Task 4 Preview 2 – This is the second Preview Update. *We are waiting for more details from our subject matter experts (SMEs) at NASA. Changes from the first preview are in* dark blue.

NASA Artemis Mission: Capacitive Wireless Charging of a Lunar Vehicle

Task sponsored by: New Mexico Space Grant Consortium
Task developed by: NASA Artemis Surface Systems Team

Task Summary

Your team is invited to support NASA's Artemis Program's plans for sustained human and robotic exploration of the lunar south pole. Your challenge, should you choose to accept it, is to develop an innovative wireless charging system for a lunar terrain vehicle (LTV) that will be exposed to extreme temperatures, abrasive electrically charged lunar dust, rugged terrain, and prolonged dark periods, with limited opportunities for maintenance. A robust LTV charging system will support scientific discovery for future Artemis missions [1].

Your team's solution may draw on multiple engineering disciplines, including electrical engineering, mechanical engineering, materials, controls, robotics, and aerospace systems.

Problem Statement

Your team will research, evaluate, and design an innovative capacitive wireless power transfer system for charging a lunar terrain vehicle (LTV) at the lunar South Pole. At full scale, the system shall deliver a minimum of 1 kW of electrical power to the rover at the receiver, subject to the *Design Requirements* below. Teams may propose higher-power systems when justified by charging needs, system efficiency, mass, cost, and overall design performance.

The charging system shall consist of a stationary power-transmitting station supplied with electrical power and a receiving system integrated with the LTV. Power shall be transferred capacitively across a physical gap without direct electrical contact between the rover and the charging station. The design shall establish and justify the transmitter/receiver geometry, operating gap, alignment tolerances, operating frequency, power electronics, and control strategy necessary to achieve reliable and efficient power transfer.

The system shall accommodate realistic rover positioning and alignment errors rather than requiring precise mechanical placement. It must also function under conditions representative of the lunar South Pole, including extreme temperatures, abrasive and electrostatically active lunar dust, vacuum, and extended periods of darkness. The design shall minimize components or operating requirements that could compromise reliability or require frequent maintenance in the lunar environment.

The proposed system shall support autonomous or semi-autonomous vehicle positioning and charging. The rover shall be capable of approaching the charging station, establishing an acceptable charging position, initiating and maintaining power transfer, and safely terminating the charging process without requiring the crew to manually connect or disconnect electrical hardware. Appropriate monitoring, controls, fault protection, and electrical and thermal safety shall be incorporated into the design.

The final design shall demonstrate technical feasibility at full scale and consider system efficiency, reliability, maintainability, mass, energy requirements, and capital and operational costs. The technology should be scalable to future lunar surface operations and provide a practical means of supplying power to mobile assets in locations where direct solar generation is intermittent or unavailable.

Background

Moon Base

NASA recently released plans for the Artemis program's Moon Base near the lunar South Pole. It will be the first lunar outpost designed to support a long-term human presence on the Moon, where astronauts could reside for missions lasting up to 28 days. NASA and its partners plan to build the base over a series of crewed and robotic missions, gradually adding infrastructure to support continued exploration, scientific discovery, and the development of new technologies. Moon Base will help establish a sustained human presence on the Moon and, ultimately, support future missions to Mars [1].

The lunar South Pole offers important opportunities for exploration, but it is also an unusually demanding environment for electrical and mechanical systems. The Sun remains very low on the horizon, producing long, rapidly moving shadows. Lunar dust (a.k.a. *lunar regolith*) is abrasive, electrostatically active, and can interfere with mechanical and electrical interfaces. These conditions present significant challenges for vehicles, power systems, and other equipment expected to operate reliably for extended periods [2].

NASA has selected the South Pole for this outpost because some of its regions receive nearly continuous sunlight, providing opportunities for solar power generation. Due to the low angle of the sun, areas of rough terrain contain permanently shadowed regions (PSRs) that never receive direct sunlight. Temperatures range from approximately 54°C (130°F) in sunlit areas to as low as −203°C (−334°F) in PSRs [2]. Because PSRs remain extremely cold, water ice[1] can remain stable for long periods, making these regions valuable potential sources of water for future lunar operations [2]. Toward these efforts, NASA's Moon Base User's Guide identifies the Functional Gaps shown in Fig. 1 [1]. See the Appendix for NASA's definitions of Functional Gaps, Technology Gaps, and related terminology.

POWER SYSTEMS

Systems to generate, store, condition, and distribute electricity for the Moon Base, supporting infrastructure, and utilization systems.

ARCHITECTURAL VALUE	CAPABILITY TARGETS
Provides a critical shared resource for: • Recharging mobility assets. • Crew habitation on the surface. • Science payloads in shadowed regions. • In-situ resource utilization (ISRU) processing.	• Demonstrate 5 kW power generation and storage, as well as survival through 120+ hours of darkness • Demonstrate survive the night capability using radioisotope thermal generators

FUNCTIONAL GAPS	
FN-P 101 L	Generate power in the south pole region on the lunar surface.
FN-P 102 L	Store energy in the south pole region on the lunar surface.
FN-P-301L	Distribute power in the south pole region on the lunar.
FN-P-401L	Provide power for deployed surface utilization payloads/equipment.
FN-P-402 L	Provide power for deployed external surface utilization payload(s) and/or equipment for mid- (month+) to long-durations (year+).

Fig. 1. NASA published Architectural Values, Capability Targets, and Functional Gaps for planned power systems. *Reproduced from [1].*

[1] In planetary science, *water ice* refers specifically to frozen H_2O, distinguishing it from other volatile compounds that can also occur as solid ice at extremely low temperatures, such as carbon dioxide, ammonia, or methane.

Powering Lunar Terrain Vehicles

NASA plans to develop Moon Base in three phases: Moon Base I, II, and III. During Moon Base II, the Astrolab FLIP rover will be delivered to the lunar surface for autonomous operation. Its performance will provide valuable data on lunar mobility and help inform the design and operation of future Lunar Terrain Vehicles (LTVs).

NASA's Artemis-generation LTVs will expand upon the capabilities of the Apollo lunar rovers by combining crewed transportation with autonomous and remotely operated exploration. Equipped with advanced power management, communications, and navigation systems, LTVs will transport astronauts and scientific equipment during crewed missions. They will also operate remotely between missions to support scientific investigations, transport cargo and payloads, and conduct resource prospecting [3].

Power management at the lunar South Pole presents particular challenges. First, it is imperative that all electrical connections be dust tolerant. Second, autonomous or semi-autonomous alignment must be reliable, despite rapidly changing illumination angles. Third, extended periods of darkness can limit solar power generation and also exposing LTVs and their charging systems to extreme temperatures. Because onboard battery capacity is limited, LTV operations must account for available energy, charging opportunities, and the ability to reach locations where the vehicle can safely remain during periods of insufficient sunlight [3, 4].

To support sustained LTV operations, NASA needs charging systems capable of operating with minimal crew intervention. Ideally, an LTV could autonomously or semi-autonomously approach a charging station, position itself within the allowable charging envelope, receive power, and safely disengage when charging is complete. Such a system would reduce reliance on astronauts to manually connect and disconnect electrical cables while supporting both crewed and remotely operated missions.

Wireless charging provides an important advantage over conventional electrical connectors. By eliminating exposed electrical contacts, problems associated with lunar regolith contamination may also be reduced.

Future Interconnectivity. Although this design challenge focuses on wireless charging of a single LTV, future lunar surface operations will require an interconnected infrastructure capable of generating, storing, and distributing power among many different assets. As Moon Base expands, wireless power transfer could support smaller robotic rovers, autonomous excavation and material-handling equipment, portable science instruments, and other battery-powered systems operating away from fixed power sources. Developing interoperable wireless charging technology could therefore contribute to a more flexible lunar power network in which multiple types of mobile and portable equipment share charging infrastructure rather than relying exclusively on dedicated solar arrays or physical electrical connections [1].

Capacitive Wireless Power Transfer

Conventional conductive charging requires physical electrical contacts between the charging station and the vehicle. On the lunar surface, these interfaces must contend with abrasive, electrostatically charged regolith that can infiltrate and interfere with mechanical and electrical systems. NASA is therefore seeking wireless power transfer (WPT) solutions and dust-tolerant electrical connectors for Moon Base power systems [1, 5].

Two principal near-field approaches are inductive power transfer (IPT), which couples energy through a time-varying magnetic field, and capacitive power transfer (CPT), which couples energy through a time-varying electric field between conductive surfaces [6]. CPT is of particular interest for applications where system mass and mechanical simplicity are important because its coupling structures can consist of relatively thin conductive plates and do not require the ferrite structures commonly used for magnetic flux guidance in high-power inductive systems [7, 8].

In a CPT system, conductive plates on the charging station and rover form the capacitive coupling interface. High-frequency alternating voltage applied to the transmitter produces a time-varying electric field that transfers energy across the gap to the receiving plates. Power electronics and compensation networks on the transmitting and receiving sides are used to achieve efficient power transfer and convert the received electrical power to the voltage and current required by the vehicle's charging system [6, 7].

Kilowatt-scale CPT has been demonstrated experimentally across gaps relevant to vehicle charging. In one study, a 6.78-MHz system using dielectric-covered circular coupling plates transferred 1.125 kW across a 12-cm gap at 85% efficiency. A smaller-plate configuration transferred 1.217 kW at 74.7% efficiency across the same gap [8]. Subsequent research demonstrated 3.75 kW across a 12-cm gap at 94.7% efficiency using a 13.56-MHz CPT system [9]. These terrestrial demonstrations do not establish performance under lunar conditions, but they demonstrate that capacitive coupling can transfer power at levels potentially relevant to vehicle charging.

CPT also presents significant engineering challenges. The coupling capacitance between separated plates is generally small, requiring careful selection of operating frequency, voltage, plate geometry, and compensation networks. Higher voltages and electric-field strengths can increase the risk of electrical discharge and impose additional insulation requirements, while higher operating frequencies can increase switching losses. Coupling and system performance can also change with plate separation and misalignment [6–8].

A lunar application introduces another layer of complexity. Charging hardware must operate in vacuum and across extreme temperature conditions while tolerating highly abrasive and electrostatically charged lunar dust [4, 10]. NASA has specifically identified lunar regolith as a threat to mechanisms and surface hardware, and recent lunar testing of NASA's Electrodynamic Dust Shield further demonstrated the importance of mitigating dust accumulation [11]. For a rover-mounted system, mass, volume, efficiency, thermal management, alignment tolerance, reliability, and autonomous operation must therefore be considered together when evaluating the feasibility of CPT for lunar charging.

Delivering Resources to the Lunar Surface

Every piece of equipment used on the Moon must first be transported from Earth, making mass a critical consideration in lunar system design. Launch vehicles have finite payload capacities. Additional mass will increase transportation requirements and compete with scientific instruments, supplies, energy-storage systems, and other resources needed for lunar operations. Consequently, every kilogram should be justified, even for equipment that will remain stationary after reaching the lunar surface.

For the proposed charging system, teams should consider the mass of both the stationary transmitter and the receiver integrated with the LTV. Rover-mounted mass is particularly important because it can affect payload capacity, mobility, energy consumption, and overall performance of the vehicle. However, mass reduction must be balanced against structural integrity, power-transfer efficiency, reliability, and durability in the lunar environment.

Physical mass is not the only resource consideration. Systems requiring greater power, cooling, volume, or other supporting infrastructure can indirectly increase the resources—and ultimately the mass—needed for lunar operations. NASA uses Equivalent System Mass (ESM) as a trade-study tool to express these resource demands as a common mass-equivalent value [12].

For this challenge, teams shall use ESM to compare their proposed CPT system with design alternatives, considering, at a minimum, the physical mass of the stationary transmitter and LTV-mounted receiver and the electrical power required for operation. Additional ESM terms shall be incorporated where applicable. More information on the calculation of ESM will be provided in the Final Task Problem Statement.

Task 4 Goals

Drawing from the background information presented above, your team shall develop an innovative capacitive wireless power transfer (CPT) system for charging a Lunar Terrain Vehicle (LTV) operating near the lunar South Pole. Your design may build upon technologies reported in current research; however, the final system should demonstrate meaningful innovation rather than simply replicate an existing design.

Minimize the mass of the full-scale charging system, particularly components integrated with the LTV. Because transporting equipment from Earth to the lunar surface is costly and payload capacity is limited, every kilogram must be justified. Balance mass reduction against power-transfer performance, reliability, and safety, considering the transmitting and receiving systems separately.

Use relevant characteristics of the *Astrolab FLIP* rover to establish a realistic basis for your full-scale LTV charging interface, including vehicle dimensions, power requirements, receiver placement, ground clearance, and other applicable features. Where *FLIP* specifications are unavailable, develop and clearly document reasonable engineering assumptions.

The design shall focus on power conditioning, capacitive power transfer, the LTV-side receiving system, and associated controls, and not power generation or storage. Therefore, teams are not responsible for designing the PV generation or primary energy-storage systems. Instead, assume that the electrical power is available at the charging station from the Moon Base power infrastructure.

The complete bench-scale prototype shall fit within the following maximum dimensions:
Length: 31 in. Width: 11 in. Height: 11 in.

Teams will use Lunar South Pole Regolith Simulant (LSP-2) for applicable bench-scale testing [14]. LSP-2 is available from *Space Resource Technologies*; approximately 1 kg per team should be sufficient for anticipated testing ($55). Teams should also research and develop a safe method for electrostatically charging the regolith simulant to simulate the properties of the regolith on the lunar surface. This will further enhance the study of the regolith's interaction with the charging interface.

The full-scale and bench-scale designs should account for the abrasive and electrostatically active nature of lunar regolith. Materials in the design that are exposed to lunar dust should resist scratching, abrasion, denting, and other surface damage that could compromise charging performance or system reliability.

The design should also anticipate other conditions that distinguish lunar charging from terrestrial wireless charging, including extreme temperatures, vacuum, imperfect LTV alignment, limited opportunities for maintenance, and the need to minimize system mass. These conditions cannot all be physically reproduced during bench-scale testing; however, their effects on the full-scale design should be evaluated and reported in the technical report.

Because costs associated with NASA systems can reflect specialized testing, qualification, transportation, and hazard-mitigation requirements, teams should use available costs for comparable terrestrial or aerospace technologies to develop and clearly document reasonable estimates of capital and operating expenses (CAPEX and OPEX). Assumptions used in the economic analysis should be identified and justified.

The complete *Design Requirements* for this task are provided in the following section.

Design Requirements

Your proposed design shall answer the Problem Statement and meet the following requirements. Unless otherwise identified as a NASA requirement, the numerical values below constitute the WERC Design Basis, established to provide a common basis for design and comparison among teams.

- ***Deliver sufficient charging power*** by providing a minimu**m of 1.0 kW of DC power to the** LTV at nominal charging conditions.
- ***Achieve efficient power transfer*** with a minimum of 80% DC-to-DC efficiency at nominal alignment and charging distance. A system efficiency of 90% or greater is a design goal.
- ***Transfer power*** **using capacitive wireless power transfer** (CPT) as the primary means of charging the LTV, with no direct electrical contact.
- ***Maintain adequate charging separation*** across a nominal transmitter-to-receiver gap of 100 mm (4 in.), with operation demonstrated in the full-scale design over a range of 75–150 mm.
- ***Accommodate imperfect LTV positioning*** by maintaining charging capability with at least ±50 mm lateral misalignment and ±10° angular misalignment.
- ***Minimize System Mass and Footprint*** of the full-scale charging system for both the stationary charging station and rover-mounted components, particularly emphasizing the components integrated with the LTV. However, do not sacrifice the system's performance for reduced mass or footprint.
- ***Support autonomous or semi-autonomous charging*** so that the LTV can approach, position itself, charge, and disengage without requiring manual connection to or disconnection from electrical cables.
- ***Provide safe and fault-tolerant operation*** by automatically terminating or limiting power transfer under unsafe or abnormal operating conditions.
- ***Demonstrate compatibility with extended LTV operations*** by addressing periods of up to 150 hours without solar input and providing for continued essential operation or safe standby.
- ***Address the lunar South Pole thermal environment*** by designing the system to survive temperatures ranging from approximately 54°C (130°F) to −203°C (−334°F). Defining and justify its operational temperature range.
- ***Provide thermal management in a lunar vacuum*** by accounting for heat generated by the charging system and providing adequate conductive and radiative heat transfer.
- ***Mitigate lunar regolith effects*** to maintain electrical performance, thermal performance, and system reliability.
- ***Support LTV mobility*** without interfering with rover clearance, approach, departure, or its anticipated 20° slope-traversal capability.

- ***Provide long-term reliability*** with a minimum design service life of three years, identifying components likely to require maintenance or replacement.
- ***Support future interoperability*** by considering how the charging interface could eventually serve other mobile or battery-powered lunar equipment.
- ***Demonstrate feasibility*** by showing that the proposed system is technically sound, operationally practical, reliable, and compatible with lunar surface operations.

Supporting Elements

- ***Review the literature*** on wireless power transfer in the lunar environment and LTV power requirements, using the *Astrolab FLIP* rover.
- ***Develop an electrical model*** of the proposed CPT system, including the capacitive coupling interface, power electronics, compensation network, losses, and representative load.
- ***Characterize and optimize system performance*** by evaluating the effects of key design variables such as operating frequency, plate geometry, charging distance, and alignment.
- ***Quantify system performance*** using appropriate calculations, simulations, and experimental data. Present power, efficiency, charging distance, and alignment performance graphically where appropriate.
- ***Develop a control strategy*** describing how the LTV and charging station identify proper positioning, initiate and regulate charging, communicate during operation, and respond to faults.
- ***Include a System Diagram*** showing the complete charging architecture from the Moon Base power source through the transmitter, capacitive interface, rover-side receiver, power conditioning, and LTV energy-storage system. (See *Team Manual*.)
- ***Develop a bench-scale prototype*** that demonstrates capacitive wireless power transfer and validates the principal features of the proposed design. The prototype shall deliver at least **25 W of continuous DC power for 10 minutes**, achieve at least **70% DC-to-DC efficiency**, and maintain a minimum transmitter-to-receiver gap of **25 mm (1 in.)**.
- ***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
- ***Demonstrate scalability*** by relating bench-scale results to the required **1-kW full-scale system**, including appropriate electrical, geometric, thermal, and efficiency considerations.
- ***Implement a risk-management plan*** that identifies the principal technical and operational risks to successful charging and describes appropriate mitigation measures.
- ***Present a Techno-Economic Analysis (TEA)*** for the proposed full-scale system. Include estimated CAPEX, operating and maintenance costs, system mass, service life, and other metrics appropriate for evaluating a lunar charging system.
- ***Use sensitivity analyses, modeling, and graphical tools*** to illustrate how key variables affect system performance and design decisions.
- ***Reflect on alternative designs*** and identify conditions under which conductive or inductive charging might be preferable to the proposed CPT system.

- ***Address safety aspects*** of the full-scale design and bench-scale demonstration, including electrical, thermal, stored-energy, and other hazards. Safety considerations shall be addressed in both the written report and the Experimental Safety Plan (ESP).
- ***Address any intangible benefits*** of the proposed charging system, including potential benefits to future lunar surface infrastructure, autonomous operations, and interoperability.
- ***To qualify for the P2 (Pollution Prevention) Award,*** document improvements in energy efficiency, material use, component longevity, waste reduction, or other relevant aspects of the system lifecycle. Place this discussion 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 and defending their design decisions based on their own work.
- ***Flash Pitch:*** The audience for the Task 4 pitch is the *NASA Architecture Team*, as potential investors in your design. Assume that, under the proposed contract, NASA will purchase and own the resulting product. (Teams solving other tasks will be assigned specific audiences.)

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 charging 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. The dimensions may be modified after 30% submission.
3. Plans for electrostatically charging the lunar regolith.
4. Potential safety concerns and related mitigation plans for running the prototype at the contest.
5. Describe any supplies or equipment you would like WERC to provide at the contest.
6. Other specifications provided in November 2026.

Bench Scale Demonstration
Teams shall design and construct a working bench-scale system to demonstrate a subset of the requirements of the Problem Statement and the *Design Requirements* listed above.

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.

Analytical Testing Protocols
Low-temperature charging performance. WERC will test your team's system under low-temperature performance by operating the bench-scale charging system under controlled cold conditions. Teams shall measure and report the temperatures of critical components and compare charging power and efficiency with performance at room temperature. Discuss the limitations of ambient-pressure testing and how system performance would be expected to differ under lunar vacuum conditions.

Your proposed system will be tested under low-temperature conditions within a Coleman 150-qt cooler (unless your design warrants a smaller cooler). Current plans are to use liquid nitrogen to cool the interior of the cooler. The fall-back position is to use dry ice.

The interior dimensions of the cooler are, nominally: 39" x 15" x 15".
This limits the size of your entire system (charging station and receiving plates/LTV to:
Length: 31 in. Width: 11 in. Height: 11 in.

Alignment-tolerance test. Your proposed system's performance under a range of varying positioning will be tested using your team's rover model, with its receiving plates mounted in the same relative position as in the full-scale concept. WERC will intentionally introduce misalignment and measure the resulting power transfer (W) and efficiency (%). This test will be conducted in Las Cruces under ambient conditions (approximately 15° - 25° C), and potentially under varying lighting conditions.

Misalignments will be similar to the examples below.

- Lateral offset: moving the rover left/right from perfect alignment (i.e., 0, 25, 50, and 75 mm).
- Angular misalignment: rotate the rover relative to the charging pad (i.e., 0°, 5°, 10°, and 15°).
- Gap distance: change the vertical or horizontal separation between transmitter and receiver (i.e., 25, 50, and 75, and 100 mm), depending on the prototype size.

The following (in blue) was added for Preview 2:
Autonomous Vehicle Alignment Test. Your vehicle's ability to align itself with the stationary charging station will be tested under low and low-angle lighting condition representative of the lunar South Pole. At the start of the test, the rover shall approach the charging station, establish an acceptable charging position, initiate and maintain power transfer, and safely terminate charging.

Semi-autonomous operation will satisfy the minimum requirement; designs demonstrating fully autonomous operation will be evaluated as a higher level of system capability. Any manual intervention required during the test will be documented as part of the demonstration results.

See the Appendix for additional discussion of autonomous and semi-autonomous operations.

Tailored Testing. Since participating teams may propose different solutions, WERC will work with each team through virtual meetings prior to the contest to develop appropriate analytical testing protocols, based on the team's 30% Project Review and the ESP. For example, the actual misalignment variations will depend on the design of your team's prototype.

Before the contest:

- 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, comply with all safety requirements established by your institution.

At the contest, your team will provide:

- A working bench-scale prototype that demonstrates your team's full-scale wireless LTV charging system and an LTV model, including all materials and supplies needed to demonstrate the system.
- Bench-Scale Rover Design Basis: The system shall be designed to deliver a nominal 25 W DC output at the specified charging gap. WERC will evaluate performance at standardized lateral and angular misalignments.

At the contest, WERC will provide:

- Basic booth setup, as described in the *Team Manual*
- Conditions that simulate below-freezing temperatures and temperature cycling.
  Temperature: the charging system shall be tested under thermal cycles below freezing and above 30°C.
- Standardized misalignment platforms to ensure all systems are tested under the same conditions.
- Lunar South Pole Regolith Simulant (LSP-2) from Space Tech [14].
- Additional items requested by your team, if needed. Although teams will provide the majority of items needed for the bench-scale demonstration, you may submit requests to WERC in the ESP by March 1, 2027 (See *Team Manual*). These may include materials not safe to ship (such as pressurized gas cylinders) or bulky, low-cost items (such as kiddie wading pools) that are impractical to ship to the contest.

Deliverables (See *Team Manual* and *Team Schedule*)

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 the NASA Architectural Team as potential investors.
- Oral Presentation—Slides and 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 benchside.

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 and completeness of the System Diagram.
- Quantitative demonstration of power transfer, charging efficiency, and alignment tolerance.
- Bench-scale demonstration that effectively demonstrates the proposed CPT technology.
- Potential for full-scale lunar implementation, including reliability, autonomy, maintainability, and compatibility with the lunar environment.
- Effectiveness of the design in addressing lunar dust, temperature extremes, vacuum, and other environmental constraints.
- Effectiveness of LTV approach, alignment, charging, and disengagement.
- Mass, size, and energy efficiency of the proposed system.
- Quality and defensibility of scaling from bench-scale results to the full-scale LTV charging system.
- Safety and risk management for both the bench-scale and full-scale systems.
- Cost effectiveness compared with alternative charging approaches considered by the team.
- Thoroughness and quality of the techno-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:

ESP and Safety Officer: Juanita Miller, miljgh@nmsu.edu
Program Manager: Ginger Scarbrough, gscarbro@nmsu.edu (for non-ESP questions)

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Appendix. NASA Terminology

Functional Gaps: describe operational shortfalls without prescribing how to fix them. They focus on mission operations, system performance requirements, and architectural needs, such as "Distributing power on the lunar South Pole."

Technology Gaps: focus on the physical implementation, material science, or engineering maturity required to close the operational need. They are defined by comparing current laboratory/flight technology readiness levels (TRL) against mission key performance parameters (KPPs). Example: Lacking specific dust-tolerant wireless charger for an LTV.

Key Performance Parameter (KPP). It is a measurable, quantitative engineering metric or characteristic that defines the minimum acceptable performance (also called threshold performance) and the goal for a mission, system, or technology development project.

Semi-Autonomous Charging. The rover can approach and position itself near the charging station, but the initiation, maintenance, and termination of power transfer still require some level of human or pre-programmed control. For example, the rover may autonomously navigate to a charging station and align itself, but the actual start and stop of charging might be triggered by a command or a fixed sequence rather than fully self-directed decision-making iee.nmsu.edu. This approach reduces the need for manual intervention but still relies on external control for critical steps.

Fully Autonomous Charging. Fully autonomous systems integrate mapping for localization and path planning, allowing the rover to independently plan a route to the charging station, dock, and initiate charging. The entire process, from navigation to safe disconnection, is self-directed, with minimal or no human input [14].