFP is open (between the Issue and Due dates set forth on the cover page of this document), the ASO PVA Project Development Team may host an open day for potential bidders to visit the SO site and proposed ASO PVA site, view existing and in-development infrastructure, and ask any additional questions that may be relevant to the bidding process (note that any and all travel to the site will be at the sole expense of the proposer).

In addition to the potential for an on-site visit day, the ASO PVA Project Development Team will also host a webinar-based questions and answers session for potential bidders before the close of the RFP interval. Further details for these potential sessions will be made available to bidders who may be interested in participating.

The ASO PVA Project Development Team additionally reserves the right to:

(i) Postpone the date of submission for all bidders or any other date defined for the Project Development flow outlined in Figure 1.3.1;
(ii) Amend this RFP document as it considers necessary for all bidders; and
(iii) To waive informalities and minor irregularities in proposals received in response to this RFP from all bidders.

1.5 Method of Procurement:

The ASO PVA Project Development Team intends to negotiate a firm, fixed-price contract for the entire scope of work for the Phase 1 design, as defined in this RFP, with the successful Proposer. At the time of proposal, each proposing firm shall provide both a binding, fixed-cost total for the Phase 1 design work proposed, as well as a non-binding estimate for Phase 2 implementation.
Moreover, the ASO PVA Project Development Team intends to award the contract to the qualified Proposer providing a proposal that is most advantageous to the ASO project, all factors outlined in this RFP document being considered.

The ASO PVA Project Development Team reserves the right to make an award based on the Proposer’s initially proposed price for the Phase 1 design without further discussion with the selected Proposer. The ASO PVA Project Development Team is not obligated to award all or any part of the work solicited and will not be responsible for the cost of proposal preparation or any other cost incurred by the Proposer to respond with this RFP process. Moreover, the ASO PVA Project Development Team reserves the right to accept, as successful, a proposal other than that representing the lowest price proposed among responses.

The successful Proposer is responsible for obtaining insurance protecting the ASO project, the Proposer, and any engaged subcontractor performing any work associated with the successful proposal. Furthermore, the successful Proposer must promptly upon selection comply with the insurance provisions and maintain insurance levels at the Proposer’s sole expense, as detailed in the ASO contract. The Proposer must also provide evidence of such insurance prior to the commencement of the ASO contract. Failure to comply with these provisions in the submitted proposal shall result in the proposal being considered non-responsive.

It is the intention of the ASO PVA Project Development Team to award between 1 and 3 Phase 1 design study awards, at the discretion of the team. Upon successful proposal acceptance, the Proposer(s) will become the project Phase 1 design Vendor(s). Should a given Vendor Phase 1 design be greenlit to proceed to Phase 2 implementation work, a Phase 1 design Vendor may become the Phase 2 implementation Vendor at the discretion of the ASO PVA Project Development Team.

However, as illustrated in Figure 1.3.1, either one of the Phase 1 vendors will be selected as the Phase 2 implementation firm, or else a new Phase 2 implementation bidding process will be run, which allows all Phase 1 vendors, as well as new external firms to compete for the Phase 2 implementation award. Note that as the Phase 1 design submittals will be the property of the ASO project, one or more of the completed designs, or combinations of completed design elements, can be provided to external firms as a basis for their implementation proposal.

The ASO PVA Project Development Team may require the Vendor to provide and pay for performance bonds, letters of credit, or other forms of security covering the faithful performance (100%) of the contract, and the payment of all obligations (100%) arising under the contract, in such a form as the ASO PVA Project Development Team may prescribe, and with approved sureties or issuers. The Vendor must pay the cost of obtaining said performance bonds or letters of credit. If requested, the Vendor shall deliver the required bonds or letters of credit to the ASO PVA Project Development Team no later than the date of completion of the contract with ASO.

1.6 Criteria for Proposal Evaluation:

The three primary categories through which proposal responses to this RFP will be evaluated include:

(i) Ability of the Proposer to complete the ASO PVA project meeting all operational and programmatic requirements. Evaluation criteria under this category include:

(a) Organization and management procedures;
(b) Experience and successful performance on and delivery of projects of similar magnitude and scope;
(c) Availability and competence of experienced management and technical personnel to be assigned to complete the project;
(d) Thoroughness of response to the requests and design requirements defined throughout this RFP document;
(e) Financial stability and willingness to commit resources required to successfully complete this project, including key personnel;
(f) Demonstration of an understanding of the technical difficulty of achieving the performance specifications;
(g) Engineering calculations and analysis supporting the claimed performance of the design;
(h) Methods for assuring compliance with defined technical requirements, specifications, and interfaces with site infrastructure;
(i) Provision of plans documenting the design, delivery, manufacturing, integration, and operation plans, including a clear division between required in-house and on-site tasks;
(j) Provisions for quality assurance for the implementable design;
(k) Relevant experience in the successful implementation of international projects.

(ii) Project price representing the best value.

(iii) Quoted schedule for completion. The date for the completion of the ASO PVA project design will be mid-March 2024, following the project development path outlined in Figure 1.3.1. Proposers must provide detailed schedules for meeting this date, including dates for interim design reviews, with adequate allowances for contingencies and plans for risk mitigation. If an alternate delivery date for the ASO PVA design project is deemed necessary, justification for the alternate date must be supplied.

1.7 ASO Action Upon Proposals:

In the event that no received proposals are consistent with the ASO PVA design project budget, or proposals received at the desired price do not fulfill the required specifications or meet project requirements with adequate allowances for contingencies, the ASO PVA Project Development Team reserves the right to:

(i) Review its specifications and reissue a new RFP call to all of the current Proposers, or any other party it feels is competent to compete for the Proposal;

(ii) Select any proposal(s) that the ASO PVA Project Development Team feels may be close to its desired standards and negotiate with the Proposer(s) thereof to determine if a combination of acceptable price, design specifications, and schedule can be obtained.

(iii) Close the RFP review process with no successful proposers awarded to be Vendors, enabling the opening of a new RFP process.

1.8 No-Quotes:

If a prospective Proposer elects not to submit a proposal in response to this RFP document, the ASO PVA Project Development Team requests a brief statement of why the given firm elected to no-quote the project.

1.9 Questions:

Questions relating to this RFP may be sent to Professor Mark J. Devlin (devlin@physics.upenn.edu) and Dr. Benjamin L. Schmitt (bschm@upenn.edu) until the RFP due date stated on the cover sheet of this document. Answers may be made available to other Proposers.

II. Expected Structure of Proposal:

2.1 Proposal Format:
The Proposal shall include:

(i) General project overview and summary (2 pages max.)
(ii) Section 1 – Technical proposal (15 pages max.)
(iii) Section 2 – Management (5 pages max., excluding curricula vitae, financial reports, and forms)
(iv) Section 3 – Delivery Schedule Summary
(v) Section 4 – Overview of Pricing
(vi) Appendix A – Signature Page

Submittals responding to this RFP call which include information that should not be disclosed or used for any purpose other than the evaluation of the proposal shall have these portions clearly marked.

2.2 General Project Overview and Summary:

The general project overview and summary shall provide a brief executive-level description of the proposal, not to include pricing information. Proposers who wish to deviate from the defined terms and conditions specified throughout this RFP document by the ASO PVA Project Development Team do so at their own risk. Additions or exceptions from the expected project proposal format must be noted and returned with the proposal. Proposers must complete the signature page (Appendix A) and include it as an appendix of the proposal submittal.

2.3 Technical Proposal:

In addition to providing a plan to meet the core requirements of the ASO PVA project detailed herein, each proposer shall provide the basis for an error budget, analysis of margins, and explicit plan for contingency mitigation for each technical specification.

While general operational requirements have been provided associated with the intended ASO PVA project scope, the ASO PVA Project Development team welcomes alternate technical proposals that exceed baseline project requirements given the advanced technical maturity of many aspects of the contemporary commercial PVA industry. Likewise, the ASO PVA Project Development team welcomes proposals that suggest project cost and schedule efficiencies, while maintaining baseline performance levels, through the potential reduction of project specifications in line with the current state-of-the-art trends in the photovoltaic power generation industry.

2.3.1 Technical Design:

The structure of the technical design proposal shall be broken into the following principal sections:

(i) Civil Design
(ii) Structural Design
(iii) Architectural Design
(iv) Electrical Design
(v) Telecommunications Design
(vi) Mechanical Design

Design concepts must be provided throughout these sections in sufficient detail to permit reasonable evaluation of the proposed approach and describe any methods of analysis used by the Proposer, where applicable. Each proposal shall address, at a minimum, each of the following considerations:

(i) Technical approach – Describe the proposed PVA concept and method of analysis
(ii) Performance estimates –
a. Estimate the ability of the proposed design to meet specification.
b. Include the estimated or known performance of systems and major components to be used to comprise the ASO PVA. These shall include, but are not limited to:
   (1) photovoltaic panel array;
   (2) control container;
   (3) battery storage facility;
   (4) charge controller station;
   (5) DC-to-AC inverter;
   (6) stepdown transformer;
   (7) high-voltage transmission lines to ASO telescope site;
   (8) voltage regulator;
   (9) blocking diode;
   (10) interface components to ASO telescope site electrical grid;
   (11) PVA plant operational monitoring/control system;
   (12) Perimeter security design and monitoring.

c. Provide error budgets for system performance and associated risks and mitigations.
d. Include estimates of the daily and annual power yield for the proposed PVA designs, including contingency for site specific operating conditions (e.g. utilize historical cloud cover, precipitation, temperature, and related data).
e. Analogous performance estimates for addition of a potential supplemental wind power generation system, as described as a Project Opportunity above.

(iii) Materials – Provide details of the materials proposed for all components of the PVA design.
(iv) Transportation – Describe how the safe and secure transportation of the constituent PVA subsystems will be achieved.
(v) Assembly – Describe features of the proposed ASO PVA design that will facilitate the efficient assembly of the entire system at its site.
(vi) Access – Describe details of the access arrangements for all of the principal subsystems of the ASO PVA design.
(vii) Cost Drivers – Describe any specifications or technical requirements of the proposed PVA system that will drive costs, and risk factors that could create significant cost overruns. Describe how to mitigate risks associated with identified cost drivers to avoid risk and cost overruns, potentially through the suggestion of alterations to specifications and requirements that could drive system efficiency. Describe the correlation between any suggested specification reduction and cost savings.

2.3.2 Manufacturing Plan:

The proposal manufacturing plan will include a discussion of:

(i) Industrial suppliers for each of the principal ASO PVA subsystems.
(ii) Plan for delivery of a final bill of materials allowing for the fabrication, integration, and deployment of each of the principal ASO PVA subsystems.
(iii) Plan for breakdown of project across subsystems to optimal photovoltaic industrial subcontractors appropriate for the scale of the ASO PVA project.
(iv) Definition of any long-lead-time systems or special equipment that may be required for initial fabrication, or ultimate deployment of the PVA on site.

2.3.3 Plan for Pre-Shipment Verification and Shipping to ASO Site:

A description shall be included to provide an outline for main steps that need to be taken for performance and quality assurance allowing for pre-shipment verification of all ASO PVA subsystems and components, as well as the plan for the safe and secure shipment of all PVA subsystems to the ASO site in Chile. Characteristics required for this outline include, but are not limited to:
(i) Method of transporting PVA subsystems to a staging site (if necessary).
(ii) List of any measurements or tests that need to be conducted to verify compliance of PVA subsystems and components within the specifications outlined throughout this RFP document.
(iii) Verification of interface compliance to ASO site infrastructure.
(iv) Initial introduction of ASO PVA Project Development Team to planned PVA operation.
(v) Plan for the disassembly and packing of all PVA subsystems for shipment to the site in Chile.
(vi) Plan for shipping to the site in Chile.

2.3.4 Assembly Plan:

The assembly plan shall include a discussion of considerations for preparation, integration, and successful operationalization of the ASO PVA on site, properly interfaced with the energy systems existing at the ASO telescope site. Specific attributes of this plan should include, but are not limited to:

(i) Site preparation.
(ii) Assembly steps.
(iii) Field equipment and facilities required.
(iv) Assembly techniques.
(v) Outline of safety protocols and procedures.
(vi) Role of each subcontractor (if applicable).
(vii) Security of unassembled systems on site prior to security perimeter deployment.
(viii) Plan for post-operationalization site cleanup.

2.3.5 Final Verification Plan:

Proposers should outline how final verification of the ASO PVA will be conducted, including, but not limited to system characteristics related to power production and transmission to the ASO telescope site energy system, proper interfacing to the ASO telescope site energy system, system battery performance, as well as safety, security, and reliability of the entire ASO PVA system.

2.3.6 Exceptions to ASO Specifications:

Any proposed exceptions to the ASO PVA Project Development team defined specification must be discussed and alternative specifications should be proposed.

2.4 Management:

The management section of the proposal shall address the Proposer’s relevant industrial experience, personnel, and resources which should qualify it to successfully deliver the design for the ASO PVA project. This section must include, but should not be limited to, the following details:

(i) Information concerning past experience and delivery of PVA systems in remote environments similar the work proposed.
(ii) A summary of primary qualifications for successful project delivery, including, but not limited to scheduling, project management, subcontracting, purchasing, field engineering, system verification, and quality control. Description of the software intended to be used to complete all aspects of the proposed system design must be included, as well as a description of the accessibility of the proposer to all necessary software platforms needed for design completion.
(iii) A list of all design facilities or proposed subcontracting design firms.
(iv) Curricula vitae for key management and technical personnel who will be assigned to the project, if successful.
(v) A summary of qualifications of any proposed subcontracting firms or consultants.
(vi) A statement of the extent to which the Proposer is willing or unable to commit necessary resources to realize the successful completion of the ASO PVA project design.

(vii) Latest certified audit and financial statements and last yearly report of the company and any parent company.

(viii) A list of any pending, ongoing, or resolved disputes or legal actions relevant to this RFP involving PVA installation designs which the Proposing firm is involved. Describe any issues related to projects offered as evidence of the Proposer’s experience and management capability.

(ix) Describe the access of the ASO PVA Project Development team to the Vendor during all phases of the PVA design project proposed.

(x) A complete Vendor certification package must be included, to be provided from the relevant University of Pennsylvania business office on request.

Additionally, the Management section must include statements regarding legal, regulatory, sanctions, and export controls regime compliance in all jurisdictions under which the work will be conducted and materials, systems, subsystems, and components will be sourced, including the following:

(i) As a U.S. Federally Funded scientific infrastructure project, it is strictly required by the ASO PVA Project Development team that all aspects of the Phase 0 (proposal), Phase 1 (design), and Phase 2 (implementation) are fully compliant with all relevant laws and regulations within all jurisdictions under which work will take place as funded by this award. As such, firms must provide written evidence regarding the origin of all material and intellectual property elements that are used to complete all project phases, ensuring that the materials and intellectual elements, along with the work of the given firm itself, does not violate any standing sanctions, counter threat financing measures, or technology export controls restrictions in place in the United States or any other jurisdiction under which the work might take place. These restrictions include, inter alia, supply chain compliance with the Uyghur Forced Labor Protection Act (U.S. Public Law 117-78), as well as full compliance with all other enacted restrictions imposed at the time of the work by the U.S. Department of the Treasury's Office of Foreign Assets Controls (OFAC) on interactions with sanctioned entities and technology export controls restrictions, including, but not limited to OFAC sanctions regimes currently imposed against, for example, the Russian Federation, People's Republic of China (PRC), Democratic People's Republic of Korea (DPRK), Cuba, Venezuela, the Islamic Republic of Iran, and other nation states, state-owned-enterprises (SOEs), or private entities currently designated under said regimes. For more information about relevant U.S. Treasury-OFAC regimes, please visit the OFAC website, here: https://ofac.treasury.gov/.

(ii) Full list of company ownership structure, including any parent and subsidiary companies relevant to the delivery of the ASO PVA design project, including the presence of any state-owned enterprises associated with the proposing company.

Note that any proposal that is received by the ASO PVA Project Development Team with incomplete or missing management information or required forms may be deemed as non-responsive.

2.5 Delivery Schedule Summary (DSS):

The Delivery Schedule Summary (DSS) shall be provided to outline the intended design work required from contract signing to project completion, as well as the proposed payment schedule for completed work. Indicate start and completion dates, as well as significant milestones for accomplishing tasks, including the kick-off System Requirement Review (SRR), Preliminary Design Review (PDR), Critical Design Review (CDR), delivery of the Complete Design Documentation (CDD) package, final design approval and acceptance by the ASO PVA Project Development Team. The schedule should clearly define the critical path throughout the entirety of the project. A schedule risk analysis should be included, as well as proposed mitigation measures to be undertaken in the event of schedule delays. A summary of personnel numbers to
be assigned to each portion of the work, and person work hours required for each project phase must be included.

2.6 Overview of Pricing:

Pricing information should only be included in Section 4 of this proposal. All pricing information should reflect a fixed price in US Dollars for the entire PVA designs to be delivered at the end of Phase 1, and whose ownership will be transferred explicitly to the ASO PVA Project Development Team thenceforth, and a price breakdown for the Phase 1 design and Phase 2 implementation of each of the major subsystems of the ASO PVA project. Prices shall include all applicable taxes and import duties on purchases made by the successful Vendor. The Vendor should also provide an estimate of the fabrication, verification testing, shipping, on-site integration, and operationalization of the entire project proposed for each configuration considered. The Vendor should assume that there will be no import duties on any items shipped to the Chile site from outside that country. The price breakdown must include at least the following items:

(i) Management;
(ii) System and Design engineering;
(iii) Estimates of the following primary PVA subsystems represented in the design:
   (1) photovoltaic panel array;
   (2) control container;
   (3) battery storage facility;
   (4) charge controller station;
   (5) DC-to-AC inverter;
   (6) high-voltage transmission lines to ASO telescope site;
   (7) stepdown transformer;
   (8) voltage regulator;
   (9) blocking diode;
   (10) interface components to ASO telescope site electrical grid;
   (11) PVA plant operational monitoring/control system;
   (12) Perimeter security design and monitoring.
(iv) Assembly and verification work completed outside Chile.
(v) Preparation and packing for shipment to Chile.
(vi) Shipment to Chile.
(vii) Assembly and verification work completed at the Chile site.
(viii) Final operationalization and acceptance work at the Chile site.
(ix) Additional cost for a performance bond in accordance with that described in Section 1.3 (above).
(x) Any applicable taxes or duties expected.
(xi) Analogous pricing estimates for addition of a potential supplemental wind power generation system, as described as a Project Opportunity above.

III. Technical Requirements and Statement of Work:

3.1 Statement of Work:

3.1.1 General Statement of Work:

The work described herein shall consist of the furnishing of labor, materials, services, data, drawings, analysis, detailed specifications, test documents, bill of materials, and other products required to deliver the
detailed Phase 1 design and Phase 2 implementation of the ASO PVA system. The work shall result in a final design of the ASO PVA, which will be delivered to the ASO PVA Project Development Team by the Vendor, and will be followed by consideration to greenlight funding for the Vendor to move onto Phase 2 implementation tasks as described earlier and outlined in the manner illustrated in Figure 1.3.1.

Note that all designs, drawings, data, and other products comprising the design shall be transferred for ownership as the intellectual property of the ASO PVA Project Development Team.

**Note that the ASO PVA Project Development Team will review the final design produced by the successful proposer at the conclusion of Phase 1 and proceed as described earlier in this document and illustrated in Figure 1.3.1 for proceeding to Phase 2 implementation. The ultimately successful Phase 2 implementation firm will then complete the integration, shipping, deployment, operationalization, and hand-off to the ASO team for nominal operations.**

### 3.1.2 Objectives of the Program:

The primary objectives of the program concern the provision of a complete set of design documents (Phase 1) that will enable the successful delivery of the final fabrication, pre-shipment verification testing, shipment, on-site assembly, site preparation, acceptance testing, and operationalization of the ASO PVA system (Phase 2), as follows:

(i) **Driving Requirements:**

(a) The PVA design shall meet key performance requirements for power production and transmission to the ASO telescope site, allowing for up to 70% of the ASO telescope site power to be provided from the PVA system.

(b) The PVA design shall consist of subsystems that can be easily transported to the site in Chile.

(c) The PVA design must take into consideration ease of assembly under the conditions at the site in Chile, including weather, seismic, and related location-specific operational requirements described in the Civil requirements summary provided herein.

(d) The PVA design must consider the provision of a system that minimizes operational maintenance, maximizes operational efficiency, and reliability of components. The ASO PVA system must have a lifetime of at least 10 years in the expected environmental conditions at the site in Chile.

(ii) **Design:**

(a) The ASO PVA will be designed by the Vendor to meet all system requirements in a balanced fashion.

(iii) **Fabrication:**

(a) The ASO PVA design will be fully detailed to enable the fabrication of the entire system according to the Vendor’s design.

(iv) **System Pre-Shipment Verification Testing:**

(a) The ASO PVA design will provide detailed documentation and lists for verification testing that must be performed prior to shipment to the site in Chile.

(v) **Pre-shipment assembly and packing:**
(a) The ASO PVA design will provide detailed checklists and documentation for the safe and secure packaging and shipment of the entire suite of constituent systems, subsystems, and components from their location of pre-shipment verification testing to the site in Chile.

(vi) Site Preparation:

(a) The ASO PVA design will provide a fully detailed Civil design to allow for the preparation of the power plant foundation preparation at the site in Chile.

(vii) Site Integration, Acceptance Testing, and Operationalization:

(a) The ASO PVA design will provide a fully detailed assembly plan, acceptance testing checklist for deployed subsystems and the fully integrated PVA system, and steps to bring into operation the entire ASO PVA for the generation of power and supply of electricity via transmission line to the ASO telescope site, including plans for the development of a smart grid control system software package, able to be interfaced with existing ASO telescope site energy control system infrastructure.

3.1.3 Summary of Vendor Deliverables:

The Vendor shall provide the following deliverables in the delivery of the full ASO PVA design package on the timescale defined below, including for milestones of the System Requirement Review (SRR), Preliminary Design Review (PDR), Critical Design Review (CDR), and Complete Design Documentation (CDD), including, but not limited to the following:

(i) Initial project schedule and work breakdown structure – 15 business days after award contract.
(ii) Detailed project price breakdown – 15 business days after award contract.
(iii) Detailed management plan – 15 business days after award contract.
(iv) Updated project schedule, status, and finance summary – monthly.
(v) ASO PVA site power requirements – at PDR.
(vi) Wind survivability calculations (i.e. wind shear) – at PDR (preliminary) and CDR (baseline).
(vii) Thermal survivability calculations – at PDR (preliminary) and CDR (baseline).
(viii) Structural fatigue analysis – at PDR (preliminary) and CDR (baseline).
(ix) Control container thermal calculations – at PDR (preliminary) and CDR (baseline).
(x) Control system and smart grid interface software plan – at PDR (preliminary) and CDR (baseline).
(xi) Site preparation plan - at PDR (preliminary) and CDR (baseline).
(xii) Pre-shipment verification checklist and plan - at PDR (preliminary) and CDR (baseline).
(xiii) Plan for PVA subsystem packing and shipment to site in Chile - at PDR (preliminary) and CDR (baseline).
(xiv) On-site integration plan, verification test checklist, and operationalization plan - at PDR (preliminary) and CDR (baseline).
(xv) Plan for quality assurance - at PDR (preliminary) and CDR (baseline).
(xvi) Operations and maintenance plan - at PDR (preliminary) and CDR (baseline).
(xvii) Long-term environmental degradation protection plan - at PDR (preliminary) and CDR (baseline).
(xviii) Compliance analysis and interface control documentation for all ASO telescope site energy infrastructure - at PDR (preliminary) and CDR (baseline).
(xix) Bill of Materials and spare parts list – delivered at design project close and acceptance by ASO PVA Project Development Team.
(xx) Complete Design Documentation – delivered at design project close and acceptance by ASO PVA Project Development Team.
3.1.4 **Kickoff System Requirement Review (SRR – 10% design maturity):**

The SRR will represent the ASO PVA design at an assessed 10% level of maturity.

Within 30 days of project initiation, the Vendor shall host a Kickoff System Requirement Review, to present the design concept of the ASO PVA system. This meeting will allow the Vendor to provide a description of the full complement of constituent subsystems, and a listing of all PVA system specifications that will be met, as well as any proposals for revised system specifications.

3.1.5 **Preliminary Design Review (PDR – 30% design maturity):**

The PDR will represent the ASO PVA design at an assessed 30% level of maturity.

At the time of the PDR, the Vendor shall have used approximately one-third of the total personnel hours allocated to produce the CDD. The Vendor shall anticipate receiving direction from the ASO PVA Project Development Team and the broader ASO telescope collaboration and SO project at the PDR, which will require the Vendor to perform additional design work to either further demonstrate proof of concept, or to redesign areas that ASO team does not believe will meet the design requirements. Materials to be reviewed at the PDR shall include:

(i) General proof of concept.
(ii) Proof of performance.
(iii) Preliminary performance estimates for entire ASO PVA system.
(iv) Survivability.
(v) Manufacturability.
(vi) Maintainability.
(vii) Material selection.
(viii) Preliminary documentation for the interface control between the ASO PVA system and ASO telescope energy infrastructure.
(ix) Proof of code compliance.
(x) Schedule update.
(xi) Budget update.
(xii) Risk management and mitigation plan.

The PDR will be held at the University of Pennsylvania. Within 5 business days of the completion of the PDR, the ASO PVA Project Development Team will provide the Vendor with a list of design characteristics that will require additional engineering or redesign. The ASO PVA Project Development Team will provide a written explanation of why the rejected characteristics of the design will not meet the specified project requirements. The Vendor will incorporate all of the comments made by the ASO project team into the PDR documentation, and present a modified PDR document bundle to the ASO project team for review and approval, before proceeding to begin work toward the CDR.

3.1.6 **Critical Design Review (CDR – 90% design maturity):**

The CDR will represent the ASO PVA design at an assessed 90% level of maturity.

At the time of the CDR, the Vendor shall have used approximately three-quarters of the total personnel hours allocated to produce the CDD. The material to be reviewed at the CDR shall include all of the project attributes reviewed at the PDR, comprising principal CDR documentation, which shall encompass:

(i) The final ASO PVA system design.
(ii) Final versions of all materials presented previously at the PDR.
The CDR will be held at the University of Pennsylvania. Within 5 business days of the completion of the CDR, the ASO PVA Project Development Team will provide the Vendor with a list of design characteristics that will require additional engineering or redesign. The ASO PVA Project Development Team will provide a written explanation of why the rejected characteristics of the design will not meet the specified project requirements. The Vendor will incorporate all of the comments made by the ASO project team into the CDR documentation, and present a modified CDR document bundle to the ASO project team for review and approval, before proceeding to begin work toward the CDD.

3.1.7 Complete Design Documentation (CDD – 100% design maturity):

The CDD will represent the ASO PVA design at an assessed 100% level of maturity.

The CDD is the final deliverable product of the ASO PVA design project described throughout this RFP document. It will contain sufficiently detailed drawings (including shop fabrication drawings), specifications, plans, procedures, risk mitigation documentation, and manuals to allow the full complement of constituent ASO PVA systems to be fabricated, verified, shipped, integrated, tested, and brought into operation to deliver electricity to the ASO PVA site in Chile. Within 5 business days of the completion and delivery of the CDD, the ASO PVA Project Development Team, ASO project team, and SO project will provide the Vendor with a list of aspects of the CDD package that require additional action or information. The Vendor will then have 10 business days to integrate and deliver the final CDD to be accepted by the ASO PVA Project Development Team no later than 5 days subsequent to CDD delivery by the Vendor.

3.1.8 Code Documentation:

The code documentation under which the ASO PVA project will operate will be defined prior to the PDR in consultation between the ASP PVA Project Development Team and the Vendor. Where not otherwise specified, the ASO PVA system will be designed to be compliant with the code documentation required for compliance with Chilean law.

3.2 ASO PVA System Design Constraints:

The following sections provide an overview of the primary site characteristics and operational requirements under which Vendors are to develop proposal materials for the ASO PVA system.

While general operational requirements have been provided associated with the intended ASO PVA project scope, the ASO PVA Project Development team welcomes alternate technical proposals that exceed baseline project requirements given the advanced technical maturity of many aspects of the contemporary commercial PVA industry. Likewise, the ASO PVA Project Development team welcomes proposals that suggest project cost and schedule efficiencies, while maintaining baseline performance levels, through the potential reduction of project specifications in line with the current state-of-the-art trends in the photovoltaic power generation industry.

3.2.1 ASO PVA System Civil Configuration and Constraints:

Given the limited amount of unused area (for existing SO and other telescope project infrastructure) or unallocated area (in the case of additional ASO telescope project infrastructure) on and around the SO site location, the ASO PVA system will require the use of a nearby location, roughly 60 meters in altitude below, and 0.6 kilometers Southeast of the SO telescope site. The ASO PVA system shall be located on and around the coordinates of latitude 22° 57’ 53.95” South, longitude 67° 47’ 6.27” West. Figure 3.2.1 provides a
Google Earth topographic relief map and imagery (gathered in February 2023) of the SO telescope and ASO PVA sites on Cerro Toco, Chile.

The ASO PVA site is located at a remote, high-altitude location in the Atacama Desert of Northern Chile, and therefore PVA system operational requirements will require design that will allow the photovoltaic array, support infrastructure, and perimeter security installations to operate uninterrupted by extreme environmental conditions. Table 3.2.1 provides a summary of the primary operating conditions under which the ASO PVA will need to be designed to withstand extreme weather, humidity, insolation, seismic, and other environmental factors associated with the remote site on Cerro Toco, Chile.

---

Table 3.2.1

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
<th>Unit</th>
<th>Notes</th>
</tr>
</thead>
</table>

---

Figure 3.2.1 – Google Earth topographic relief map and imagery of the SO telescope and ASO PVA sites on Cerro Toco, Chile.
<table>
<thead>
<tr>
<th><strong>ASO PVA Site</strong></th>
<th><strong>Latitude</strong></th>
<th>South</th>
<th>ASO PVA site is roughly 0.6 km line of sight away from SO telescope site, and roughly 1.2 km along existing road to the SO site.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Longitude</strong></td>
<td>22° 57’ 53.95”</td>
<td>South</td>
<td>ASO PVA site is roughly 0.6 km line of sight away from SO telescope site, and roughly 1.2 km along existing road to the SO site.</td>
</tr>
<tr>
<td><strong>Altitude</strong></td>
<td>5130 m</td>
<td></td>
<td>ASO PVA site location roughly 60 meters in elevation below SO telescope site.</td>
</tr>
<tr>
<td><strong>Survival Wind</strong></td>
<td>69 m/s, peak</td>
<td></td>
<td>PVA infrastructure must be designed to survive a wind load of 69 m/s at the site without damage. Air density 0.72 kg/m^3, 270-year return wind.</td>
</tr>
<tr>
<td><strong>Temperature</strong></td>
<td>-50 to 25 °C</td>
<td></td>
<td>Maximum diurnal variation is 30°C. The annual average temperature at the SO telescope site is -4°C. There shall be multiple temperature sensors installed around the PVA system.</td>
</tr>
<tr>
<td><strong>Pressure</strong></td>
<td>58 to 61 kPa</td>
<td></td>
<td>Typical measured air pressure at the at the SO telescope site (5190 m). Compare with average air pressure at sea level of 101 kPa.</td>
</tr>
<tr>
<td><strong>Rain</strong></td>
<td>20 mm/hr</td>
<td></td>
<td>While infrequent, occasional rain and thunderstorms can occur on site.</td>
</tr>
<tr>
<td><strong>Ice/Snow</strong></td>
<td>1 to 200 cm</td>
<td></td>
<td>The ASO PVA must be designed to survive, without damage, the following conditions: hailstones of 2 cm diameter at 25 m/s, 2 m of snow on the PVA system surfaces, radial ice of 1 cm thickness on all exposed surfaces.</td>
</tr>
<tr>
<td><strong>Diameter</strong></td>
<td>74 to 1000 µm</td>
<td></td>
<td>The ASO PVA site ground surface is a mixture of loose sand, volcanic soil, and gravel with no vegetation of any kind to stabilize the surface. Vehicle-disturbed and wind-blown sand, dust, and grit grains is a factor for system operation on site and mitigations must be planned.</td>
</tr>
<tr>
<td><strong>Concentration</strong></td>
<td>1 g/m^3</td>
<td></td>
<td>The ASO PVA site ground surface is a mixture of loose sand, volcanic soil, and gravel with no vegetation of any kind to stabilize the surface. Vehicle-disturbed and wind-blown sand, dust, and grit grains is a factor for system operation on site and mitigations must be planned.</td>
</tr>
<tr>
<td><strong>Lightning</strong></td>
<td>Yes</td>
<td></td>
<td>While infrequent, occasional thunderstorms can occur, requiring the inclusion of a lightning protection system included in the ASO PVA site design.</td>
</tr>
<tr>
<td><strong>Relative Humidity</strong></td>
<td>0 to 90 %</td>
<td></td>
<td>The ASO PVA site humidity averages are 53% in the Austral summer (January) and 31% in the Austral winter 31%, with an annual humidity average of 39%. The monthly average water vapor pressure in the Austral summer (January) is 4.0 hPa and in the Austral winter (July) is 1.2 hPa, with an annual average of 2.3 hPa.</td>
</tr>
<tr>
<td><strong>Insolation Level</strong></td>
<td>High</td>
<td></td>
<td>The ASO PVA site is situated just north of the Tropic of Capricorn, which combined with the high-altitude and low precipitable water vapor levels in the Atacama Desert region results in a high level of insolation on site. The median midday solar flux in</td>
</tr>
</tbody>
</table>
the wavelength of 0.3-60 micrometers for the month of December is 1290 W/m² and for the month of June is 840 W/m². Ultraviolet radiation levels are approximately 70% higher than those experienced at sea level.

<table>
<thead>
<tr>
<th>Solar Radiation (Short Wavelength)</th>
<th>1290</th>
<th>W/m²²</th>
<th>0.3 µm &lt; λ &lt; 60 µm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar Radiation (Long Wavelength)</td>
<td>100</td>
<td>W/m²²</td>
<td>280 µm &lt; λ &lt; 400 µm</td>
</tr>
<tr>
<td>Seismic Activity</td>
<td>Yes</td>
<td></td>
<td>The ASO PVA site is in a seismically active zone, but the source of the earthquakes is located at the tectonic plate interface, which is more than 100km below the surface of the site so that the strength of the earthquakes is lower than the strength experienced closer to the Chilean coastline at sea level. Design for 0.3G horizontal and 0.3G vertical acceleration.</td>
</tr>
</tbody>
</table>

Table 3.2.1 – Summary of the primary operating conditions under which the ASO PVA will need to be designed to withstand extreme weather, humidity, insolation, seismic, and other environmental factors associated with the remote site on Cerro Toco, Chile.

3.2.2 ASO PVA Operational Requirements and Constraints:

3.2.2.1 ASO PVA Project Objectives and Opportunities:

The baseline ASO PVA system will be designed to reduce the diesel fuel consumption of the primary SO telescope site infrastructure by 70% (e.g. major power draws from systems including telescope superstructure motion, pulse tube cryocoolers, dilution refrigeration systems, readout electronics, computing, control room systems, heating/cooling, etc.).

As outlined in Section 1.3 of this RFP document, the deployment of the ASO PVA system provides a project opportunity to allow expansion of the PVA capacity by 50% and 100%. Furthermore, a scenario for the potential addition and integration of supplemental wind power generation capacity at the high-altitude PVA site that could extend renewable energy production capacity to further hours of the daily operation cycle is called for.

In summary, the required and alternative configurations sought in this RFP go as:

1.) [Baseline Renewable Energy System - Required] Design and pricing information for the baseline ASO PVA facility, able to reduce the on-site diesel usage by 70%.

2.) [Baseline+50/100 Renewable Energy System - Required] Design and pricing information for a system that could be expanded by 50% and 100% of the baseline capacity.

3.) [Hybrid Renewable Energy System – If Provided] Design and pricing information for a hybrid renewable energy system capable of meeting baseline requirements, such as the inclusion of a supplemental wind power generation capacity at the high-altitude PVA site.

3.2.2.2 ASO PVA Site Characteristics:
Figure 3.2.2 provides an approximate geometrical overview of the ASO PVA site as currently planned. This initial site definition has been driven by a variety of factors, including:

(i) **Ease of access:** the ASO PVA site is situated directly adjacent to the graded dirt road that is used to access the SO telescope site and connects to a major highway access road.

(ii) **Adjacency to SO Telescope Site:** the ASO PVA site is located on the closest suitable flat area near the SO telescope site, roughly 0.6 kilometers line of sight from the SO telescope site, and 1.2 kilometers along the site access road to the center of the SO telescope site.

(iii) **Minimization of Site Preparation Scope:** the ASO PVA site terrain is roughly flat and mostly consists of a loose sand base with scattered volcanic rock and boulders. Should the site need to be significantly expanded in footprint, more extensive volcanic rock clearance and grading would be necessary (illustrated in the darker regions shown in Figure 3.2.2 near the perimeter of the ASO PVA site definition). Images of the site terrain quality can be seen in Figure 3.2.1, and additional site photography can be provided to Proposers, on request.

(iv) **Sufficient Area for Power Production and Infrastructure Requirements:** The ASO PVA site footprint shown in Figure 3.2.2 results in a 30.81 acre area. While this footprint could be increased, if necessary, with further site preparation steps described above, a site footprint just over 30 acres was selected to ensure that up to 3 MW of solar power production could be accommodated.

The Proposer, drawing on industry experience and best practices for the deployment of photovoltaic power generation platforms in remote environments, will need to present an optimized plan for scaling of the total number of solar array panels and battery storage capacity to provide balanced electrical power generation to the SO telescope site resulting in the coverage of at least 70% of the SO site power consumption demand. The Proposer will be responsible for defining optimized system balancing between direct power delivery from the PVA panels, power delivery from battery, battery charging regimes, and periods of diesel generator operation governed by a smart grid control system.
3.2.2 – Initial geometrical overview of the ASO PVA site as currently planned. Note that the site boundaries may be redefined by the Proposer, though additional heavy site grading, clearance, and preparation activities may be required to remove volcanic rock and uneven terrain found at or near the perimeter of this initial site definition.

3.2.2.3 **ASO PVA High-Voltage Transmission Line to SO Telescope Site:**

The Proposer will need to design and appropriately scale a high-voltage AC transmission line to transmit power generated by the ASO PVA to the SO telescope site. The transmission line will need to be installed an appropriate distance away from the SO telescope site access road in a covered trench, protected from the environment as well as personnel and the general public traveling along the site path. Figure 3.2.3 illustrates the generic route configuration that the PVA high-voltage AC transmission line shall be installed in along the SO telescope site access road, roughly 1.2 kilometers in extent measured from the approximate center of the ASO PVA site to the approximate center of the SO telescope site. Note that a direct, line-of-sight
route for the PVA transmission line to the SO telescope site was ruled out given a steep rock face and extreme terrain along that path.

Figure 3.2.3 – Illustration of the configuration that the PVA high-voltage AC transmission line shall be installed in along the SO telescope site access road. The proposed route is roughly 1.2 kilometers in extent measured from the approximate center of the ASO PVA site to the approximate center of the SO telescope site. Note that a direct, line-of-sight route for the PVA transmission line to the SO telescope site was ruled out given the existence of a steep rock face and extreme terrain along that path.

3.2.2.4 ASO PVA Integration with Existing Diesel Generation Systems:

The ASO PVA shall be designed to be integrated with existing diesel generation systems and support infrastructure operating on the SO telescope site. Per internal SO site infrastructure documentation, the SO telescope site currently operates with power generated by a synchronized set of primary diesel generators controlled in parallel such that individual generators are powered on or off per load requirements. Each generator is controlled by a DSE8610 MkII controller manufactured by Deep Sea Electronics.

Full power will be provided to run the SO telescope site by a combination of one, two, or three of the four main diesel generators at any given time, while a fifth single small utility generator will be operated in low load situations. The primary SO telescope site diesel generators are Perkins 2206C-E13 model industrial
diesel engines, with manufacturer specified gross mechanical output of 324-406 kWm and typical electrical output of 350-438 kVA.

3.2.2.5 ASO PVA System Scaling Power Requirements:

While PVA subsystem scaling shall be defined by the Proposer, initial micro grid infrastructure estimates for baseline ASO telescope only operations suggest rough scaling to meet the 70% reduction in diesel generation of: a ~1 MW solar array, 4 MWh in battery storage, a DC-to-AC converter supplying a 1.2-2.4kVAC transmission line, and a 500 kVA stepdown transformer to interface with the primary control cabinet controlling the existing diesel generation systems on the SO telescope site. These estimates are only to be used by the Proposer for considering the sense of scale for SO telescope site operations; a change in scaling of these estimates would be needed for various power generation balancing proposals as well as any added project scope, such as the project opportunities mentioned previously for a baseline power production potential 50% to 100% higher than specified here, or the consideration of supplemental wind-generation capacity. Table 3.2.2 describes the power requirements of the SO telescope site, which provides the baseline for ASO PVA subsystem scaling.

<table>
<thead>
<tr>
<th>SO Telescope Site</th>
<th>Typical Load (kW)</th>
<th>Typical Load (kVA)</th>
<th>Circuit Breakers (kW)</th>
<th>Circuit Breakers (kVA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large Aperture Telescope (LAT)</td>
<td>134</td>
<td>143</td>
<td>193</td>
<td>224</td>
</tr>
<tr>
<td>Small Aperture Telescopes (SAT) x3</td>
<td>164</td>
<td>207</td>
<td>308</td>
<td>342</td>
</tr>
<tr>
<td>Garage</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Lab</td>
<td>13</td>
<td>15</td>
<td>147</td>
<td>163</td>
</tr>
<tr>
<td>Office</td>
<td>6</td>
<td>7</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td>Computing</td>
<td>5</td>
<td>6</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>TOTAL:</td>
<td>324</td>
<td>380</td>
<td>673</td>
<td>756</td>
</tr>
</tbody>
</table>

Table 3.2.2 – Power requirements of the SO telescope site (baseline for ASO PVA subsystem scaling).

The vendor should provide design and pricing for the baseline system and a system that could be expanded to 50% and 100% of this capacity. This includes appropriately sized voltage converters, transformers, and transmission lines, but not batteries or panels.

3.2.2.6 ASO PVA Duty Cycle and Subsystem Failure Mitigation:

System switching (between PV and diesel generator operations) and balancing between PVA power generation, battery storage, and electrical supply to the SO telescope site shall be defined within the design of the Proposer. The ASO PVA shall be designed such that, with normal preventative maintenance, the array will operate for at least 10 years, within the 24-hour continuous duty cycle specified, without the need to replace significant subsystems. For mitigation of a potential failure of any subsystem, a straightforward repair procedure must be provided, with spare parts inventoried for contingency where in line with best practices. As such, a spare parts list should be provided as a part of the design package within the provided bill of materials for the entire project design.

3.2.2.7 Interface Definition Between ASO PVA System and SO Telescope Site:

The primary interface between the ASO PVA and the SO site will consist of the electrical power supply and telecommunications connections to the SO telescope site. The Proposer will design all civil, structural,
architectural, electrical, telecommunications, and mechanical design features of the site outside of this interface.

The design provided by the Vendor shall include provision of all electrical wiring on the ASO side of the interface. All connector and receptacle types shall be approved by the ASO PVA Project Development Team. All electrical buses within the ASO PVA project design shall have separate panels with circuit breakers. Fuses shall not be used in the electrical distribution system, and junction boxes shall be provided to accommodate all electrical connections outlined in the design. All junction boxes shall meet National Electrical Code specifications for NEMA Type IV. Telecommunications must consist of fiber optical communications installed between the ASO PVA site and the SO telescope site via a covered trenchway near the pathway created for the high-voltage transmission cable to the SO telescope site from the PVA. The ASO PVA design must include safety and equipment grounds, as is required by the SO telescope project more broadly. The grounding system shall be specifically designed to prevent or minimize ground loops.

Additionally, the installation of a fiber optic communications cable running to the SO site will allow for the development of a shared trenchway concept for both the proposed fiber optic cable and ASO renewable energy system high-voltage transmission line. The shared cable run will intersect with existing junction boxes along the site access road and, potentially, call for the installation of additional junction boxes at strategic locations along the route, allowing for fiber optic connections to other adjacent project sites. The high-voltage electrical transmission cable will run all the way to the SO site power control station and stepdown converter, with subsequent low-voltage cables running back in the same trenchway to reach junction boxes along the trenchway for connection to SO site infrastructure and, potentially, other project sites. Figure 3.2.4 illustrates the shared fiber optic and high-voltage transmission line concept.
Figure 3.2.4 – Overview of shared trenchway concept for on-site fiber optic cable (from outside the site) and high-voltage electrical transmission line (from ASO renewable energy system to the SO site). The shared cable run will intersect with existing junction boxes along the site access road, allowing for fiber optic connections to other project sites. High-voltage electrical transmission line cable will connect to SO site power control station and stepdown converter. Resultant low-voltage cables will run back along same trenchway to reach junction boxes along trenchway for connection to SO site infrastructure and, potentially, other adjacent project sites.

3.2.2.8 RFI and EMI Mitigation Requirements for ASO PVA Infrastructure:

The SO telescope site is located in a radio quiet zone and relies on equipment that does not generate Radio Frequency Interference (RFI) or Electromagnetic Interference (EMI) that can interfere with the scientific operations of the observatory. A 2017 report from NREL (https://www.nrel.gov/docs/fy17osti/67440.pdf) suggests that the ASO PVA site would provide sufficient standoff distances so that the main source of potential EMI – the DC-to-AC inverter system – would not pose significant risk to scientific operations.

Proposers should include RFI and EMI mitigation measures where feasible and follow best practices throughout the ASO PVA system design.

Any telecommunications connections (e.g. fiber optic and ethernet) between the ASO PVA and the SO telescope site for both control system data sharing and communications (e.g. intercom systems between the
two sites) shall be wired and installed in via the described covered trenchway. Wireless communications systems shall be prohibited.

3.2.2.9 ASO PVA Site Control Container and Operational Maintenance:

The Proposer should provide details for the provision of a small control container to be included on the ASO PVA site. The design of the control container shall include an insulated, temperature-controlled room within the security perimeter of the ASO PVA site. Air temperature in the control container shall be maintained in the range of 10-20°C. The control container shall be accessible through a standard size door, and have a secondary container opening for the loading and unloading of larger equipment (e.g. control computer racks).

The Proposer shall also provide a design for any additional infrastructure to maintain the proper operation of the PVA subsystems within the environmental conditions outlined in this RFP document for the site. This may include, but is not limited to, shelter and heating systems for the PVA battery array, and PVA panel designs allowing for precipitation (e.g. snow and rain) shedding, as well as provisions for any ice buildup that will occur on subsystem surfaces.

Proposers shall provide designs that include best practices for the clearance of dust, grit, and sand from panel surfaces, potentially including automated panel clearance systems. Surface finish selection should be conducted according to best practices in the PV industry, mitigating to the greatest extent possible, long-term system degradation due to thermal expansion and contraction due solar heating and diurnal temperature gradients.

3.2.2.10 ASO PVA System Code Requirements, Environmental Impact Assessment, and Regulatory Permitting:

The ASO PVA system shall be designed to meet all applicable requirements of National Electrical Code, Occupational Safety and Health Administration Standards, Underwriters Laboratory Requirements of 1950, and the requirements outlined in the design contract. This is particularly important when considering design provisions for preventative maintenance during operations.

The ASO PVA design study firm will be responsible for providing guidance, quotation, and scoping for the site permitting, environmental impact assessment (EIA), and related regulatory approvals required to be obtained from Chilean regional and federal authorities before the commencement of any Phase 2 implementation work. While these support responsibilities will fall to the contracting firms, the ASO Project Development Team will take ultimate responsibility for interactions with Chilean regional and federal authorities and will be responsible for obtaining any and all required regulatory and permitting approval documentation prior to the commencement of any Phase 2 implementation work.

3.2.2.11 Requirements for Critical Infrastructure Protection:

As a remote site operating without a continuous personnel presence, there is a real potential for acts of sabotage, theft, or other criminal activity targeting the critical infrastructure comprising the ASO PVA system. Critical infrastructure protection measures should include countermeasures that must be implemented for the protection of subsystems during the construction phase of the project, and then countermeasures during the operations phase of the project.

The Proposer shall include provisions in their design for significant critical infrastructure monitoring and protection of the ASO PVA system allowing for the hardening of the site perimeter. Countermeasures may include systems such as heavy-duty fencing, gates, concrete slab, earthen berms, trenching, and similar installations surrounding the entire ASO PVA system.
Designs should also provide proposals for site monitoring and security alarm notification systems made available to the SO site operations team during all future site operations. Considerations for site monitoring provided by commercial satellite optical or synthetic aperture radar (SAR) data sources may be included in the proposal.

Considerations for fire alarm annunciation and suppression systems shall be included for all infrastructure within the ASO PVA design.

3.2.2.12 ASO PVA System Deployment Constraints:

The ASO PVA system must be designed for easy assembly under the conditions at the ASO PVA site. During construction, the SO telescope site may be able to provide electrical power, however designs should include the potential for temporary electrical generators to be utilized at the site to support construction activities. The design must include provision of all other materials, equipment, tools, labor, and supervision necessary to complete the assembly, testing, and operationalization of the ASO PVA system. Any custom tools required for assembly shall be considered part of the PVA system and should be specified in the design. The design should include details on any site preparation activities that may be required prior to PVA system installation.

The ASO PVA site is roughly 40 kilometers from the nearest town of San Pedro de Atacama, Chile. Access to this site with standard 20 foot sea containers is possible, as is access by heavy equipment. Typical maritime ports of entry for the region include the Port of Antofagasta and Port of Iquique, Chile.

3.3 Requirements for Drawings, Specifications, and Testing:

3.3.1 Design and Manufacturing Drawings:

Design and manufacturing drawings shall be produced on standard sized drawing forms. Drawings shall confirm to good commercial practice and use symbols, conventions, and notations endorsed by manufacturing and standards associations such as the Drawing Requirements Manual by Jerome H. Liebllich (ISBN 1-57053-034-3), DIN, or ISO codes. The ASO PVA design must be in metric units, though allowances will be made for off-the-shelf subassemblies.

One editable electronic version of all final design fabrication drawings, schematics, assembly drawings, procurement specifications, bill of materials, and spare parts lists shall be supplied to the ASO PVA Project Development Team. Sub-contractors shall furnish sufficient drawings such that their equipment can be operated and maintained by the SO project following deployment and installation.

3.3.2 Design Calculations and Data:

One editable electronic copy of all design calculations, design data, studies, computer programs, and other information prepared or utilized in the performance of the design work shall be delivered to the ASO PVA Project Development Team.

3.3.3 Assembly and Verification Planning:

At the completion of the PDR, the Vendor shall submit to the ASO PVA Project Development team for its approval, the following plans:

(i) A plan for any test assembly or verification of ASO PVA subsystems before shipment to the site in Chile for integration;

(ii) A verification plan that will enable the field qualification of the ASO PVA system in accordance with the requirements outlined in this RFP document;
(iii) A software and control system verification and test plan;
(iv) A plan for packing and shipment of the ASO PVA subsystems to the site in Chile;
(v) A plan for the integration, characterization, field verification, and operationalization of the ASO PVA system at the site in Chile.

3.3.4 Quality Assurance and Inspection:

The Vendor shall submit documentation detailing quality assurance and inspection procedures to the ASO PVA Project Development team for review and approval prior to the start of procurement and manufacturing defined in Phase 2, if approved. Quality assurance tests will be performed on materials, components, and assemblies as specified in the quality assurance procedure. An electronic version of all quality assurance and inspection documentation shall be delivered to the ASO PVA Project Development Team prior to the CDD.

3.3.5 Operations Manual and Procedure Delivery:

At the time of delivery of the CDD, the Vendor shall deliver one editable electronic copy of an operations and maintenance manual for use during Phase 2 implementation, and, ultimately, by the SO project during normal operations. The manual must at least contain the following details:

(i) Detailed mechanical and electrical drawings, including exploded-view assembly drawings, wiring diagrams, parts lists, and recommended procedures for system maintenance and testing;
(ii) A maintenance section that describes the method for removal of subsystems, methods to reassemble the system and bring it into operation;
(iii) An operations section, which describes the function of the various mechanical and electrical subsystems of the ASO PVA system;
(iv) A narrative section describing the operation of all control system and housekeeping data streams associated with the ASO PVA system. Note that while proprietary and/or subcontractor-developed data acquisition systems are welcomed to monitor the functionality of site operations, all site operation characteristics and related housekeeping data streams must be made available for export to the main SO housekeeping and data acquisition system.

3.4 Management Requirements:

Proposers shall take note of the following management requirements for the ASO PVA project:

(i) Terms and conditions shall be set by the agreed upon Contract;
(ii) The ASO PVA Project Development Team contacts shall be:

Professor Mark J. Devlin and Dr. Benjamin L. Schmitt
David Rittenhouse Laboratories
University of Pennsylvania
209 South 33rd Street
Philadelphia, Pennsylvania, 19104
United States of America
Email: devlin@physics.upenn.edu and bschm@upenn.edu

(iii) The Vendor shall, within 15 working days of award of contract, submit to the ASO PVA Project Development Team for approval, an electronic copy of the following:
   a. A detailed project schedule, showing the work breakdown structure of the project, the order in which the Vendor proposes to complete the work, and dates for each milestone and work task (including SRR, PDR, ICDs, CDR, delivery of the CDD package, design approval and delivery). The schedule must clearly display the critical path for the project.
b. A list of approximately 10 milestones to be monitored by the ASO PVA Project Development Team and points of contact from the National Science Foundation (the funding agency for this project).

c. A list of Vendor key personnel and contacts.

d. A detailed price breakdown plan for progress payments.

e. Proof of insurance.

(iv) Each month, the Vendor shall provide an electronic copy of a status report and an updated project schedule, made available by e-mail to the ASO PVA Project Development Team. These items shall be delivered to the ASO PVA Project Development Team by the 5th working day of the month. In addition, weekly or bi-weekly teleconferences shall be held between the Vendor and the ASO PVA Project Development Team to discuss progress. Frequent visits to the Vendor by ASO PVA Project Development Team members may be required at the discretion of the ASO project.

(v) Quarterly financial and quality assurance and quality compliance reports must be provided.

(vi) Changes to any specifications, requirements, or scope of work must be authorized by the ASO PVA Project Development Team in writing.

(vii) Subcontractors must be authorized by the ASO PVA Project Development Team.

(viii) All drawings, designs, data, programs, specifications, reports, memoranda, etc., relating to the work must be available for review by the ASO PVA Project Development Team at reasonable times. Any such material originated in the course of the work shall be the property of the ASO Project.

(ix) The final payment for the contract will not be made until the Vendor has demonstrated full compliance with the specifications outlined for the ASO PVA project. Title will pass from the Vendor to the ASO Project with the final payment.
APPENDIX A - Signature Page:

The undersigned hereby acknowledges that they are a duly authorized agent of the Proposer listed below and further acknowledges that they have read and understand the specifications, scope of services, requirements, and agreement considerations regarding this RFP document.

Additionally, the Proposer agrees that any of the documents and responses that it provides to this RFP request may, at the option of the University of Pennsylvania and ASO PVA Project Development Team, become a legally binding and essential portion of the final agreement between the Proposer and the University of Pennsylvania. Furthermore, the undersigned, for themselves and on behalf of the Proposer and its owners, directors, officers, affiliates, and employees, agrees to participate, at its sole cost and expense, and waives any right to compensation, damages, or claims of any kind against the University of Pennsylvania, its affiliates, officers, directors, employees, and agents, in connection with this RFP document, whether or not the Proposer is awarded an agreement.

The undersigned, for themselves and on behalf of the Proposer, represents and warrants that neither the undersigned, nor to the knowledge of the undersigned, the Proposer or any officer, director, owner, employee or agent of the Proposer, has not, and covenants that none of the foregoing shall communicate or enter into any agreement with any other firm or other person or entity in any manner that would constitute collusion, “bid-rigging,” fixing prices, or otherwise restraining freedom of competition in connection with the subject matter outlined within this RFP document.

Name of Firm: ________________________________

Signature: __________________________________

Printed Name: ________________________________

Title: _______________________________________

Business Address: ________________________________

City, State, Zip Code: ___________________________

Country: _____________________________________

Telephone: __________________________________

Fax: _________________________________________

Email Address: _________________________________

Reason for No Quote (if applicable):

________________________________________________________________________________________
APPENDIX B – List of Acronyms:

ACT – Atacama Cosmology Telescope
ASO – Advanced Simons Observatory
CDD – Complete Design Documentation
CDR – Critical Design Review
CLASS – Cosmology Large Angular Scale Surveyor
DAQ – Data Acquisition System
DOE – U.S. Department of Energy
DSS – Delivery Schedule Summary
EIA – Environmental Impact Assessment
EME – Electromagnetic Emission
EMI – Electromagnetic Interference
ICD – Interface Control Document
LAT – Large Aperture Telescope
LATR – Large Aperture Telescope Receiver
NREL – National Renewable Energy Laboratory
NSF – National Science Foundation
PDR – Preliminary Design Review
PVA – Photovoltaic Array
RFI – Radio Frequency Interference
RFP – Request for Proposals
SAR – Synthetic Aperture Radar
SAT – Small Aperture Telescope
SATR – Small Aperture Telescope Receiver
SO – Simons Observatory
SPdA – San Pedro de Atacama, Chile
SRR – System Requirement Review
The ASO PVA Request for Proposals draft document was released for an initial comment period on 28 June 2023, with the comment period officially closing on 12 July 2023. During this interval, a number of firms provided feedback and questions regarding the draft RFP document, to which the ASO PVA Project Development Team is grateful. For visibility to all proposers, a summary of responses to comments provided during the comment period goes as follows:

- If required for the optional hybrid (solar and wind infrastructure) project scenario, proposers are requested to acquire historical annual wind data for Cerro Toco, Chile. Additionally, annual wind simulations may be available in open source data sets (e.g. https://www.meteoblue.com/en/weather/historyclimate/climatemodelled/cerro-toco_chile_3869731).

- Proposals shall be in the English language and the currency of pricing quotations shall be in US dollars. Proposals submitted in response to this RFP document must remain valid for at least 90 days from the RFP close date.

- For the design (Phase 1) of the project, the ASO PVA Project Development Team may require the Vendor to provide and pay for performance bonds, letters of credit, or other forms of security covering the faithful performance (100%) of the contract, and the payment of all obligations (100%) arising under the contract, in such a form as the ASO PVA Project Development Team may prescribe, and with approved sureties or issuers. The Vendor must pay the cost of obtaining said performance bonds or letters of credit. If requested, the Vendor shall deliver the required bonds or letters of credit to the ASO PVA Project Development Team no later than the date of completion of the contract with ASO. Any issues with this requirement should be indicated in writing to the ASO PVA Project Development team.

- Requirements for specific product warranties and performance may be considered on a case-by-case basis based on what can be found on the market, since not all suppliers may provide “limited” warranties for equipment operations at the ASO site elevation.

- Requirements for supplier and country of origin restrictions are provided in detail in Section 2.4 of this RFP document. Any additional questions on supplier and country of origin restrictions shall be indicated in writing to the ASO PVA Project Development team.

- Electrical norms, including standard wire coloring, shall be required to be compatible with Chilean standards.

- Contracts and legal arbitration clauses shall be compliant with the laws of Chile and the Chilean Chamber of Commerce.

- The wind and thermal survivability and structural fatigue analysis shall apply to all structures, buildings, and related infrastructure encompassed in the proposal.

- Depending on the location of successful proposers, accommodations shall be given for the location of all in-person project meetings in consultation and agreement with the ASO PVA Project Development Team.

- The ASO PVA Project Development Team reserves the right to select zero, one, or more (up to three) successful Phase 1 design proposing firms to move on to Phase 1 design work.
- The bidding for Phase 1 design proposals shall be on a binding, fixed-cost basis, with details provided in the proposal response included for a non-binding cost estimate for the Phase 2 implementation of the project being proposed. At the conclusion of Phase 1, firms completing this phase will provide and updated binding, fixed-cost for the Phase 2 implementation work encompassed in their completed Phase 1 design.

- As of 17 July 2023, the ASO PVA Project Development Team is working with regional authorities to complete initial professional site surveying work, to potentially include geotechnical sampling enabling a characterization of the soil dynamics of the PVA site. The ASO PVA Project Development team will update potential proposers should results of a potential soil dynamics study be obtained prior to the close of the RFP period on 25 September 2023.

- The ASO PVA design study firm will be responsible for providing guidance, quotation, and scoping for the site permitting, environmental impact assessment (EIA), and related regulatory approvals required to be obtained from Chilean regional and federal authorities before the commencement of any Phase 2 implementation work. While these support responsibilities will fall to the contracting firms, the ASO Project Development Team will take ultimate responsibility for interactions with Chilean regional and federal authorities and will be responsible for obtaining any and all required regulatory and permitting approval documentation prior to the commencement of any Phase 2 implementation work. Any further questions on the project EIA process shall be submitted in writing to the ASO PVA Project Development team by potential proposers.