2027

Task 2: Request for Proposals *– Interim – We are waiting on synthetic soil recipe and sourcing native vegetation (See p. 15)*

Solar Facility Vegetation Control Using Passive Systems

Task sponsored by: El Paso Electric Charitable Foundation

Task developed by: El Paso Electric Company

Task Summary

Your team is invited to support clean energy production by developing a large-scale passive or low-intervention system to control vegetation at utility-scale solar installations located in the Chihuahuan Desert, where vegetation can emerge rapidly despite the arid climate. The proposed design must function as a retrofit for an existing solar facility rather than as a greenfield design.

Vegetation growing around photovoltaic (PV) modules can introduce significant risks, including electrical outages, wildfires, and equipment damage. It can also restrict access needed for operations and maintenance (O&M). By reducing these risks and limiting the need for routine vegetation management, your team's solution could lower solar power lifecycle costs, enabling utilities to maintain affordable electricity rates while expanding clean energy generation. Solutions should also integrate well with existing facilities and support an orderly and professional appearance.

The solution may draw on multiple engineering perspectives, including biological, ecological, hydrological, geotechnical, materials, geosynthetics, electrical, or other innovative approaches.

Problem Statement

Design an innovative, passive vegetation-management system as a retrofit for El Paso Electric Company's (EPE) 29-acre Aggie Power facility, which includes a 10,000-module, 3-megawatt (MW) solar installation and a 1-MW battery energy storage system.

The solution shall maintain a neat and orderly appearance, demonstrate potential for deployment at larger utility-scale solar facilities such as EPE's 70-acre, 10-MW San Elizario Solar Facility, and provide effective vegetation control for a minimum of 10 years under climatic conditions typical of the Chihuahuan Desert. Proposed solutions may consist of a single technology or multiple integrated components.

The retrofitted solution shall maintain safe and continuous site operations during both installation and operation, and shall comply with all applicable regulatory requirements, support environmental considerations, and minimize lifecycle costs.

Performance requirements. Vegetation, whether intentional or unwanted, shall not:

- Exceed 6 inches in height within PV array areas,
- Exceed 5% ground cover within treated areas,
- Shade any portion of a PV module,
- Obstruct access roads, equipment pads, or inspection routes.

Monitoring and Mitigation. Develop a post-installation monitoring strategy to identify areas where undesirable vegetation is becoming established, determine if supplemental vegetation control is needed, and plan for corrective action, if warranted.

Key constraints. Exclude the use of loose ground coverings, as well as labor-intensive methods, such as herbicides, pre-emergents, and physical removal (mowing, trimming, pulling, tilling, grazing, etc.)

Refer to the *Design Requirements* (pp. 11-13) for a complete list of task requirements.

Background

Managing Risk: Vegetation Management

Utility-scale PV installations are critical to the transition to low-carbon energy. Because these facilities may span hundreds or thousands of acres, they require ongoing operations and maintenance (O&M) to ensure safe, reliable, and cost-effective performance throughout their service life. Minimizing costs is essential to providing affordable electricity to the customer.

After a facility is commissioned, O&M activities begin. These include all actions that sustain facility performance throughout its expected service life. Within utility-scale solar installations, vegetation management is a key O&M function because unmanaged vegetation can reduce energy production, restrict access, increase wildfire hazards, and increase maintenance costs.

Historically, vegetation management has represented a significant portion of solar facility O&M expenses because it relies on recurring, labor-intensive activities such as mowing, herbicide application, and manual inspections [1]. Increasingly, operators are seeking passive strategies to reduce human intervention. They are also adopting risk-based, data-driven technologies such as LiDAR, aerial imagery, and satellite observations to better understand site conditions and prioritize maintenance activities. This approach reflects a broader industry shift toward proactively managing risk while controlling long-term operating costs [2].

PV Module Function, Efficiency, and Reliability

The top priority for all solar utility operations is providing reliable, efficient power to the electrical grid. Because vegetation management can play a key role in this effort, it is important to review the fundamentals of solar energy generation.

Definitions

- *A PV module* consists of multiple photovoltaic cells that are electrically connected, either in series or parallel. The cells and circuits in the module are sealed within a protective polymer laminate.
- *PV Panels* are field-installable units that contain PV modules.
- *PV arrays* are collections of PV panels that operate together as part of a solar energy system or facility.
- *PV system reliability* refers to the ability of solar technologies to produce power consistently and predictably throughout their expected service life. A reliable PV system aims to provide uninterrupted power, even during extreme weather events [3].
- *PV module efficiency* is the percentage of incoming solar energy that is converted into usable electrical power. This value, known as the module's *conversion efficiency*, is conventionally measured under standardized test conditions (STC) to enable comparisons among modules. Even under these controlled conditions, conversion efficiencies remain relatively low because much of the sun's energy is lost as heat during the energy conversion process [4].
- *PV performance* describes the conversion efficiency of specific PV modules under actual operating conditions, where weather extremes, heat, dirt, and shading can reduce energy production [4].
- *Efficiency vs Performance.* Although the terms *PV efficiency* and *PV performance* have distinct meanings, they sometimes appear to be used interchangeably in the literature. This is because *conversion efficiency*, in both cases (STC and operating conditions), is used to compute the percentage of solar energy converted into usable electrical power.

Grounding Grids

An integral part of a solar facility's infrastructure is the grounding grid: a buried network of interconnected conductors that provides a low-resistance path for fault currents and lightning energy to safely dissipate into the earth. The grounding grid is connected to PV equipment, support structures, electrical systems, and other metallic infrastructure to protect personnel and equipment from electrical hazards.

Grounding grids are buried throughout a solar site and can be damaged by excavation, trenching, driven anchors, deep tillage, or other ground-disturbing activities. Therefore, retrofit solutions should avoid interfering with or damaging existing grounding infrastructure. When available, EPE will provide additional information about the Aggie Power grounding grid in WERC's Task FAQs. This information will be shared directly with teams that formally reserve their place in this task.

Producing energy from the sun

Utility-scale solar facilities use large arrays of PV modules containing crystalline silicon solar cells protected by transparent polymer materials and housed in solar panels. The crystals initially have no free electrons. When sunlight strikes the silicon, its photons can free some of the silicon electrons, leaving behind positively charged holes. An internal electric field separates the electrons and the holes, creating a voltage across the cell. When connected to a circuit, the electrons flow through the wiring to perform useful work before recombining with the holes, thus producing a continuous electric current [5].

The current flows in a single direction, known as direct current (DC). However, the electric grid operates on alternating current (AC), where the direction of flow periodically reverses. Inverters convert the DC output from the modules into AC power. From there, the electricity is sent through power lines to the grid, supplying power to homes and businesses.

PV Performance – Short-term Operational Losses

PV module performance is influenced by both short-term operating conditions and long-term material degradation. During normal operation, the power output of a PV module decreases when the modules become hot, soiled, or shaded. High temperatures, such as midday heat, reduce voltage and power output, making it important to keep modules as cool as possible during operation. Soiling and shading reduce the amount of sunlight reaching the PV cells, lowering their power-generating efficiency and potentially creating hotspots that can damage the modules [6].

PV Degradation and Retirement

While operational losses are generally temporary, module performance gradually declines over time due to irreversible degradation mechanisms. One of the most significant is thermal cycling. The repeated transition between daytime heating and nighttime cooling induces mechanical stresses in the inherently brittle crystalline silicon cells and their solder joints. Over time, these stresses introduce microcracks that propagate through the cells, disrupting current flow, increasing electrical resistance, and reducing the amount of energy converted into usable electrical power. As a result, the module's in-service performance declines over time because an increasing fraction of the available solar energy is dissipated as heat rather than converted into usable electrical power [6].

In arid regions, daily temperature swings are often substantial. Clear skies and low humidity allow intense solar radiation to heat PV modules during the day, while limited atmospheric moisture and cloud cover promote rapid cooling after sunset. As a result, PV modules in desert environments experience greater thermal cycling stresses, which can accelerate degradation and shorten service life. In contrast, humid, cloudy climates generally experience smaller daily temperature fluctuations because clouds and atmospheric moisture reduce direct solar heating during the day and limit heat loss at night.

Other degradation mechanisms include ultraviolet (UV) exposure, which degrades protective polymer materials, reducing sunlight transmission to the silicon semiconductors. In addition, corrosion at electrical contacts increases resistance and reduces power output.

These principles inform the development of vegetation-management strategies that intentionally support PV module performance and longevity by creating conditions that maintain, and potentially enhance, PV module efficiency and lifespan.

Eventually, PV modules reach a stage in which continued operation is not economically viable. Historically, a common rule of thumb has been to define module end-of-life when performance declines to 80% of its rated capacity. However, many operators now base retirement decisions on economic performance, continuing to operate the modules as long as they remain safe, reliable, and financially viable [7].

Vegetation-related Risks

If left unmanaged, vegetation can contribute to high O&M costs in the following ways.

Obstructing maintenance access. Excessive vegetation can limit access to equipment, potentially extending equipment downtime and delaying repairs.

Retaining moisture. Vegetation can trap moisture around equipment by reducing air circulation and slowing evaporation. The moisture may accelerate corrosion and degrade protective coatings.

Creating wildlife habitats. Dense vegetation provides shelter for rodents, birds, and other wildlife. Not only might they be harmed by facility operations, the animals can also damage equipment or create safety hazards for personnel.

Increasing fire risk. Dry vegetation can catch fire when exposed to ignition sources such as electrical faults, potentially causing damage to equipment and infrastructure.

Shading losses. If vegetation shades a PV module, the module's efficiency will diminish. In addition, it can develop hot spots, where energy is dissipated as heat rather than converted to electricity. These hot spots reduce power output, accelerate degradation, and may lead to permanent module damage.

Conventional vegetation-control practices

Traditional vegetation control focuses on preventing unwanted vegetation growth, removing established vegetation, or a combination of both. Although many of these methods can be effective, most are not passive measures, and therefore are not suited to this design challenge.

Nevertheless, understanding conventional practices provides important context for evaluating and developing passive vegetation-control strategies. The following section reviews conventional vegetation-control approaches from the perspective of hot desert climates, where native vegetation can thrive because it has adapted to sunny, hot, dry conditions.

Prevention

Weed-suppressing native vegetation or agrivoltaics.* Some solar facilities use low-growing native vegetation or understory crops to suppress weeds, with agrivoltaics providing additional land-use value [8, 11]. Studies in New Mexico and West Texas suggest that carefully selected native plant communities may also be successful in limiting taller vegetation [12]. In arid environments, however, sparse plant cover can leave bare soil vulnerable to weed invasion, and limited water supplies can constrain agrivoltaics. Teams may incorporate weed-suppressing vegetation strategies, but must demonstrate that the proposed approach can reliably meet the project requirements for vegetation control, maintenance, and cost over the required service life.

** Agrivoltaics are defined as the intentional use of land for both solar energy generation and agricultural production, including crops, livestock, or pollinator habitat.*

Loose groundcover materials. These materials have been used for vegetation prevention in the arid southwest, but this approach has lost favor because they: 1) do not provide reliable long-term weed prevention; 2) are costly to install; 3) must be re-applied over time; 3) can increase runoff and alter site drainage patterns; 4) may create uneven surfaces; and 5) retain heat that can elevate module temperatures and reduce PV efficiency [12].

This design challenge defines loose groundcover materials as: unbound materials placed over the ground surface, including gravel, crushed stone, rock, sand, mulch, wood chips, or similar natural or manufactured materials. Materials that are fused, bonded, or otherwise formed into a continuous surface are not included in this category.

Pre-emergent herbicides. Pre-emergent herbicides prevent many weeds from germinating but do not eliminate all vegetation, making additional control measures necessary. They also require ongoing investments in chemical applications, including periodic re-formulation to mitigate herbicide resistance, scheduled treatments, worker training, safety protocols, and regulatory compliance. Environmental concerns include chemical drift, runoff, and potential impacts on workers and surrounding ecosystems. In addition, perception of their use can be negative, particularly when stakeholders perceive chemical vegetation control as conflicting with broader environmental stewardship goals [12].

Removal

Post-emergent herbicides. Post-emergent herbicides can effectively eliminate most existing vegetation, but they share the same concerns as pre-emergent herbicides. In addition, labor is required to remove dead vegetation to reduce fire hazards and prevent reseeding.

Physical removal. Although effective, these approaches are not passive and require repeated implementation, resulting in ongoing labor, equipment, fuel, and maintenance costs [1]. Each physical removal strategy has unique disadvantages, as discussed below [11]:

Above-ground physical removal:

- *Mowing or string trimming.* These methods remove above-ground growth but leave root systems intact, requiring frequent retreatment. They also introduce the risk of power tools damaging the facility and thrown debris damaging the modules.
- *Livestock grazing.* A form of agrivoltaics, livestock grazing using “solar sheep” can provide effective vegetation control. This approach is not passive and should not be considered for this task, due to manure management and potential interference with equipment access [1, 13].

Soil-disturbing physical removal:

Although effective, removing a plant’s roots disturbs the soil, creating favorable conditions for additional weed germination and growth. The process may also cause erosion, alter drainage patterns, and adversely affect site access, stormwater management, and long-term site stability.

- *Hand Removal.* The manual uprooting of unwanted vegetation. Hand removal is labor-intensive, presents worker safety concerns, and causes soil disturbance that can contribute to erosion and subsequent weed establishment.
- *Tillage.* The digging, stirring, or turning of soil to remove vegetation. Tillage typically requires mechanized equipment and fuel, may cause more soil disturbance than hand removal, and can damage solar infrastructure or other site improvements.

Summary: Conventional vegetation-control practices

Of the traditional vegetation-control methods listed above, none are suitable for a passive control system, with the possible exception of weed-suppressing native vegetation. See References [1, 8, 9, 10] for additional discussions of traditional vegetation-management strategies and their economic considerations.

Passive Vegetation Management at the Task 2 Site

Passive vegetation-control systems offer a long-term approach to weed mitigation that minimizes human intervention. Rather than repeatedly removing vegetation, these systems modify site conditions to suppress plant germination and growth by restricting access to light, water, nutrients, or other resources needed for plant establishment.

The examples below illustrate some possible solution pathways but should not be interpreted as a complete list of acceptable approaches. Innovative alternatives are encouraged.

Potential Passive and Low-Intervention Approaches

- *Biological soil amendments:* Biological amendments may be used to modify soil conditions by promoting beneficial native microbial, fungal, or other biological communities that suppress undesirable vegetation while maintaining soil health.
- *Engineered ground covers, surface treatments, or coatings:* Applied to the soil surface to physically block sunlight and/or prevent root establishment.
- *Geotextiles, geosynthetic barriers, and engineered barriers:* Permeable or impermeable materials, membranes, or rigid barriers above or beneath the soil surface to physically block root penetration and light transmission to the soil, while meeting site drainage and access requirements.
- *Soil amendments or modifications that may consider media regeneration and reuse:* Altering soil chemistry or structure (e.g., pH adjustment, salinity, compaction, nutrient depletion) to create conditions inhospitable to plant growth, while incorporating methods to periodically restore or recycle the treated media for continued use.
- *Electrical stimulation.* Applying low-level electrical currents or fields to the soil or root zone to disrupt plant cellular processes and inhibit germination or growth without chemical or mechanical intervention. Although not strictly passive, this approach may provide low-intervention vegetation control and is therefore permitted.

  Teams proposing electrical stimulation shall address integration with or modification of EPE's existing grounding grid, as applicable, and consider electrical safety, system compatibility, power requirements, and potential impacts on existing facility equipment. Contact WERC for additional information regarding the existing grounding system at the Aggie Power facility.
- Passive hydrologic controls: Managing water availability through grading, drainage design, or moisture-limiting layers to create soil conditions too dry (or otherwise hydrologically unfavorable) for vegetation to establish and persist, while maintaining required drainage and erosion control.
- Other approaches: Teams may propose other innovative passive strategies that meet the performance, safety, environmental, maintenance, and cost requirements of this design challenge.

Assessing Weed Mitigation Strategies

Equations (1) through (3) below provide examples of weed-control metrics based on comparing weed abundance in untreated and treated plots (see reference [14]). These metrics provide a useful starting point, but teams are encouraged to identify and evaluate additional assessment methods appropriate for their proposed solution and supporting research.

Weed Control Percentage (WCP): Measures % of growing weeds destroyed due to herbicides, pulling, etc.

- Initial weed count = the number of actively growing weeds before applying treatment;
- Weed count at interval = the number of weeds after treatment has been applied:

$$WCP = \frac{Initial\ weed\ count - Weed\ count\ at\ interval}{Initial\ weed\ count}\ x\ 100 \quad (1)$$

Weed Control Efficiency (WCE): Compares weed dry weight in treated and untreated plots.

- W_C = weed dry weight for the control (untreated) plot;
- W_T = weed dry weight in the treated plot.

$$WCE = \frac{W_C - W_T}{W_C} x\ 100 \quad (2)$$

Weed Persistence Index (WPI): Evaluates the reduction in weed growth over time.

W_C and W_T are defined above for equation (2).

- W_{pC} = Weed population in the control (unweeded) plot;
- W_{pT} = Weed population in the treated plot.

$$WPI = \frac{W_T}{W_C}\ x\ \frac{W_{PC}}{W_{pT}} \quad (3)$$

Task 2 Study Site

The El Paso Electric Company (EPE) recently installed the Aggie Power facility in Las Cruces, NM, comprising a 3-MW solar installation and a 1-MW battery energy storage system (BESS) (Fig. 1). It provides solar energy for about one-third of the 900-acre New Mexico State University campus. The facility spans 29 acres of previously unoccupied Chihuahuan Desert land and is equipped with 10,000 single-access tracking solar panels and a 1-MW Tesla battery pack.

Fig. 1. Aggie Power facility, aerial view. Desert plants line the outside perimeter of the facility.

For solar facilities in arid and semi-arid environments, vegetation management is a recurring concern despite relatively low rainfall. Many desert plants are opportunistic, meaning they readily germinate and grow rapidly in areas that are disturbed by plowing, land clearing, or fires. Their rapid growth allows them to take over before slower-growing plants can become established. Heavy Monsoon-season precipitation (July – early September in Southern New Mexico) provides ideal conditions for opportunistic plants, as vegetation often seems to appear overnight after heavy rain.

This effect can be pronounced in PV facilities where site clearing disturbs the land, providing ideal conditions for opportunistic plants to take root. In the Chihuahuan Desert, for example, the Russian thistle (tumbleweed) (Fig. 2) is a key indicator of recent soil disturbance. Other species commonly found in disturbed desert soils include black henbane, yellow star thistle, creosote, and mesquite [15].

Fig. 2. Russian thistle (tumbleweed). Left: actively growing; Right: fully mature and dried. The dry plants break from their base and tumble across the landscape, freely spreading seeds. Tumbleweeds are indicators of disturbed soils.

The Chihuahuan Desert

North America's four major deserts are located in the western portion of the continent (Fig. 3). The Great Basin Desert is considered a cold desert, and the other three (Mojave, Sonoran, and Chihuahuan) are hot deserts. The Aggie Power facility is located within the Chihuahuan Desert; therefore, it is important to understand this ecosystem when evaluating vegetation-management strategies.

Fig. 3. The four deserts of North America (north to south: Great Basin, Mojave, Sonoran, Chihuahuan deserts). The Chihuahuan Desert is shaded mauve. Desert boundaries shown are approximate and may vary among published maps due to differences in classification criteria. Reproduced from [17].

The Chihuahuan Desert is characterized by higher elevations and colder winters than the other two North American hot deserts, with winter freezes being common [18]. The region supports nearly 3,500 plant species, including approximately 1,000 endemic species found nowhere else in the world, and nearly one-quarter of the world's cactus species are native to this desert [16]. Its native vegetation is dominated by low shrubs, succulents, and small cacti[1].

Annual precipitation typically ranges from 8 to 9.5 inches, with most occurring during the summer monsoon season from July through early September. The remainder is associated with winter storms. These precipitation events can rapidly trigger seed germination and vegetation growth, particularly in disturbed soils such as those commonly found within solar facilities [18].

Native vegetation in this region can be patchy, allowing space for opportunistic plants to take hold. Although sparse, many species have the potential to grow high enough to interfere with a module's exposure to sunlight. Fig. 4 shows a north-side view of the Aggie Power facility. The unmanaged vegetation outside the facility boundary illustrates the natural plant community capable of encroaching on the site. Early-stage growth of opportunistic plants are visible in rows parallel to the PV modules.

[1] *Note that the iconic saguaro cactus, often depicted in desert landscapes, with its thick green ribbed trunk and upward-curving arms, is native to the Sonoran Desert (Fig. 1, red shading). It cannot survive the freezing winters in the Chihuahuan Desert.*

Fig. 4. Aggie Power facility viewed from the north. Vegetation outside the perimeter fence serves as a potential seed source at the facility. *Photo by G. Scarbrough, August 6, 2026.*

The San Elizario Solar Facility will serve as the scale-up case for this design challenge. Fig. 5 shows Russian thistle encroachment at El Paso Electric Company's San Elizario Solar Facility, a 10-MW solar installation located approximately 60 miles southeast of Las Cruces in the same Chihuahuan Desert environment. The 70-acre facility contains 18,930 solar panels and provides electricity to approximately 5,000 residential and business customers. Although the vegetation appears relatively sparse, some Russian thistle plants reach the midpoint of the tilted PV modules, where they may create shading and hot spots. Russian thistle typically grows to about 3 feet tall but can reach heights of 4 to 6 feet under some conditions.

Fig. 5. EPE Facility in San Elizario, TX (about 60 miles SE of Las Cruces, NM). Note the Russian thistle beginning to grow to at least half the height of the PV modules.

Retrofit Design Considerations

Because the proposed solution will be implemented at an operating solar facility, teams must design a retrofit that can be incorporated into the site without requiring substantial modification to its current infrastructure.

Compatibility. The retrofit system shall be compatible with existing site infrastructure, including PV modules, racking and tracker systems, pile foundations, underground and aboveground electrical cabling, inverters, fencing, access roads, and drainage features, and it shall not damage, undermine, or restrict the movement of any of them. It shall not damage, undermine, or restrict the movement of any of these components, and shall not require modification of the existing facility's layout or equipment.

Installation. Installation shall be low-disruption, practical, and scalable for utility-scale deployment, minimizing facility shutdown time, equipment and labor costs, time to deploy the system across many acres, while avoiding damage to existing infrastructure. Installation methods shall be safe to perform around energized equipment and within the tight spacing between module rows.

O&M. The installed system shall not interfere with O&M, ensuring that access lanes for vehicles and personnel remain clear, and inspection, module washing, and repair activities may proceed unimpeded.

Visual Integration and Site Appearance

The solar facility is regularly photographed and serves as a visible representation of the utility's clean energy infrastructure. As a result, retrofit solutions should maintain a neat, organized, and professional appearance consistent with the facility's environmental sustainability mission. Designs should avoid visual clutter or a patchwork appearance and, where practical, provide a uniform appearance across the site. Materials and components should also maintain their appearance during prolonged exposure to intense sunlight and desert conditions, resisting fading, discoloration, weathering, and other visible deterioration.

Site Monitoring and Corrective Action

The proposed solution shall provide a minimum design life of ten (10) years before major replacement or reconstruction is required. During the 10-year period, unwanted ground cover shall not exceed 5% of the treated area at any point in time. However, because perfect vegetation control cannot be guaranteed, the proposed solution should incorporate an adaptive management approach that monitors for invasive species, evaluates site conditions, and identifies appropriate vegetation-control measures if needed.

Design Requirements

Your proposed design shall answer the *Problem Statement* given on page 1 and demonstrate these key features (discussed above):

- ***Propose a solution that can be retrofitted*** to EPE's Aggie Power facility and feasibly scaled for implementation at the San Elizario Solar Facility. The solution shall minimize human intervention, require little to no routine inspection, maintenance, or material replenishment, and comply with all applicable regulations.
- ***Deliver long-term vegetation control*** for a minimum of *10* years under high solar intensity conditions. Opportunistic plant occurrence should fall below a target tolerance of *5%*.
- ***Include a System Diagram*** (or PFD) for the selected system. (See *Team Manual*).

- ***Maintain PV performance and limit degradation*** by avoiding conditions that impair PV efficiency or accelerate module degradation. Where feasible, create conditions having the potential to increase module efficiency and/or extend service life.
- ***Support site management*** by protecting facility infrastructure and preserving site access.
- ***Minimize health and safety risks*** throughout the system lifecycle, including installation, operation, maintenance, and decommissioning**.**
- ***Limit ecological harm*** by minimizing water use, chemical use, impacts on native plants and wildlife, and the potential to spread invasive species.
- ***Manage site conditions*** by minimizing adverse impacts on soil stability, erosion, dust control, and stormwater runoff.
- ***Demonstrate scalability*** by applying the solution to a *29-acre* solar facility, with the potential to scale up to a 70-acre site.
- ***Demonstrate feasibility*** by showing that the solution is technically sound, operationally practical, and economically viable for installation, operation, and maintenance at utility-scale solar facilities. Designs shall account for seasonal and operational variations and minimize total lifecycle costs, including capital, operating, maintenance, and end-of-life considerations.
- ***Address regional conditions*** to promote long-term performance under the environment of the Chihuahuan Desert, SW United States, including extreme heat, intense UV exposure, high winds, alkaline soils, and sudden heavy rainfall.
- ***Meet electrical and fire safety requirements***. Materials near energized equipment shall be non-conductive or properly grounded, and the system shall not add combustible material or otherwise increase wildfire risk.
- ***Preserve existing drainage patterns and avoid creating conditions that*** concentrate runoff, increase erosion, or adversely impact stormwater-management features.
- ***Develop a monitoring strategy covering a minimum ten-year operational period*** that evaluates the condition and effectiveness of the vegetation-control system at the time of inspection. Identify inspection frequencies, conditions to be observed or measured, thresholds indicating that acceptable vegetation control is no longer being achieved, and appropriate corrective or supplemental vegetation-control measures.
- ***Maintain unrestricted vehicular and pedestrian access*** to PV arrays, inverters, battery systems, transformers, combiner boxes, and associated infrastructure.
- ***Develop a visually appealing solution*** that maintains a neat, orderly, and professional appearance over its expected service life. Materials and components should resist fading, discoloration, and other visible degradation associated with prolonged exposure to intense sunlight and desert conditions.

Supporting Elements:

- ***Review the literature*** for previous vegetation mitigation efforts for PV facilities and develop your own innovative solution.
- ***Use modeling and predictive tools***, as appropriate, to support design development and optimization by evaluating alternative concepts, characterizing vegetation-growth behavior, and forecasting system performance under seasonal, climatic, and operational changes representative of local conditions. This step is optional.

- ***Implement a risk-management plan*** that identifies the key variables and potential failure modes that could reduce the system's effectiveness over time. Identify predictive indicators of increased vegetation-control risk, locations or circumstances most susceptible to reduced performance, and preventive or adaptive measures for mitigating those risks. This step is optional.
- ***Develop a bench-scale prototype*** to demonstrate the capabilities of your design. Validate the prototype's operational feasibility and sustainability through extended bench-scale studies conducted at your institution, report these in your deliverables, and demonstrate the design's functionality during the Bench-scale Demonstration (see details below).
- ***Quantify the effectiveness of your approach*** (see reference [14]) by analyzing prototype performance and scaling the results to a utility-scale solar facility.
- ***Present a Techno-Economic Analysis*** (TEA) for implementing your full-scale vegetation management system. Report all costs for a full-scale operation on an annual basis as $/acre/yr.

  For the full-scale solution, include your estimates of capital costs (CAPEX) and operational costs (OPEX). Include appropriate graphical representations of these estimates.
  - Capital expenses typically include, but are not limited to, equipment, pipes, pumps, etc., required to install the vegetation management system. Do not include the cost of buildings or other structures, unless they are directly associated with the retrofit vegetation control system.
  - Operating expenses (OPEX) shall include all materials required for both operation and maintenance. Include anticipated equipment or supplies, consumables (chemicals, sacrificial components, etc.), disposal costs (include hauling, if needed), and other O&M costs identified by your team. Use the following operating costs:
    - Labor rates: Professional engineer ($150/hr), operator ($70/hour).
    - Energy costs: If appropriate, use an electricity rate of $0.09/kWh and/or research an industrial natural gas rate (state in $/MM BTU);
  - Visualization tools: Use sensitivity analyses, graphs, and other visuals to illustrate how key parameters impact system performance and economics.
- ***Develop a community engagement or public involvement plan***, as applicable (see *Team Manual*).
- ***Reflect on alternative designs*** and the conditions under which they may be preferable to yours.
- ***Address any intangible benefits*** of the selected treatment process.
- ***Address safety aspects*** of constructing, operating, and/or maintaining the proposed system. These issues should be addressed:
  - for both the full-scale design and the bench-scale demonstration
  - In both the written report and the ESP
- ***To qualify for the P2 (Pollution Prevention) Award***, document your project's success in improving energy efficiency, pollution prevention, and/or waste minimization. Place this in a separate "Pollution Prevention" section of the report.
- ***Report the use of AI, machine learning, predictive modeling, automation, or other decision-support tools,*** and describe how the tools were used. These resources may be used only to support the team's independent engineering research, analysis, calculations, assumptions, and conclusions. Teams remain fully responsible for verifying all information, performing the underlying engineering analysis, and defending their design decisions based on their own work.
- ***Flash Pitch:*** The audience for the Task 2 pitch is *El Paso Electric Company* as potential investors in your contract engineering services.

30% Project Review

Due in late December, the 30% Project Review ("30% Review" for short) outlines the general design and functionality of your vegetation management system, with emphasis on your plans for demonstrating and testing your system during the contest in Las Cruces. The 2027 *Team Manual* gives general guidelines for the 30% Review. Pay particular attention to submitting a **complete** System Diagram (PFD).

Include the following project-specific details:

1. *System Diagram.* This serves as a robust outline of all processes in your treatment system, showing balanced inputs and outputs.
2. *Drawing of your bench-scale demonstration setup*. The draft should be a 3-D view, drawn to scale, with dimensions labeled.
3. *Potential safety concerns* and related mitigation plans for running the prototype at the contest.
4. *Supplies or equipment* you would like WERC to provide at the contest.

Bench Scale Demonstration

Teams shall design and construct a working bench-scale system to demonstrate the requirements listed in the *Problem Statement* and the *Design Requirements*. The prototype will be displayed and demonstrated at the contest in Las Cruces, NM: April 4-7, 2027.

The demonstration will be conducted in a 10' × 10' booth with an 8' table and 120V power. Standard laboratory resources (e.g., fume hoods and ovens) will not be available.

Bench-scale preparation before the contest:

- WERC will provide (information in blue to be updated soon):
  - A recipe to simulate native soils in the Aggie Power area.
  - A list of native plants to use for testing invasive species
  - Sources for these soil constituents and plant seeds and/or cuttings.
- Your team shall submit the 30% Project Review, build and test the bench-scale prototype at your institution, attend the ESP-preparation short course, obtain ESP approval to operate the prototype at the contest, and submit an Equipment Transport Form, if shipping items to Las Cruces.
- During prototype construction and testing at your institution, comply with all safety requirements established by your institution. At the WERC design contest, you will comply with all of WERC's safety requirements, as established in your team's ESP.

At the contest, your team will provide:

- A working bench-scale prototype that demonstrates your team's full-scale vegetation-mitigation system, including all materials and supplies needed to demonstrate the system.

At the contest, WERC will provide:

- Basic booth setup, as described in the *Team Manual*
- Any other supplies or equipment requested by your team in the 30% Review and/or the ESP.

Contest Analytical Testing Techniques (Guided by WERC)
Demonstrate the functionality and effectiveness of the vegetation-mitigation system during the bench-scale demonstrations on Tuesday, April 6, 2027.

Task 2 teams will likely demonstrate their solutions outdoors. Since participating Task 2 teams may propose widely different solutions, WERC will work with each team through virtual meetings prior to the contest to develop appropriate analytical testing protocols. These protocols will be based on the team's 30% Project Review and the ESP.

Deliverables (See *Team Manual*)
Each team must submit (*see Dates and Deadlines, next page*):

- 30% Project Review
- ESP and required short course
- Technical Report—System design, data analysis, bench-scale results, full-scale plans, and 3 independent audits.
- Equipment Transport Form (if shipping equipment to Las Cruces)
- Flash Pitch—The audience for the Task 2 Pitch is El Paso Electric Company as potential investors.
- Oral Presentation—Slide presentation summarizing the design and key findings
- Poster Presentation—Visual summary of the design and results; presentation at the poster.
- Bench-Scale Demonstration—Working model, tested onsite; presentation bench-side.

Evaluation Criteria
Each year, the WERC Environmental Design Contest and its sponsors award more than $35,000 in cash prizes. Awards include task-specific prizes and overall contest awards.

Read the *2027 Team Manual*, as a team, for a comprehensive understanding of the contest evaluation criteria: https://werc.nmsu.edu/team-info/guidelines.html

Judges' evaluation of your entry will include consideration of the following points specific to this task.

- Quality of the System Diagram
- Quantitative confirmation of vegetation management
- Bench-scale demonstration that effectively demonstrates the technology.
- Potential for real-life implementation, including passivity, effectiveness, expected reliability, and maintainability.
- Ability to support PV module reliability and performance.
- Minimal waste generation; Efficient waste management, if applicable
- Cost effectiveness of your solution, compared with other options your team identifies.
- Thoroughness and quality of economic analysis.
- Originality and innovation demonstrated by the proposed technology.
- Other specific evaluation criteria that may be provided at a later date (watch the FAQs).

Dates, Deadlines, FAQs (*dates subject to change—watch website FAQs*)

Today	Email us to reserve a spot for your team and join the email list for this task. Registration is limited to the first 34 teams.
Weekly	Check FAQs weekly for updates: Task-specific FAQs: 2027 Tasks/Task FAQs General FAQs: WERC General FAQs
Nov. 1 – Dec. 31, 2026	Early Bird Registration (discount applies)
Dec. 31, 2026	30% Project Review Due
Dec. 1, 2026 – March 1, 2027	Mandatory on-demand Course: *Preparing the Experimental Safety Plan*. See WERC's website and Team Manual for information.
February 15, 2027	Final date to register a team.
March 1 – 5, 2027	Email ESP to Juanita Miller (miljgh@nmsu.edu). Include requests for chemicals, materials, etc.
March 22, 2027	Submit Equipment Transport form (if shipping items to Las Cruces)
March 26, 2027	Technical Report due
March 29, 2027	Submit Flash Pitch Slides and Summary
April 4 – 7, 2027	Contest in Las Cruces

Contacts:

Safety Officer: Juanita Miller, miljgh@nmsu.edu (for ESP and bench-scale safety issues)

Program Manager: Ginger Scarbrough, gscarbro@nmsu.edu (for non-ESP questions)

References

[1] Rodriguez-Pastor, D.A., Ruiz-Diez, A., Gonzalez-Lopez, J.J., Soltero, V.M., and R. Chacartegui. Sustainable vegetation management methods in commercial photovoltaic plants. *Agricultural Systems.* Volume 237. 2026. 104810. https://doi.org/10.1016/j.agsy.2026.104810 (Accessed July 28, 2026).

[2] Brackett. B. Vegetation Management: Trends and Challenges in 2026. *Energy Central*. March 18, 2026. https://www.energycentral.com/energy-biz/post/vegetation-management-trends-and-challenges-in-2026-BjVdJUh7qy3zj4Y (Accessed August 5, 2026).

[3] United States Department of Energy. Photovoltaic Reliability and Standards Development. https://www.energy.gov/cmei/systems/photovoltaic-reliability-and-standards-development (Accessed August 11, 2026).

[4] United States Department of Energy. Solar Photovoltaic Performance and Efficiency. https://www.energy.gov/cmei/systems/solar-photovoltaic-performance-and-efficiency-basics (Accessed August 11, 2026).

[5] Krisciunas, K. How solar panels work, in theory and in practice. *AIP Advances*. 2023. 13. 10.1063/5.0153883 (Accessed August 5, 2026).

[6] Yang, H., Yin, Y., and A. Abu-Siada. 2025. A Comprehensive Review of Solar Panel Performance Degradation and Adaptive Mitigation Strategies. *IET Control Theory Appl.*, 19: e70040. https://doi.org/10.1049/cth2.70040 (Accessed August 5, 2026).

[7] Ian Marius Peters, Jens Hauch, Christoph Brabec, and Parikhit Sinha. The value of stability in photovoltaics. *Joule.* Volume 5, Issue 12. 2021. Pp. 3137-3153. https://doi.org/10.1016/j.joule.2021.10.019 (Accessed August 12, 2026).

[8] McCall, J., Macdonald, J., Burton, R., and J. Macknick. 2023. Vegetation Management Cost and Maintenance Implications of Different Ground Covers at Utility-Scale Solar Sites. Sustainability, 15(7), 5895. https://doi.org/10.3390/su15075895 (Accessed July 28, 2026).

[9] Zhang, Xiuqi & Yuan, Shuai and Qi Wang. 2023. Causes and Prevention of Photovoltaic Module Hot Spot Effect. *Journal of Physics: Conference Series.* 2520. 012012. 10.1088/1742-6596/2520/1/012012 (Accessed July 28, 2026).

[10] Guangzhou TERLI New Energy Technology Co. Blog: Comprehensive Analysis of Hotspot Effects in Solar Panels. https://www.terli.net/blog/comprehensive-analysis-of-hotspot-effects-in-solar-panels.html (Accessed August 5, 2026).

[11] Lawrence, J. Planning and Managing Permanent Vegetation Under Solar Arrays. *Cornell Field Crops.* September 2022. https://blogs.cornell.edu/whatscroppingup/2022/09/01/planning-and-managing-permanent-vegetation-under-solar-arrays/ (Accessed August 5, 2026).

[12] National Renewable Energy Laboratory; Sandia National Laboratory; SunSpec Alliance; SunShot National Laboratory Multiyear Partnership; (SuNLaMP) PV O&M Best Practices Working Group. *Best Practices for Operation and Maintenance of Photovoltaic and Energy Storage Systems, 3rd ed.* 2018. https://docs.nlr.gov/docs/fy19osti/73822.pdf (Accessed July 28, 2026).

[13] Warren, C. How grazing sheep can reduce vegetation management costs and bolster community support for solar projects. *The Electric Power Research Institute (EPRI) Journal*. June 2023. https://eprijournal.com/solar-sheep/ (Accessed August 5, 2026).

[14] Arshad, M. A., Abbas, R. N., Khaliq, A., and Z. Ahmed. 2024. Assessing Herbicide Efficacy and Susceptibility for Weed Management and Enhancing Production of Non-GMO Soybean Cultivation. *Preprints.* https://doi.org/10.20944/preprints202404.0494.v1

[15] Wanstall, J. and L. Beck. *Noxious and Troublesome Weeds of New Mexico*. 2021. https://www.emnrd.nm.gov/sfd/wp-content/uploads/sites/4/troublesome_weeds_nm.pdf (Accessed July 28, 2026).

[16] United States National Park Service. Chihuahuan Desert Ecoregion. January 20, 2022. https://www.nps.gov/im/chdn/ecoregion.htm (Accessed July 28, 2026).

[17] ArcGIS Web Map Viewer. North American Deserts. https://www.arcgis.com/apps/mapviewer/index.html?webmap=cf1e62d3182a4734ac13407960d0e5af (Accessed August 5, 2026).

[18] Arizona-Sonora Desert Museum. The North American Deserts. https://www.desertmuseum.org/books/nhsd_northamerica.php (Accessed July 28, 2026).