Silicon Carbide (SiC) Packaging Prize
Official Rules

MAY 2026 MODIFICATION

AMERICAN MADE
U.S. DEPARTMENT OF ENERGY

Preface

The U.S. Department of Energy's Silicon Carbide (SiC) Packaging Prize will be governed by 15 U.S.C.§3719 and this Official Rules document. This is not a procurement under the Federal Acquisitions Regulations and will not result in a grant or cooperative agreement under 2 CFR 200. The Prize Administrator reserves the right to modify this Official Rules document if necessary and will publicly post any such notifications as well as notify registered prize participants.

The following table describes changes that will be implemented in this rules document:

Date	Modification
12/09/2024	The SiC Packaging Prize has adjusted dates due to the delay of the Phase 1 Winner Announcement. Modifications: • Section 1.2 Key Dates • Section 4.5 Important Dates • Section 5.5 Important Dates
4/09/2025	The vocabulary in the rules document has been amended to comply with the Executive Order on Ending Radical and Wasteful Government DEI Programs and Preferencing, and Agency-Wide Policy to Promote Equal Opportunity.
05/07/2026	The SiC Packaging Prize has adjusted the prize timeline and rules to ensure alignment with Administration and departmental priorities and the U.S. Department of Energy's statutory authorities. The rules document now refers all competitors to the timeline posted on HeroX for current important dates and deadlines. The vocabulary in the rules document has been amended to refer to the National Laboratory of the Rockies (NLR), formerly known as the National Renewable Energy Laboratory (NREL), and edited associated email addresses. The Eligibility and Competitors (Section 1.3) and Appendix 1 have been amended to provide further clarity. Section 5.8 has been updated to include a score of "0" for "Non-Responsive" on the review scale. In addition, language has been added to Sections 3.5, 4.8, and 5.8 to clarify that reviewers will evaluate each bulleted consideration statement individually. Scores will range from 1–6 for Sections 3.5 and 4.8, and from 0–6 for Section 5.8, based on the extent to which the reviewer agrees that the submission addresses the statements for consideration.

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Executive Summary

The U.S. Department of Energy (DOE) Office of Electricity is launching the American-Made Silicon Carbide (SiC) Packaging Prize. This prize establishes a final goal of developing 10-kV, 2,000-A rated SiC power modules that expand the state of the art in semiconductor packaging.

Silicon carbide devices have become prime candidates for future high-performance power electronics due to their high breakdown voltage, low switching loss, and high-temperature operation. However, conventional packaging techniques limit the performance of SiC power modules because of parasitic inductance and heat dissipation issues. To enable grid-based applications, SiC power module capabilities need to be expanded to handle higher voltage and higher current than commercially available products. Toward this end, the DOE Office of Electricity established the American-Made SiC Packaging Prize as a three-phase contest to achieve the goals stated above.

1.1 Prizes Overview

The Silicon Carbide (SiC) Packaging Prize offers a total prize pool of $2.25 million in cash across three phases.

Phase 1 – Design Study

In this phase, prize participants will describe their team, explain their plan to make progress toward developing SiC semiconductor packaging, and showcase any prototypes they have. As part of this phase, participants will provide evidence of a design prototype meeting or exceeding Phase 2 metrics. At the end of Phase 1, up to 10 winning teams will receive $50,000 each in cash prizes and will be eligible to compete in Phase 2 (Phase 1 Total Prize Pool: $500,000).

Phase 2 – Initial Demonstration

In Phase 2, winning teams from Phase 1 will develop a physical prototype of their SiC packaging solution meeting Phase 2 metrics. In this phase, teams must send their prototypes to Oak Ridge National Laboratory for testing to validate the metrics achieved. At the end of Phase 2, up to four winning teams will receive $250,000 each in cash and become eligible to compete in Phase 3 (Phase 2 Total Prize Pool: $1,000,000).

Phase 3 – Final Demonstration

In Phase 3, winning teams from Phase 2 will continue the development of their SiC packaging solution and showcase their working prototypes. In this phase, teams must send their prototypes to Oak Ridge National Laboratory for testing in order to validate the metrics achieved. In Phase 3, one winning team will receive $750,000 in cash (Phase 3 Total Prize Pool: $750,000). To receive the prize, teams must meet the established goal of the SiC semiconductor power devices achieving 10 kV, 2,000 A with an ability to switch at 20 kHz at a maximum case temperature of 85 °C.

Phase	Winners	Prizes
Phase 1 - Design Study	Up to 10 winners	$50,000/winner ($500,000 total prize pool)
Phase 2 - Initial Demonstration	Up to 4 winners	$250,000/winner ($1,000,000 total prize pool)
Phase 3 – Final Demonstration	Up to 1 grand prize winner	$750,000 Grand Prize

1.2 Key Dates

Refer to the timeline on HeroX for relevant dates and deadlines.

1.3 Eligibility and Competitors

All-Phase Eligibility

1.3.1 This competition is open only to individuals; private entities (for-profits and nonprofits); nonfederal government entities such as states, counties, Tribes, and municipalities; and academic institutions, subject to the following requirements:

1.3.1.1 An individual prize competitor (who is not competing as a member of a group) must be a United States citizen or permanent resident.

1.3.1.2 A group of individuals competing as one team may win, provided that the online account holder of the submission is a United States citizen or permanent resident. Individuals competing as part of a team are eligible to participate if they are legally authorized to work in the United States.

1.3.1.3 Private entities must be incorporated in and maintain a primary place of business in the United States.

1.3.1.4 Academic institutions must be based in the United States and is accredited by a nationally recognized accrediting agency or association.

1.3.2 DOE employees and DOE support service contractors, employees of sponsoring organizations, members of their immediate families (e.g., spouses, children, siblings, or parents), and persons living in the same household as such persons, whether or not related, are not eligible to participate in the prize. Individuals who worked at DOE (federal employees or support service contractors) within 6 months prior to the submission deadline of any contest are not eligible to participate in the prize.

1.3.3 Federal entities and federal employees are not eligible to participate in any portion of the prize.

1.3.4 DOE national laboratory employees cannot compete in the prize.

1.3.5 Entities and individuals publicly banned from doing business with the United States government

such as entities and individuals debarred, suspended, or otherwise excluded from or ineligible for participating in federal programs are not eligible to compete.

1.3.6 Individuals participating in a foreign government talent recruitment program[1] sponsored by a country of risk[2] and teams that include such individuals are not eligible to compete.

1.3.7 Entities owned by, controlled by, or subject to the jurisdiction or direction of a government of a country of risk are not eligible to compete.

1.3.8 To be eligible, an individual authorized to represent the competitor must agree to and sign the following statement upon registration with HeroX:

> *I am providing this submission package as part of my participation in this prize. I understand that the information contained in this submission will be relied on by the federal government to determine whether to issue a prize to the named competitor. I certify under penalty of perjury that the named competitor meets the eligibility requirements for this prize competition and complies with all other rules contained in the official rules document. I further represent that the information contained in the submission is true and contains no misrepresentations. I understand false statements or misrepresentations to the federal government may result in civil and/or criminal penalties under 18 U.S.C. § 1001 and § 287, and 31 U.S.C. §§ 3729-3733 and 3801-3812.*

In keeping with the goal of growing a community of innovators, competitors are encouraged to form multidisciplinary teams while developing their concepts. The HeroX platform provides a space where parties interested in collaboration can post information about themselves and learn about others who are also interested in competing in this contest.

Phase 2 Eligibility

- Only winners of Phase 1 are eligible to compete in Phase 2.

Phase 3 Eligibility

- Only winners of Phase 2 are eligible to compete in Phase 3.

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[1] Foreign Government-Sponsored Talent Recruitment Program is defined as an effort directly or indirectly organized, managed, or funded by a foreign government, or a foreign government instrumentality or entity, to recruit science and technology professionals or students (regardless of citizenship or national origin, or whether having a full-time or part-time position). Some foreign government-sponsored talent recruitment programs operate with the intent to import or otherwise acquire from abroad, sometimes through illicit means, proprietary technology or software, unpublished data and methods, and intellectual property to further the military modernization goals and/or economic goals of a foreign government. Many, but not all, programs aim to incentivize the targeted individual to relocate physically to the foreign state for the above purpose. Some programs allow for or encourage continued employment at United States research facilities or receipt of federal research funds while concurrently working at and/or receiving compensation from a foreign institution, and some direct participants not to disclose their participation to U.S. entities. Compensation could take many forms including cash, research funding, complimentary foreign travel, honorific titles, career advancement opportunities, promised future compensation, or other types of remuneration or consideration, including in-kind compensation.

[2] DOE has designated the following countries as foreign countries of risk: Iran, North Korea, Russia, Belarus, and China. This list is subject to change.

2 Background

2.1 Prize Background

The Silicon Carbide (SiC) Packaging Prize is part of the American-Made program, which is your fast track to energy innovation. Funded by the U.S. Department of Energy and administered by the National Laboratory of the Rockies (NLR), American-Made transforms innovative ideas into real energy solutions through prizes, collegiate competitions, technical assistance vouchers, and opportunities to work with a network of experts.

The Silicon Carbide (SiC) Packaging Prize is funded by the DOE Office of Electricity - Applied Grid Transformation Solutions Program, Energy Delivery Grid Operations Technology Program, and Transformer Resilience and Advanced Components Program.

Silicon carbide devices have become prime candidates for future high-performance power electronics due to their high breakdown voltage, low switching loss, and high-temperature operation. However, conventional packaging techniques limit the performance of SiC power modules because of parasitic inductance and heat dissipation issues. To enable grid-based applications, SiC power modules need to be expanded to higher voltage and higher current ratings.

It is widely realized that SiC is now an established technology that is transforming the power industry in many applications across the industrial, energy, and automotive segments, with an impact ranging from watts up to megawatts.

SiC has many advantages over previous implementations of silicon and insulated-gate bipolar transistors (IGBTs), including higher switching frequencies, lower operating temperatures, higher current and voltage capacities, and lower losses, which lead to increased power density, reliability, and efficiency. And because of the cooler temperatures and smaller magnetics, thermal management and power components are now becoming smaller, lighter, and cheaper, thereby lowering total bill-of-materials costs while also enabling smaller footprints.

SiC has become a mature technology and a very common solution for systems requiring power delivery, particularly charging and discharging in energy storage applications like electric vehicle charging and solar systems with batteries. These kinds of systems usually contain several opportunities for SiC technology, such as DC/DC boost converters, bidirectional inverters (with both AC and DC elements), and flexible battery-charging circuitry. In summary, SiC enables up to 3% higher system efficiency, 50% higher power density, and a reduction in passive component volume and costs.[3]

2.2 Prize Phases

The Silicon Carbide (SiC) Packaging Prize contains three phases—Design Study, Initial Demonstration, and Final Demonstration—to incentivize expanded research and development as it relates to SiC semiconductor packaging in the energy marketplace.

Phase 1 – Design Study: Competitors will describe their team, explain their plan to make progress toward SiC semiconductor packaging, showcase their current prototypes, and provide evidence of their current metrics that are in alignment with the goals of the prize. The goal of this phase is to develop a set of design documents for a Phase 2 prototype that adheres to the requirements set in the Hardware and Testing Requirements described in Appendix B. Subsequent phases require physical prototypes and compatibility of those designs with the independent test facility. The Hardware and Testing Requirements

[3] The value of using SiC in Energy Storage Systems (ESS) | Wolfspeed

described in Appendix B is provided from the test facility that outlines requirements for interfacing with the test facility and for the design documents to be provided. Hence, the goal of Phase 1 is to establish a baseline design "kit," which is to be used in Phase 2 and which satisfies the documentation requirements outlined by the Hardware and Testing Requirements described in Appendix B.

Based on progress toward the Phase 1 performance targets, up to 10 winners will be selected to receive a $50,000 cash award each (total prize pool: $500,000) and to compete in Phase 2.

Phase 2 – Initial Demonstration: In Phase 2, winners from Phase 1 will showcase and demonstrate their advancements made during the prize competition in packaging solutions for SiC semiconductor modules that meet, exceed, or make progress toward the Phase 2 performance metrics as outlined in Table 1. This phase is designed to scale from the Phase 1 targets and act as a milestone toward eventually achieving the Phase 3 target of innovating an improvement over state-of-the-art packaging and creating transformative solutions. Winning teams are expected to meet or exceed the targets specified, but in the case where no teams meet or exceed the targets, we may consider teams for award with promising designs that score highly in the review, but whose prototypes do not hit the Phase 2 metrics.

In Phase 2, competitors will provide their prototype for testing at Oak Ridge National Laboratory. Please review Section 4.7 for the details on the prototype submission requirements for Phase 2.

Based on progress toward the Phase 2 performance targets, up to four winners will be selected to receive a $250,000 cash award each (total prize pool: $1,000,000). The winners will be eligible to compete in Phase 3.

Phase 3 – Final Demonstration: Competitors will demonstrate an advancement in packaging solutions for SiC semiconductor modules, meeting or exceeding the Phase 3 performance metrics as outlined in Table

1. The goal of the final phase is to achieve the high-voltage and high-current targets while continuing to innovate toward an improvement over state-of-the-art packaging and creating transformative solutions. We realize that the goals in Phase 3 are pushing the state of the art, but we expect winning teams to meet or exceed the target metrics. If there are no teams that meet or exceed the target metrics, DOE may choose to award the prize to the team that has made the most progress over the course of the prize, or the team that achieved metrics closest to the final metrics goal.

In Phase 3, competitors will provide their prototype for testing at Oak Ridge National Laboratory. Please review Section 5.7 for the details on the prototype submission requirements for Phase 3. Submissions will be evaluated based on progress toward the Phase 3 performance targets, and one winner will be selected at $750,000 cash award (total prize pool: $750,000).

Table 1: Performance metrics required for each phase of the prize.

Performance Metrics*		
Metric	Phase 2 Target	Phase 3 Target
Heat Flux**	500 W/cm^2	1,000 W/cm^2
Voltage Hold-Off***	4.5 kV	10 kV
Current Handling	1,500 A	2,000 A
Switching Characteristics	dI/dt > 80 A/ns dV/dt > 100 V/ns Voltage Overshoot < 5%	dI/dt > 150 A/ns dV/dt > 150 V/ns Voltage Overshoot < 5%
Max Case Temperature	85ºC	85ºC
Demonstrated Operational Time	90 minutes continuous at 20 kHz inductive switching	90 minutes continuous at 20 kHz inductive switching

** Benchmarked against a half-bridge module configuration with antiparallel diodes.*
*** Assumes liquid cooling.*
**** Using commercially available die ≤1,700 V rated.*

2.3 Prize Goal Requirements

Only submissions relevant to the goals of this program are eligible to compete. The prize administrator must conclude that all the following statements are true when applied to your submission:

- The proposed solution is related to the SiC Semiconductor packaging industry.
- The majority of activities that are described in and support the submission package are performed in the United States and have the potential to benefit the U.S. market.
- The proposed solution represents an innovation that will move the industry beyond its current state.
- The proposed solution is not dependent on new, pending, or proposed federal, state, or local government legislation, resolutions, appropriations, measures, or policies.
- The proposed solution does not involve the lobbying of any federal, state, or local government office.
- The proposed solution is based on fundamental technical principles and is consistent with a basic understanding of the U.S. market economy.
- The submission content sufficiently confirms the competitor's intent to commercialize early-stage technology and establish a viable U.S.-based business in the near future with revenues that do not solely depend on licensing fees of intellectual property.

2.4 Additional Requirements

Please read and comply with the additional requirements in Appendix A.

COMPETITORS WHO DO NOT COMPLY WITH THESE REQUIREMENTS MAY BE DISQUALIFIED.

3 Phase 1 – Design Study

3.1 Phase 1 Goal

In this phase, prize participants will describe their team, explain their plan to make progress toward developing SiC semiconductor packaging, and showcase any prototypes they have. As part of this phase, participants will provide evidence of a design prototype for an isolated SiC half-bridge module that meets or exceeds Phase 2 metrics.

3.2 Phase 1 Prizes

Based on progress toward the Phase 1 performance targets, up to 10 winners will be selected at $50,000 cash award each (total prize pool: $500,000).

3.3 How To Enter

Go to HeroX and follow the instructions for registering and submitting all required materials before the submission deadline. Competitors also have the ability to form teams or find partners through the HeroX platform.

3.4 Important Dates

Refer to the timeline on HeroX for relevant dates and deadlines.

3.5 What To Submit

A complete submission package for Phase 1 should include the following items:

- 90-second online video (public)
- Cover page and Narrative
- Submission Summary PowerPoint slide (public)
- Letters of commitment or support (optional).

All submission materials, except the online public video, should be submitted as a PDF.

The following details provide more guidance on what information to provide and how reviewers evaluate and score submissions. Reviewers will evaluate submissions by assigning a single score for each bulleted consideration statement in the narrative section, based on their overall agreement or disagreement with a series of statements. The scores are as follows:

1	2	3	4	5	6
Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree

3.5.1 Online Public Video (Will Be Made Public)

Online Public Video – *What's your team and solution, in 90 seconds?*	
Suggested content competitor provides: • Showcase the innovative nature of your team, work, and prototype. • Describe your solution, why it is transformational, and how you will meet the metrics in in prize. • Describe who you are (your organization and key team members) and why you have a competitive edge.	**A single score on a scale of 1–6 is provided, taking the following statements into consideration:** • The video showcases the work done to date and how the innovation works. • The video describes the current state of the prototype and explains how the team will advance the solution over time. • The video shows a knowledgeable and skillful team that is committed to completing the entire prize.

Post your publicly accessible video online (e.g., YouTube, Vimeo). Be creative and produce a video that conveys the required information in exciting and interesting ways, but do not focus on time-consuming activities that only improve production values (i.e., technical elements such as décor, lighting, and cinematic techniques). Assistance from others with experience in this area may be helpful. Members of the American-Made Network may be able to help you create your video.

3.5.2 Cover Page Content

List basic information about your submission, including:

- Project title
- Team name
- Short description
- Key project members (names, contacts, and links to their professional online profiles)
- Other partners (if any)
- Your city, state, and nine-digit ZIP code.

3.5.3 Narrative

You should answer each of the four questions in the following tables. The content bullets are only suggestions to guide your responses. You can decide where to focus your answers. The individual answers to the four questions do not have a word limit; however, the aggregate response to these four questions must not exceed 2,500 words, not including captions, figures/graphs, or references. A word count must be included at the end of your submission (see template for details). You may also include up to five supporting images, figures, or graphs. The reviewers will score the questions based on the content you have provided.

<table>
<tr><th colspan="2">Narrative
Max 2,500 words and 5 supporting images or figures (PDF)</th></tr>
<tr><th colspan="2">Question 1 – Team
Why is your team well positioned to deliver a SiC packaging solution?</th></tr>
<tr><td>Suggested content competitor provides:
Describe your team and why the team is capable of developing an impactful industry-ready SiC packaging solution.
Provide short bios for the team.
Provide information about similar projects or past technical approaches that provides evidence about the team's technical skills and experience.</td><td>Each bullet is scored on a scale of 1–6, taking the following statements into consideration:
The team is well-suited to be successful throughout the prize competition.
The team has past relevant experience and provided evidence that they have the skills to succeed.
The team possesses the capabilities needed.</td></tr>
<tr><th colspan="2">Question 2 – Solution
What makes your solution unique, relevant, and something that could be adopted by industry? Is your solution capable of achieving the metrics in Table 1 now, or is it likely your solution will achieve those metrics with further development during this prize?</th></tr>
<tr><td>Suggested content competitor provides:
Describe your solution in detail.
Provide information to explain why your solution is needed and why your solution is unique.
Explain why the SiC industry needs this packaging solution.
Provide diagrams, pictures, product designs and other information that will help describe your packaging solution.
Describe how your solution will meet or exceed the metrics requirements in Table 1.</td><td>Each bullet is scored on a scale of 1–6, taking the following statements into consideration:
The solution is novel and will make significant improvements in the industry.
The design and solution presented is likely to be successful in achieving the stated goals of this prize with further development during this prize.</td></tr>
</table>

Question 3 – Development Plan What is your plan for product development over the course of the prize and into the future?	
Suggested content competitor provides: • Describe the development plan that you will implement during the course of the prize. • Discuss how you will implement the plan, including timelines, partners, and milestones that will be achieved. • Describe how you will test the solution. • Describe what types of physical testing capabilities the project team possesses.	**Each bullet is scored on a scale of 1–6, taking the following statements into consideration:** • The proposed solution is viable, and the team should be able to make significant progress during the course of the prize toward the metrics in Table 1. • The plan, timelines, and milestones seem reasonable to achieve success. • The team has a solid plan to continue advancing the solution during the prize. • The testing capabilities the team has access to shows the ability to credibly evaluate stated performance.
Question 4 – Industry Integration What is your plan to develop this solution and integrate it into industry?	
Suggested content competitor provides: • Describe how your team will get industry buy-in for your solution. • Describe industry partners and pilot partners. • Describe your commercialization plan. • Describe your approach and how industry needs will inform product development.	**Each bullet is scored on a scale of 1–6, taking the following statements into consideration:** • The team demonstrates that they are building industry partnerships that will enable long-term success. • The solution is well-tailored to meet industry needs.

3.5.4 Submission Summary Slide (Will Be Made Public)

Make a public-facing, one-slide submission summary that introduces your team and/or organization and your mission. There is no template, so competitors are free to present the information in any format. Any text must be readable in a standard printed page and a conference room projection and should be in at least 14-pt font.

3.5.5 Letters of Support or Commitment (Optional)

Attach one-page letters (of support, intent, or commitment) from other relevant entities to provide context. Letters of support from partners or others that are critical to the success of your proposed solution will likely increase your score. General letters of support from parties that are not critical to the execution of your solution will likely not factor into your score. Please do not submit multipage letters.

3.6 How We Determine and Award Winners

The Prize Administrator screens all completed submissions and ensures that the teams are eligible. Then the Prize Administrator, in consultation with DOE, assigns subject-matter-expert reviewers who

independently score the content of each submission. The reviewers will be composed of federal and nonfederal subject matter experts with expertise in areas relevant to the competition. They will review the competitor's submission package according to the criteria above. A reviewer may not (1) have personal or financial interests in the competition; (2) be an employee, officer, director, or agent of any entity that is a registered participant in a competition; or (3) have a familial or financial relationship with an individual who is a registered participant.

3.6.1 Reviewer Panel Scoring

The scoring of submissions will proceed as follows:

- All reviewers are required to accept conflict of interest and nondisclosure terms prior to providing the reviews.
- Reviewers will review each submission individually and assess the response from the competitor to each bulleted consideration statement under the Online Public Video (Section 3.5.1) and the Narrative (Section 3.5.3).
- Reviewers will score each bulleted consideration statement on a scale from 1–6, depending on the degree to which the reviewer agrees that the submission reflects the statements for consideration.
- Each bulleted consideration statement will be added together to generate a total score for the submission.
- The total scores from each reviewer will be averaged to produce a final score for the competing team/organization. This score will inform the judge's decision on prize awards.

3.6.2 Interviews

DOE may decide to interview some or all of the competitors. The interviews would be held prior to the notification of the winners and would serve to help clarify questions the reviewers may have. Participating in interviews is not required, and interviews are not an indication of a competitor's likelihood of winning.

3.6.3 Final Determination

DOE will designate a federal employee as the judge before the final determination of the winners. Final determination of the winners by the judge will take into account the reviewers' feedback and scores, application of program policy factors as determined at the sole discretion of DOE, and the interview findings (if applicable).

3.6.4 Winner Notification

Approximately 60 days after the contest closes, the prize administrator will notify the winners and request the necessary information to distribute the prizes.

3.7 Additional Terms and Conditions

See Appendix A for additional requirements.

COMPETITORS THAT DO NOT COMPLY WITH THE ADDITIONAL REQUIREMENTS IN APPENDIX A MAY BE DISQUALIFIED.

4 Phase 2 – Initial Demonstration

4.1 Phase 2 Goal

This phase is designed to create a prototype that meets the Phase 2 targets. It is a milestone toward achieving the Phase 3 target with the goal of innovating an improvement over state-of-the-art packaging and creating transformative solutions. Winning teams are expected to meet or exceed the targets specified, but in the case where no teams meet or exceed the targets, the Prize Administrator and DOE may consider teams that are making improvements in their design and are close to meeting the targets as potential winners.

4.2 Phase 2 Prizes

Based on progress toward the Phase 2 performance targets, up to four winners will be selected at $250,000 cash award each (total prize pool: $1,000,000). Winners will be eligible to compete in Phase 3.

4.3 Phase 2 Requirements

Only competitors who win Phase 1 – Design Study are eligible to compete in Phase 2 – Initial Demonstration. In Phase 2 – Initial Demonstration, competitors will submit a prototype for performance testing at Oak Ridge National Laboratory. They will also submit documents outlining the progress they have made since their Phase 1 submission regarding developing their prototype, including challenges they have faced and any impacts those challenges have had on their design and/or performance goals. Further, they will describe their framework for the commercialization of their silicon carbide semiconductor packaging as well as their manufacturing plan, along with techno-economic analysis, including letters of support from potential commercial partners, if available.

4.4 How To Enter

To enter Phase 2 – Initial Demonstration, a competitor must:

- Send their silicon carbide semiconductor prototypes to the Oak Ridge National Laboratory testing facility. All submissions must be postmarked by a date to be determined by the end of Phase 1. Refer to Section 4.7.1 for more details. Early sample submittal to the national laboratory testing facility is strongly encouraged.
- Complete a final submission package (see Section 4.8) online at https://www.herox.com/SiCPackagingPrize by the submission date provided on HeroX.

4.5 Important Dates

Refer to the timeline on HeroX for relevant dates and deadlines.

4.6 Initial Demonstration Process

The Initial Demonstration Phase consists of the following steps:

1. **Progress and Submission** – Competitors develop prototypes and pathways to commercialization for their design submitted in Phase 1. Competitors create commercially relevant prototypes (i.e., a silicon carbide semiconductor prototype that is needed or useful as it relates to an already existing or soon-to-exist product, application, system, or device), aided by the Phase 2 – Initial Demonstration basic prototype performance testing services. Competitors also make meaningful progress in understanding cost and pricing, developing a business model, and creating a

commercialization and manufacturing plan. Competitors complete their submission packages and submit online before the phase closes.

Competitors will first develop their prototypes, complete the Silicon Carbide Semiconductor Prototype Testing Package, and send that package to Oak Ridge National Laboratory. The prototypes will be tested, and the results will be provided to the competitors, the Prize Administrators, DOE, and the expert reviewers.

Additionally, the competitors will submit the Final Submission Package.

- **Prototype Testing Submission Package**
  This submission package contains two parts (additional detail in Section 4.7):
  - Physical Prototype - The first will include the prototypes that will be sent to Oak Ridge National Laboratory.
  - Online Accompanying Documents - The second part is a submission package that is to be submitted via HeroX containing the Hardware and Testing Requirements described in Appendix B.

- **Final Submission Package**
  - The submission will consist of a cover page and narrative, a summary PowerPoint slide, and letters of commitment or support (optional). Please see Section 4.8 for more detail.

2. **Assessment –** The Prize Administrator screens submissions for eligibility and completion and assigns subject matter experts to independently score the content of each submission. The reviewers assess the competitor activities according to the following criteria:

   - **Prototype Performance –** How much the prototype has met or exceeded performance goals described in Table 2, and how much the prototype has proven/shown that it can integrate with the intended device/system.

   - **Commercialization and Manufacturing Readiness** – How much due diligence, techno-economic analysis, market assessment, and manufacturing readiness assessment the competitor has done and what plans and concrete steps the competitor has taken to create a solid pathway to commercialization.

3. **Announcement –** After the winners are publicly announced, the Prize Administrator notifies them and requests the necessary information to distribute cash prizes.

4.7 Prototype Testing Submission

A complete silicon carbide semiconductor prototype testing package should include the following items:

- **Physical Prototype Submission –** One complete and operational silicon carbide semiconductor prototype will be designated for testing at ORNL. To account for unforeseen technical, testing, or manufacturing acceptance issues with the prototypes, up to three complete, operational and identical prototypes may be submitted, though additional units will only be evaluated as need-based spares, and only a single set of test data will be compiled.

- **Online Accompanying Documents** – A completed Appendix B table submitted via HeroX for prototype performance testing.

Testing results will be used as a key evaluation factor in relation to the content included in all Phase 2 submission materials, specifically the performance of the prototype as it relates to the submitted prototype(s)'s ability to meet or exceed the performance specifications described in Table 2, as well as with the overall final submission package.

4.7.1 Physical Prototype Submission

All competitors are required to submit at least one and up to three prototypes of their silicon carbide semiconductor to Oak Ridge National Laboratory (ORNL) for prototype performance testing. The device should be a 4.5-kV/1,500-A power module that is composed of series- and parallel-connected 1.7-kV SiC MOSFETs. The module shall also have ancillary componentry necessary for interconnection (bus bars, ribbon bonds, screw terminals, etc.), thermal management (baseplate), and gate control (gate control circuit). Performance testing will be done to determine the prototype's ability to meet or exceed the specifications listed in Table 2 in Section 4.7.2. ORNL has been chosen as the testing organization to ensure fairness and comparability across all submissions.

The results from the testing are anticipated to be provided to the competitor via the Prize Administrator within approximately 3 months following the sample submission deadline. Please refer to the timeline on HeroX for relevant dates and deadlines.

It is the responsibility of the researcher at ORNL to examine the silicon carbide semiconductor prototypes upon receipt to determine if they are obviously untestable (e.g., broken, incomplete, improperly assembled, etc.). It is the responsibility of the competitor to confirm that the researcher at ORNL either received or did not receive the silicon carbide semiconductor prototypes, and if the silicon carbide semiconductor prototypes are NOT received or is obviously untestable, it is the competitor's responsibility to send a new prototype(s) by the prototype submission deadline.

Early submission of silicon carbide semiconductor prototypes is highly encouraged, as submissions postmarked after the prototype submission deadline will not be accepted. The prototype submission deadline date is provided on HeroX. The Silicon Carbide Packaging Prize is prepaying for the testing of eligible prototypes (i.e., met the HeroX registration deadline and overall prize eligibility; refer to Section 1.3).

Testing results will be sent directly to the Prize Administrator, who will share individual results privately with each competitor.

Competitors are responsible for the cost to ship their prototypes to the test laboratory; however, the Prize Administrator will pay for the return shipping of prototypes to competitors following testing. It is the intention of the Prize Administrator to ensure that all prototypes are returned to competitors. However, it is agreed to and understood by the competitors that the prototypes may be destroyed and/or become unusable in the process of the testing, shipping, or handling of the prototypes. Therefore, competitors agree that DOE, the National Laboratory of the Rockies, Oak Ridge National Laboratory, American-Made, or any DOE or national lab employee is not at fault if the provided prototypes are returned in broken, damaged, or unusable condition.

Each competitor shall submit at least one, but up to three, identical silicon carbide semiconductor prototypes that meet the hardware requirement as described in Appendix B, Section B.1. The testing facility (ORNL) cannot and will not test protypes that fall outside of these parameters.

Mailing instructions: Competitors should package prototypes appropriately to shield against damage during shipping. Once shipped, competitors must email the testing laboratory and copy the Prize Administrator (electricity.prize@nlr.gov) with confirmation of shipment, team name, submission title, team

captain name and contact, and tracking number. Contact and shipping information for the testing laboratory will be provided to registered eligible competitors after Phase 2 – Initial Demonstration opens.

Competitors should also provide their return mailing information to have their samples returned to them following testing, including:

- Name
- Company
- Address
- State
- ZIP code
- Phone number

Please note that DOE, NLR, and ORNL are not responsible for any damage to the sample, nor are they responsible should the sample be unable to be tested for any reason.

4.7.2 Performance Testing

As part of the prototype testing submission package, competitors must submit at least one and up to three identical prototypes that can demonstrate a packaging solution meeting or exceeding the Phase 2 performance metrics as outlined in Table 2 below. Testing results will be taken into consideration by DOE when determining winners.

Table 2: Performance metrics required for Phase 2 – Initial Demonstration.

Performance Metrics*		
	Phase 2 Target	Weighted
Heat Flux (W/cm^2)**	500	15%
Voltage Hold-Off***	4.5 kV	35%
Current Handling	1,500 A	15%
Switching Characteristics	dI/dt > 80 A/ns dV/dt > 100 V/ns Voltage Overshoot < 5%	15%
Max Case Temperature	85°C	10%
Demonstrated Operational Time	90 minutes continuous at 20 kHz inductive switching	10%

** Benchmarked against a full-bridge module configuration with antiparallel diodes.*
*** Assumes liquid cooling.*
**** Using commercially available die ≤1,700 V rated*

4.7.3 Online Accompanying Documents

In addition to the prototypes mailed directly to ORNL, competitors must complete and submit the Testing Requirements section of Appendix B. This information will be shared with the researchers at Oak Ridge National Laboratory doing the testing and will be provided to our external panel of reviewers.

4.8 Final Submission Package

A complete submission package for Phase 2 – Initial Demonstration should include the following items:

- Cover page and Narrative
- Submission Summary PowerPoint slide (public)
- Letters of commitment or support (optional).

All submission materials, except the online public video, should be submitted as a PDF

The following details provide more guidance on what information to provide and how reviewers will evaluate and score your submission. Reviewers will evaluate your submission by assigning a score for each bulleted consideration statement in the narrative section, based on their overall agreement or disagreement with a series of statements.

1	2	3	4	5	6
Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree

4.8.1 Cover Page Content

List basic information about your submission, including:

- Project title
- Team name
- Short description
- Key project members (names, contacts, and links to their professional online profiles)
- Other partners (if any)
- Your city, state, and nine-digit ZIP code.

4.8.2 Narrative

You should answer each of the following questions. The content bullets are only suggestions to guide your responses. You decide where to focus your answers. The individual answers to the questions do not have a word limit; however, the aggregate response to these questions must not exceed 2,500 words, not including captions, figures/graphs, or references. A word count must be included at the end of your submission (see template for details). You may also include up to five supporting images, figures, or graphs. The reviewers will score the questions based on the content you have provided.

<table>
<tr><th colspan="2">Narrative
Max 2,500 words and 5 supporting images or figures (PDF)</th></tr>
<tr><th colspan="2">Question 1
How did the proposed technology meet or fail to meet the metrics in Table 2?</th></tr>
<tr><td>Suggested content competitor provides:
Evaluate testing data to show satisfaction of metrics described in Table 2.
Evaluate any metrics from Table 2 that were not met and how those failures will be addressed forward.
Identify any limiting features in package design that contributed to missed metrics or underperformance compared to theoretical predictions.
Describe the design approach, process, and material novelties that supported this design meeting the proposed metrics.</td><td>Each bullet is scored on a scale of 1–6, taking the following statements into consideration:
The team has correctly identified areas of needed improvement.
Suggested means of correction appear valid and achievable.
The team has proposed a reasonable design change to will most likely meet the proposed metrics.</td></tr>
<tr><th colspan="2">Question 2
What design changes are needed to accommodate and/or to fully achieve Phase 3 metrics?</th></tr>
<tr><td>Suggested content competitor provides:
Identify any limiting features in package design.
Quantify any limiting features via analytical analysis, simulation and/or experimental testing.
Of the issues identified in Phase 2, how will the changes proposed by your team affect the design approach for Phase 3.</td><td>Each bullet is scored on a scale of 1–6, taking the following statements into consideration:
The team has correctly identified areas of limitations.
The team has proposed a reasonable design to meet Phase 3 technical metrics.</td></tr>
</table>

Question 3 What steps will you need to take to manufacture your product at a scale that is relevant to industry?	
Suggested content competitor provides: • Identify compatibility of proposed package design with current high-volume manufacturing techniques. • Identify any changes to typical high-volume manufacturing processes that would be required to enable realistic manufacture of the package design.	**Each bullet is scored on a scale of 1–6, taking the following statements into consideration:** • The proposed plan will allow for manufacturing of 10,000 units per year. • The new process identified for design incorporation into current high-volume manufacturing practices is realistic and achievable.
Question 4 What issues does your group see as barriers to commercialization for your prototype? What possible solutions have you considered to these barriers?	
Suggested content competitor provides: • Identify any issues with possible transition of technology to industry. • Is this approach suitable for multiple device vendors and standard commercially available configurations?	**Each bullet is scored on a scale of 1–6, taking the following statements into consideration:** • Project team has demonstrated either no issues with industry uptake of technology or realistic solutions to any proposed issues. • The proposed solution is applicable across a wide range of commercially available configurations of semiconductors.
Question 5 Are all the materials and components you used for your test prototype readily available?	
Suggested content competitor provides: • Identify any issues with supply chain and material sourcing. • Quantify the impact of novel materials and processes used in the prototype as compared to current state of the art.	**Each bullet is scored on a scale of 1–6, taking the following statements into consideration:** • Project team has demonstrated either a robust supply chain or realistic alternatives to any proposed supply chain limitations.

Question 6 What has your team accomplished over this phase of the prize?	
Suggested content competitor provides: • Identify any design changes that occurred between Phases 1 and 2. • Identify any iterative testing designs and any applicable analytical analysis, simulation, and/or testing results. • Evaluate and quantify the effect of any design change using analytical equations, simulations, and/or experimental results.	**Each bullet is scored on a scale of 1–6, taking the following statements into consideration:** • Project team has demonstrated iterative improvement in proposed packaging solutions. • Team has quantified improvement using analytical, simulation or experimental tools yielding credible and realistic results.
Reviewer Recommendation	
There is no direct corresponding submission requirement for this score. Rather, it is an overall assessment of all materials submitted in HeroX.	**A single score on a scale of 1–6 is provided, taking the following statements into consideration:** • The innovation, team, and plan should be strongly considered for a prize.

4.8.3 Submission Summary Slide *(Will Be Made Public)*

Make a public-facing, one-slide submission summary that introduces your team and/or organization and your mission. There is no template, so competitors are free to present the information in any format. Any text must be readable in a standard printed page and a conference room projection and should be in at least 14-pt font.

4.8.4 Letters of Support or Commitment *(Optional)*

Attach one-page letters (of support, intent, or commitment) from other relevant entities to provide context. Letters of support from partners or others that are critical to the success of your proposed solution will likely increase your score. General letters of support from parties that are not critical to the execution of your solution will likely not factor into your score. Please do not submit multipage letters.

4.9 How We Determine and Award Winners

The Prize Administrator screens all completed submissions and ensures that the teams are eligible. Then the Prize Administrator, in consultation with DOE, assigns subject-matter-expert reviewers who independently score the content of each submission. The reviewers will be composed of federal and nonfederal subject matter experts with expertise in areas relevant to the competition. They will review the competitor's submission package according to the criteria above.

4.9.1 Reviewer Panel Scoring

The scoring of submissions will proceed as follows:

- Reviewers will review each submission individually and assess the competitor's response to each bulleted consideration statement under the Narrative and the Reviewer

Recommendation (both in Section 4.8.2).

- Reviewers will score each bulleted consideration statement on a scale of 1–6, depending on the degree to which the reviewer agrees that the submission reflects the statements for consideration.
- Each bulleted consideration statement will be added together to generate a total score for the submission.
- The total scores from each reviewer will be averaged to produce a final score for the competing team/organization. This score will inform DOE's decisions on prize awards.

4.9.2 Interviews

DOE may decide to interview some or all of the competitors. The interviews would be held prior to the notification of the winners and would serve to help clarify questions the reviewers may have. Participating in interviews is not required, and interviews are not an indication of a competitor's likelihood of winning.

4.9.3 Final Determination

DOE will designate a federal employee as the judge before the final determination of the winners. Final determination of the winners by the judge will take into account the reviewers' feedback and scores, application of program policy factors as determined at the sole discretion of DOE, and the interview findings (if applicable).

4.9.4 Winner Notification

Approximately 60 days after the contest closes, the Prize Administrator will notify the winners and request the necessary information to distribute the prizes.

4.10 Additional Terms and Conditions

See Appendix A for additional requirements.

COMPETITORS THAT DO NOT COMPLY WITH THE ADDITIONAL REQUIREMENTS IN APPENDIX A MAY BE DISQUALIFIED.

5 Phase 3 – Final Demonstration

5.1 Phase 3 Goal

The goal of the final phase is to achieve the high voltage and high current targets, while continuing to innovate toward an improvement over state-of-the-art packaging and creating transformative solutions. We realize that the goals in Phase 3 are pushing the state-of-the-art, but we expect winning teams to meet or exceed the target metrics. If there are no teams that meet or exceed the target metrics, DOE may choose to award the prize to the team that has made the most progress over the course of the prize, or the team that achieved metrics closest to the final metrics goal. DOE also reserves the right adjust the final prize down based on results achieved.

5.2 Phase 3 Prizes

Based on progress toward the Phase 3 performance targets, one winner will be selected at up to $1,000,000 cash award (total prize pool: $1,000,000).

5.3 Phase 3 Requirements

Only competitors who win Phase 2 – Initial Demonstration are eligible to compete in Phase 3 – Final Demonstration. In Phase 3 – Final Demonstration, competitors will submit a prototype for performance testing at the national labs. They will also submit documents outlining the progress they have made since their Phase 2 submission regarding developing their prototype including challenges they have faced and any impacts that has had on their design and/or performance goals. Further, they will describe their framework toward the commercialization of their silicon carbide semiconductor packaging as well as their manufacturing plan, along with techno-economic analysis, including letters of support from potential commercial partners, if available.

5.4 How to Enter

To enter Phase 3 – Final Demonstration, a competitor must:

- Send their silicon carbide semiconductor prototypes to the approved national laboratory testing facility. All submissions must be postmarked by a date to be determined by the end of Phase 2. Refer to Section 5.7.1 for more details. Early sample submittal to the national laboratory testing facility is strongly encouraged.
- Complete a final submission package (see Section 5.8) online at https://www.herox.com/SiCPackagingPrize by a date to be determined by the end of Phase 2.

5.5 Important Dates

Refer to the timeline on HeroX for relevant dates and deadlines.

5.6 Final Demonstration Process

The Final Demonstration Phase consists of the following steps:

1. **Progress and Submission –** Competitors develop prototypes and pathways to commercialization of their design submitted in Phase 1. Competitors create commercially relevant prototypes (i.e., a silicon carbide semiconductor prototype that is needed or useful as it relates to an already existing or soon-to-exist product, application, system, or device), aided by the Phase 2 – Initial Demonstration basic prototype performance testing services. Competitors also make meaningful progress in understanding cost and pricing, developing a business model, and creating a

commercialization and manufacturing plan. Competitors complete their submission packages and submit online before the phase closes.

Competitors will develop their prototypes, complete the Silicon Carbide Semiconductor Prototype Testing Package, and send that package to Oak Ridge National Laboratory. The prototypes will be tested, and the results will be provided to the competitors, the Prize Administrators, DOE, and the expert reviewers.

Additionally, the competitors will submit the Final Submission Package.

There are two submission packages required for Phase 3 – Final Demonstration:

- Prototype Testing Submission Package (Refer to the timeline on HeroX for relevant deadline). This submission package will be two parts. See Section 5.7 for more detail.
    - Physical Prototype - The first will include the prototypes that will be sent to Oak Ridge National Laboratory.
    - Online Accompanying Documents - The second part is a submission package that is to be submitted via HeroX containing the Hardware & Testing Requirements described in Appendix 2.
- Final Submission Package (Refer to the timeline on HeroX for relevant deadline)
    - The submission will consist of a cover page and narrative, a summary PowerPoint slide, and letters of commitment or support (optional). Please see Section 5.8 for more detail.

2. **Assessment –** The Prize Administrator screens submissions for eligibility and completion and assigns subject-matter expert reviewers to independently score the content of each submission. The reviewer criteria assess the following competitor activities:
    - Prototype Performance – How much the prototype has met or exceeded performance goals described in Table 3, and how much the prototype has proven/shown that it can integrate with the intended device/system.
    - Commercialization and Manufacturing Readiness – How much due diligence, techno-economic analysis, market assessment, and manufacturing readiness assessment the competitor has done and what plans and concrete steps the competitor has taken to create a solid pathway to commercialization.
3. **Announcement –** After the winners are publicly announced, the Prize Administrator notifies them and requests the necessary information to distribute cash prizes.

5.7 Prototype Testing Submission

A complete silicon carbide semiconductor prototype testing package should include the following items:

- Physical Prototype Submission – At least one, but up to three, complete, operational and identical silicon carbide semiconductor prototypes provided to Oak Ridge National Laboratory.
- Online Accompanying Documents – A completed Appendix B table submitted via HeroX for prototype performance testing.

Testing results will be used as a key evaluation factor in relation to the content included in all Phase 3 submission materials, specifically the performance of the prototype as it relates to meeting or exceeding the performance specifications described in Table 3, as well as with the overall final submission package.

5.7.1 Physical Prototype Submission

All competitors are required to submit at least one and up to three prototypes of their silicon carbide semiconductor to Oak Ridge National Laboratory (ORNL) for prototype performance testing. The device should be a 10-kV/2,000-A power module that is composed of series- and parallel-connected 1.7-kV SiC MOSFETs. The module shall also have ancillary componentry necessary for interconnection (bus bars, ribbon bonds, screw terminals, etc.), thermal management (baseplate), and gate control (gate control circuit). Performance testing will be done to determine the prototype's ability to meet or exceed the specifications listed in Table 3. ORNL has been chosen as the testing organization to ensure fairness and comparability across all submissions.

The results from the testing are anticipated to be provided to the competitor via the Prize Administrator within approximately 3 months following the sample submission deadline. Please refer to the timeline on HeroX for relevant dates and deadlines.

It is the responsibility of the researcher at ORNL to examine the silicon carbide semiconductor prototypes upon receipt to determine if they are obviously untestable (e.g., broken, incomplete, improperly assembled, etc.). It is the responsibility of the competitor to confirm that the researcher at ORNL either received or did not receive the silicon carbide semiconductor prototypes, and if the silicon carbide semiconductor prototypes are NOT received or is obviously untestable, it is the competitor's responsibility to send a new prototype(s) by the prototype submission deadline.

Early submission of silicon carbide semiconductor prototypes is highly encouraged, as submissions postmarked after the prototype submission deadline will not be accepted. The prototype submission deadline date is provided on HeroX. The Silicon Carbide Packaging Prize is pre-paying for the testing of eligible prototypes (i.e., met the HeroX registration deadline and overall prize eligibility; refer to Section 1.3).

Testing results will be sent directly to the Prize Administrator, who will share individual results privately with each competitor.

Competitors are responsible for the cost of shipping their prototypes to the test laboratory; however, the Prize Administrator will pay for the return shipping of prototypes to competitors following testing. It is the intention of the Prize Administrator to ensure that all prototypes are returned to competitors. However, it is agreed to and understood by the competitors that the prototypes may be destroyed and/or become unusable in the process of the testing, shipping, or handling of the prototypes. Therefore, competitors agree that the Department of Energy (DOE), the National Laboratory of the Rockies, Oak Ridge National Laboratory, American-Made, or any DOE or national lab employee is not at fault if the provided prototypes are returned in broken, damaged, or unusable condition.

Each competitor shall submit at least one, but up to three, identical silicon carbide semiconductor prototypes that meet the hardware requirement as described in Appendix B, Section B.1. The testing facility (ORNL) cannot and will not test protypes that fall outside of these parameters.

Mailing instructions: Competitors should package prototypes appropriately to shield against damage during shipping. Once shipped, competitors must email the testing laboratory and copy the Prize Administrator (electricity.prize@nlr.gov) with confirmation of shipment, team name, submission title, team captain name and contact, and tracking number. Contact and shipping information for the testing laboratory will be provided to registered eligible competitors after the Phase 3 – Final Demonstration opens.

Competitors should also provide their return mailing information in order to have their samples returned to them following testing, including:

- Name
- Company
- Address
- State
- ZIP code
- Phone number.

Please note that DOE, NLR, and ORNL are not responsible for any damage to the sample, nor are they responsible should the sample be unable to be tested for any reason.

5.7.2 Performance Testing

As part of the prototype testing submission package, competitors must submit at least one and up to three identical prototypes that can demonstrate a packaging solution meeting or exceeding the Phase 3 performance metrics as outlined in Table 3. Testing results will be taken into consideration by DOE when determining winners.

Table 3: Performance metrics required for Phase 3 – Final Demonstration.

Performance Metrics*		
	Phase 3 Target	Weighted
Heat Flux (W/cm^2)**	1,000	15%
Voltage Hold-Off***	10 kV	35%
Current Handling	2,000 A	15%
Switching Characteristics	dI/dt > 150 A/ns dV/dt > 150 V/ns Voltage Overshoot < 5%	15%
Max Case Temperature	85°C	10%
Demonstrated Operational Time	90 minutes continuous at 20 kHz inductive switching	10%

** Benchmarked against a full-bridge module configuration with antiparallel diodes.*
*** Assumes liquid cooling.*
**** Using commercially available die ≤ 1700 V rated*

5.7.3 Online Accompanying Documents

In addition to the prototypes mailed directly to ORNL, competitors must complete and submit the Testing Requirements section of Appendix B.

This information will be shared with the researchers at Oak Ridge National Laboratory doing the testing and will be provided to our external panel of reviewers.

5.8 Final Submission

A complete submission package for Phase 3 should include the following items:

- Cover page and Narrative
- Summary PowerPoint slide (public)
- Letters of commitment or support (optional).

All submission materials, except the online public video, should be submitted as a PDF.

The following details provide more guidance on what information to provide and how reviewers will evaluate and score your submission. Reviewers will evaluate your submission by assigning a score for each bulleted consideration statement in the narrative section, based on their overall agreement or disagreement with a series of statements.

0	1	2	3	4	5	6
Non-Responsive	Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree

5.8.1 Cover Page Content

List basic information about your submission, including:

- Project title
- Team name
- Short description
- Key project members (names, contacts, and links to their professional online profiles)
- Other partners (if any)
- Your city, state, and nine-digit ZIP code.

5.8.2 Narrative

You should answer each of the following questions. The content bullets are only suggestions to guide your responses. You decide where to focus your answers. The individual answers to the questions do not have a word limit; however, the aggregate response to these four questions must not exceed 5,000 words, not including captions, figures/graphs, or references. A word count must be included at the end of your submission (see template for details). You may also include up to ten supporting images, figures, or graphs. The reviewers will score the questions based on the content you have provided.

Narrative

Max 5,000 words and 10 supporting images or figures (PDF)

Question 1

How has your team progressed toward developing a packaging solution according to the metrics in Table 3?

Suggested content competitor provides:	Each bullet is scored on a scale of 0–6, taking the following statements into consideration:
• Identify any design changes that occurred between Phases 2 and 3. • Identify any iterative testing designs and any applicable analytical analysis, simulation, and/or testing results. • Evaluate and quantify the effect of any design change using analytical equations, simulations, and/or experimental results.	• Project team has demonstrated iterative improvement in proposed packaging solutions. • The team has quantified improvement using analytical, simulation or experimental tools.

Question 2

What are the steps you will need to take to manufacture the product at scale?

Suggested content competitor provides:	Each bullet is scored on a scale of 0–6, taking the following statements into consideration:
• Identify compatibility of proposed package design with current high-volume manufacturing techniques. • Identify any changes to typical high-volume manufacturing that would be required to enable realistic manufacture of the package design.	• The team has sufficiently addressed high-volume manufacturing. • If a new process is identified, the team has described a realistic and achievable process for incorporation into current high volume manufacturing practices.

Question 3

What are the risks for large-scale manufacturing and how would you mitigate them?

Suggested content competitor provides:	Each bullet is scored on a scale of 0–6, taking the following statements into consideration:
• Identify roadblocks to adoption of this technology and potential mitigation pathways.	• The team has adequately addressed perceived barriers and suggested mitigation pathways are well conceived.

Question 4 What is your plan to develop this solution and integrate it into industry?	
Suggested content competitor provides: • Describe how your team will get industry buy-in for your solution. • Describe any industry partners and pilot partners. • Describe your industry integration plan and plans for the future beyond the prize.	**Each bullet is scored on a scale of 0–6, taking the following statements into consideration:** • The team demonstrated that they are building industry partnerships that will enable their long-term success. • The solution has been proven to be needed by industry.
Reviewer Recommendation	
There is no direct corresponding submission requirement for this score. Rather, it is an overall assessment of all materials submitted in HeroX.	**A single score on a scale of 0–6 is provided, taking the following statements into consideration:** • The innovation, team, and plan should be strongly considered for a prize.

5.8.3 Submission Summary Slide *(Will Be Made Public)*

Make a public-facing, one-slide submission summary that introduces your team and/or organization and your mission. There is no template, so competitors are free to present the information in any format. Any text must be readable in a standard printed page and a conference room projection and should be in at least 14-pt font.

5.8.4 Letters of Support or Commitment *(Optional)*

Attach one-page letters (of support, intent, or commitment) from other relevant entities to provide context. Letters of support from partners or others that are critical to the success of your proposed solution will likely increase your score. General letters of support from parties that are not critical to the execution of your solution will likely not factor into your score. Please do not submit multipage letters.

5.9 How We Determine and Award Winners

The Prize Administrator screens all completed submissions and ensures that the teams are eligible. Then the Prize Administrator, in consultation with DOE, assigns subject-matter-expert reviewers who independently score the content of each submission. The reviewers will be composed of federal and nonfederal subject matter experts with expertise in areas relevant to the competition. They will review the competitor's submission package according to the criteria above.

5.9.1 Reviewer Panel Scoring

The scoring of submissions will proceed as follows:

- Reviewers will review each submission individually and assess the competitor's response to each bulleted consideration statement under the Narrative (Section 5.8.2) and the Reviewer Recommendation (Section 5.8.2).
- Reviewers will score each bulleted consideration statement on a scale from 0–6, depending on the degree to which the reviewer agrees that the submission reflects the statements for consideration.
- Each bulleted consideration statement will be added together to generate a total score for the submission.
- The total scores from each reviewer will be averaged to produce a final score for the competing team/organization. This score will inform DOE's decisions on prize awards.

5.9.2 Interviews

DOE may decide to interview some or all of the competitors. The interviews would be held prior to the notification of the winners and would serve to help clarify questions the reviewers may have. Participating in interviews is not required, and interviews are not an indication of a competitor's likelihood of winning.

5.9.3 Final Determination

DOE will designate a federal employee as the judge before the final determination of the winners. Final determination of the winners by the judge will take into account the reviewers' feedback and scores, application of program policy factors as determined at the sole discretion of DOE, and the interview findings (if applicable).

5.9.4 Winner Notification

Approximately 60 days after the contest closes, the Prize Administrator will notify the winners and request the necessary information to distribute the prizes.

5.10 Additional Terms and Conditions

See Appendix A for additional requirements.

COMPETITORS THAT DO NOT COMPLY WITH THE ADDITIONAL REQUIREMENTS IN APPENDIX A MAY BE DISQUALIFIED.

Appendix A: Additional Terms and Conditions

A.1 Requirements

Your submission for the prize is subject to the following terms and conditions:

- You must post the final content of your submission or upload the submission form online by 5 p.m. E.T. on the prize submission deadline date, before the prize's phase submission period closes. Late submissions or any other form of submission may be rejected.
- You must include all the required elements in your submission. The prize administrator may disqualify your submission after an initial screening if you fail to provide all required submission elements. At the sole discretion of DOE, competitors may be given an opportunity to rectify submission errors due to technical challenges.
- Your submission must be in English and in a format readable by Microsoft Word or Adobe PDF. Scanned handwritten submissions will be disqualified.
- Submissions will be disqualified if they contain any matter that, in the sole discretion of the U.S. Department of Energy (DOE) or the National Laboratory of the Rockies (NLR), is indecent, obscene, defamatory, libelous, and/or lacking in professionalism.
- If you click "Accept" on the HeroX platform and proceed to register for any of the prizes described in this document, these rules will form a valid and binding agreement between you and DOE and are in addition to the existing HeroX Terms of Use for all purposes relating to these contests. You should print and keep a copy of these rules. These provisions only apply to the prize described here and no other prize on the HeroX platform or anywhere else.
- The prize administrator, when feasible, may give competitors an opportunity to fix nonsubstantive mistakes or errors in their submission packages.
- As part of your submission to this prize, you will be required to sign the following statement:

> I am providing this submission package as part of my participation in this prize. I understand that the information contained in this submission will be relied on by the federal government to determine whether to issue a prize to the named competitor. I certify under penalty of perjury that the named competitor meets the eligibility requirements for this prize competition and complies with all other rules contained in the official rules document. I further represent that the information contained in the submission is true and contains no misrepresentations. I understand false statements or misrepresentations to the federal government may result in civil and/or criminal penalties under 18 U.S.C. § 1001 and § 287, and 31 U.S.C. §§ 3729-3733 and 3801-3812.

ALL DECISIONS BY DOE ARE FINAL AND BINDING IN ALL MATTERS RELATED TO THE PRIZE.

A.2 Verification for Payments

The prize administrator will verify the identity and role of competitors before distributing any prizes. Receiving a prize payment is contingent upon fulfilling all requirements contained herein. The prize administrator will notify winning competitors using provided email contact information for the individual or entity that was responsible for the submission. Each competitor will be required to sign and return to the prize administrator, within 30 days of the date on the notice, a completed NLR Request for ACH Banking Information form and a completed W-9 form (https://www.irs.gov/pub/irs-pdf/fw9.pdf). In the sole discretion of the prize administrator, a winning competitor will be disqualified from the competition and receive no prize funds if: (i) the person/entity does not respond to notifications, (ii) the person/entity fails to sign and return the required documentation within the required time period, (iii) the notification is returned as undeliverable, (iv) the submission or person/entity is disqualified for any other reason.

In the event of a dispute as to any registration, the authorized account holder of the email address used

to register will be deemed to be the competitor. The "authorized account holder" is the natural person or legal entity assigned an email address by an internet access provider, online service provider, or other organization responsible for assigning email addresses for the domain associated with the submitted address. All competitors may be required to show proof of being the authorized account holder.

A.3 Teams and Single-Entity Awards

The prize administrator will award a single dollar amount to the designated primary submitter, whether consisting of a single entity or multiple entities. The primary submitter is solely responsible for allocating any prize funds among its member competitors or teammates as they deem appropriate. The prize administrator will not arbitrate, intervene, advise on, or resolve any matters or disputes between team members or competitors.

A.4 Treatment of Submission Materials

The elements of the submission that are designated as public will become publicly available as part of this prize. Therefore, these elements must not include trade secrets or business-sensitive, proprietary, or otherwise confidential information.

If it is necessary to share trade secrets or business-sensitive, proprietary, or otherwise confidential information, it should only be done in an element that is NOT designated as public. Any confidential, proprietary, or privileged information must be marked as described below. Failure to comply with these marking requirements may result in the disclosure of the unmarked information under the Freedom of Information Act or otherwise.

The submission must be marked as follows and identify the specific pages containing trade secrets or confidential, proprietary, or privileged information:

> "Notice of Restriction on Disclosure and Use of Data: Pages [list applicable pages] of this document may contain trade secrets or confidential, proprietary, or privileged information that is exempt from public disclosure. Such information shall be used or disclosed only for evaluation purposes. [End of Notice]"

The header and footer of every page that contains confidential, proprietary, or privileged information must be marked as follows: "Contains Trade Secrets or Confidential, Proprietary, or Privileged Information Exempt from Public Disclosure." In addition, each line or paragraph containing proprietary, privileged, or trade secret information must be clearly marked with double brackets.

DOE, the prize administrator, and any other third-party supporting DOE in the contest assume no liability for the public disclosure of any information in the elements designated public and for any unmarked information any element NOT designated as public.

Furthermore, by making a submission and consenting to the rules of the prize the competitor is granting to DOE, the Prize Administrator, and any other third parties supporting DOE in the contest, a license to display publicly and use the elements of the submission that are designated as public and any unmarked information in the elements of the submission that are NOT designated as public for government purposes, including posting or linking elements on websites or publicizing the submissions and competitors in the media and other announcements. The competitor is granting to DOE, the Prize Administrator, and other third parties a limited license to use or disclose any properly marked information for evaluation purposes only.

A.5 Representation and Warranties

By entering, the competitor represents and warrants that:

1. The competitor's entire submission is an original work by the competitor and the competitor has not included third-party content (such as writing, text, graphics, artwork, logos, photographs, likeness of any third party, musical recordings, clips of videos, television programs, or motion pictures) in or in connection with the submission, unless (i) otherwise requested by the prize

administrator or disclosed by the competitor in the submission, and (ii) the competitor has acquired the necessary rights to use and to authorize others, including DOE, to use the submission, as specified throughout the rules.

2. To the best of the competitor's knowledge, the use of the submission in the prize, including any use by DOE or the prize administrator, does not and will not infringe upon or violate any rights of any third party or entity, including, without limitation, patent, copyright, trademark, trade secret, defamation, privacy, publicity, false light, misappropriation, intentional or negligent infliction of emotional distress, confidentiality, or any contractual or other rights.

3. All persons who were engaged by the competitor to work on the submission or who appear in the submission in any manner have:

    A. Given the competitor their express written consent to submit the submission for exhibition and other exploitation in any manner and in any and all media, whether now existing or hereafter discovered, throughout the world;
    B. Provided written permission to include their name, image, or pictures in or with the submission (or, if a minor who is not the competitor's child, the competitor must have the permission of the minor's parent or legal guardian) and the competitor may be asked by the prize administrator to provide permission in writing; and
    C. Not been and are not currently under any union or guild agreement that results in any ongoing obligations resulting from the use, exhibition, or other exploitation of the submission.

4. The submission is free of malware.

A.6 Contest Subject to Applicable Law

All contests are subject to all applicable federal laws and regulations. Participation constitutes each participant's full and unconditional agreement to these official rules and administrative decisions, which are final and binding in all matters related to the contest. This notice is not an obligation of funds; the final award is contingent upon the availability of appropriations.

A.7 Resolution of Disputes

DOE is solely responsible for administrative decisions, which are final and binding in all matters related to the contest.

Neither DOE nor the prize administrator will arbitrate, intervene, advise on, or resolve any matters between team members or among competitors.

A.8 Publicity

The winners of these prizes (collectively, "winners") will be featured on DOE and NLR websites.

Except where prohibited, participation in the contest constitutes each winner's consent to DOE's and its agents' use of each winner's name, likeness, photograph, voice, opinions, and/or hometown and state information for promotional purposes through any form of media worldwide, without further permission, payment, or consideration. Additionally, except where prohibited, participation in the contest constitutes each of the winning competitor's agreement to provide a written publicity release to the prize administrator to evidence the winning competitor's consent if requested by the prize administrator.

A.9 Liability

Upon registration, all participants agree to assume any and all risks of injury or loss in connection with or in any way arising from participation in this contest. Upon registration, except in the case of willful misconduct, all participants agree to and, thereby, do waive and release any and all claims or causes of action against the federal government and its officers, employees, and agents for any and all injury and damage of any nature whatsoever (whether existing or thereafter arising; whether direct, indirect, or

consequential; and whether foreseeable or not) arising from their participation in the contest, whether the claim or cause of action arises under contract or tort.

In accordance with the delegation of authority to run this contest delegated to the judge responsible for this prize, the judge has determined that no liability insurance naming DOE as an insured will be required of competitors to compete in this competition per 15 U.S.C. § 3719(i)(2). Competitors should assess the risks associated with their proposed activities and adequately insure themselves against possible losses. Competitors shall indemnify the Federal Government against third party claims for damages arising from or related to prize competition activities

A.10 Records Retention and Freedom of Information Act

All materials submitted to DOE as part of a submission become DOE records and are subject to the Freedom of Information Act. Where necessary, materials should be marked as noted in Section A.4. Such information will be withheld from public disclosure to the extent permitted by law. Without assuming any liability for inadvertent disclosure, DOE will seek to limit disclosure of such information to its employees and to outside reviewers when necessary for review of the application or as otherwise authorized by law. This restriction does not limit the Government's right to use the information if it is obtained from another source.

Competitors will be notified of any Freedom of Information Act requests for their submissions in accordance with 29 C.F.R. § 70.26. Competitors may then have the opportunity to review materials and work with a Freedom of Information Act representative prior to the release of materials. DOE does intend to keep all submission materials private except for those materials designated as "will be made public."

A.11 Privacy

If you choose to provide HeroX with personal information by registering or completing the submission package through the contest website, you understand that such information will be transmitted to DOE and may be kept in a system of records. Such information, except as noted in the official rules above, will be used only to respond to you in matters regarding your submission and/or the contest unless you choose to receive updates or notifications about other contests or programs from DOE on an opt-in basis. DOE and NLR are not collecting any information for commercial marketing.

A.12 General Conditions

DOE reserves the right to cancel, suspend, and/or modify the prize, or any part of it, at any time. If any fraud, technical failure, or any other factor beyond DOE's reasonable control impairs the integrity or proper functioning of the prize, as determined by DOE in its sole discretion, DOE may cancel the prize. Any performance toward prize goals is conducted entirely at the risk of the competitor, and DOE shall not compensate any competitors for any activities performed in furtherance of this prize.

Although DOE may indicate that it will select up to several winners for each prize, DOE reserves the right to only select competitors that are likely to achieve the goals of the program. If, in DOE's determination, no competitors are likely to achieve the goals of the program, DOE will select no competitors to be winners and will award no prize money.

All applications submitted to DOE are subject to a due diligence review.

DOE may conduct a risk review, using government resources, of the competitor and project personnel for potential risks of foreign interference. The outcomes of the risk review may result in the submission being eliminated from the prize competition. This risk review, and potential elimination, can occur at any time during the prize competition. An elimination based on a risk review is not appealable.

A.13 Program Policy Factors

While the scores of the expert reviewers will be carefully considered, it is the role of the prize judge to maximize the impact of prize funds. Some factors outside the control of competitors and beyond the

independent expert reviewer scope of review may need to be considered to accomplish this goal. The following is a list of such factors. In addition to the reviewers' scores, the below program policy factors may be considered in determining winners:

- The extent to which a project demonstrably advances the policy priorities of DOE and the administration.
- Geographic diversity and potential economic impact of projects
- Whether the use of additional DOE funds and provided resources are nonduplicative and compatible with the stated goals of this program and the DOE mission generally
- The degree to which the submission exhibits technological or programmatic diversity when compared to the existing DOE project portfolio and other competitors
- The degree to which the submission is likely to lead to increased employment and manufacturing in the United States or provide other economic benefits to U.S. taxpayers
- The degree to which the submission will accelerate transformational technological, financial, or workforce advances in areas that industry by itself is not likely to undertake because of technical or financial uncertainty
- The degree to which the submission supports complementary DOE-funded efforts or projects, which, when taken together, will best achieve the goals and objectives of DOE
- The degree to which the submission expands DOE's funding to new competitors and recipients who have not been supported by DOE in the past
- The degree to which the submission enables new and expanding market segments

A.14 National Environmental Policy Act Compliance

DOE's administration of this prize may be subject to the National Environmental Policy Act (NEPA) (42 U.S.C. § 4321, et seq.). NEPA requires federal agencies to consider the environmental effects of certain proposed actions as part of an agency's decision-making processes. NEPA applies when a proposed action constitutes a "major Federal action"; actions with no or minimal Federal involvement, e.g., where a Federal agency cannot control the outcome of the action, are not considered "major Federal actions" (42 U.S.C. § 4336e(10)(B)(i)). For additional background on NEPA, please see DOE's NEPA website at http://nepa.energy.gov/.

While NEPA compliance is a federal agency responsibility and the ultimate decisions remain with the federal agency, if DOE determines that this prize is subject to NEPA, all participants in this prize will be required to assist in the timely and effective completion of the NEPA process in the manner most pertinent to their participation in the prize competition. Participants may be asked to provide DOE with information on their planned activities such that DOE can conduct a meaningful evaluation of the potential environmental impacts.

A.15 Use of Artificial Intelligence

Use of Generative Artificial Intelligence (AI) Technology10: Use of generative AI technology in the development of a competitor's prize submission is not prohibited. Competitors must indicate in the technical concept paper (not included in the word count) the extent to which, if any, generative AI technology was used and how it was used to develop their submission (including all submission elements described in Section 4.2). Competitors are responsible for the accuracy, authenticity, and authorship representations of their submission under consideration, including content developed with the assistance of generative AI tools. Reliance on generative AI may introduce significant risks, including, but not limited to, research misconduct resulting from fabrication, falsification, or plagiarism when proposing, performing, or reviewing research, or in reporting research results.

A.16 Definitions

Prize administrator – prize administrator means both the Alliance for Energy Innovation, operating in its capacity under the management and operating contract for NLR, and Office of Electricity. When the prize administrator is referenced in this document, it refers to staff from both the Alliance for Energy

Innovation and Office of Electricity staff. Ultimate decision-making authority regarding prize matters rests with the Director of Office of Electricity.

A.17 Return of Funds

As a condition of receiving a prize, competitors agree that if the prize was made in error or based on fraudulent or inaccurate information provided by the competitor to DOE, DOE has the right to demand that any prize funds or the value of other noncash prizes be returned to the government.

ALL DECISIONS BY DOE ARE FINAL AND BINDING IN ALL MATTERS RELATED TO THE PRIZE.

Appendix B: Prototype Requirements

All submissions must include and meet the requirements listed below for each phase of the Silicon Carbide (SiC) Packaging Prize.

B.1 Hardware Requirements

The following hardware requirements must be included in each prototype for testing purposes:

- Gate driver and auxiliary power supply with required isolation to ensure protect across full voltage rage, both from the incoming power and signals for each switch position.
  - NOTE: Gate drive interconnection, balancing, and internal protection is the responsibility of the design team.
  - NOTE: Interconnection to testing should be one G/S connection per switch position.
- Isolation module designs only.
- The inclusion of any specialized interface components, such as high isolation bar clamps, Belleville washer stacks, pressure distribution system or specialized heatsink interface or connections, is the responsibility of the design team to supply to the national laboratory testing facility.

B.2 Testing Requirements

The following table must be completed and be provided to the national laboratory testing facility with the submission of your prototype for testing.

Baseline Design Information	
Measured, either simulated or estimated worst case: On-State Resistance: Gate Resistance and Capacitance: Commutation Loop Inductance: Efficiency of Die Level Switches:	
Maximum case temperature, with respect to fluid operation temperature and maximum die junction:	
CTI of case and all exposed materials in the creepage/clearance path:	

Operation ability and limits: First Quadrant Operation: Third Quadrant Operation: Body Diode Limits: Synchronous Rectification:	
Additional sensor characteristics:	

Interface Control Diagram	
Exit Termina and I/O Pin Locations, Markings, and Definitions (DC+, DC-, AC1, AC2, GS1, GS2, GS3, GS4, Desat, Thermal, etc.)	
Gate Drive Voltage Minimum: Maximum: **Gate Drive Current** Minimum: Maximum: **Gate Drive Power** Minimum: Maximum:	

Special requirements for Gate driver side R_{on}/R_{off} sizing	
Additional Auxiliary Supply – Voltages and Isolation Needed	

Isolation Dimensions and Assumptions:	
Isolation specifications, such as creepage, clearance, OV category. Show minimum distances and definitions utilized for module format and all features (in between buses, signals, baseplate, in mount condition hardware, etc.).	
Basic and functional distances	
Electrical keep out/isolation window to be included in test configuration.	

Mechanical Specifications:	
Mating Bus Bar Special Requirements: Maximum Temperature Rise: Thickness: Thermal Sinking:	
Sizing of Mating or Bolting Connections: **Connector Torque** Minimum: Maximum: **Mounting Torque** Minimum: Maximum:	

Thermal Interface Connection Specifications	
Heat Flux Calculation (W/cm^2) Explicitly identify the size and number of active components per switch position used in the calculation as well as the loss assumptions	
Fluid and Fluid Supply Preparation	
Fluid Operation Temperature ORNL Test Condition Range:	
Prototype Minimum: Prototype Maximum:	

Flow Rate: ORNL Test Condition Range: Prototype Minimum: Prototype Maximum: Maximum Pressure Drop: Thermal Rejection Rate:	

Protection and Required Startup and Shutdown Sequencing	
Protection in case of failure internal to module, such as baseline failure modes, desat feedback, thermal feedback (NTC/PTC/RTD), or ground current measurement	
Safe operating conditions, such as base indication of module functionality, gate driver initialization, auxiliary power, precharge internal capacitance, etc.	

Thermal dwell and/or release times	
Pulse testing operation – required coolant conditions.	
Continuous testing operation – required coolant conditions.	
Controlled shutdown	