CABLE Prize Stage 2 FAQs

Updated July 11, 2022

Stage 2 Rules, Request for Information, Goals, and Objectives

Question (Q) 1: How were the Stage 2 prize rules and scope for testing determined?
Answer (A): Because of the importance of testing in Stage 2, from November 2021 to January 2022 and through the National Renewable Energy Laboratory (NREL, the Prize Administrator), the U.S. Department of Energy (DOE) issued a request for information (RFI) on proposed specific testing requirements, which also sought input on other aspects of the Stage 2 contests, such as the inclusion of superconductors. See question Q2, Q3, and Q4 below for additional information.

Q2: What were the results of the RFI?
A: Key results of the RFI included:

- Superconductors and non-superconductors may be fairly compared if a "room-temperature-equivalent" factor was developed for superconductors
- While some goals involving ratios of nonconductivity-related properties or percentages above a baseline were suggested for testing and had strong proponents, other respondents identified problematic aspects of some of these candidate properties (e.g., ability of ratio-type goals to be manipulated in scoring systems) and encouraged DOE to maintain absolute rather than relative goals.
- While a key focus for new materials should be on large markets, a good strategy supports competitors whose materials could be competitive in early premium markets, provided these markets lead to more widespread markets.
- Semiquantative factors, such as future learning-curve cost reductions, might be reasonable for competitors to put forward in their technical narrative as part of the description of their manufacturing process if deployed at industrial scale.
- Affordability must be reinterpreted because it is implausible, if not impossible, to take a base conductor, such as copper or aluminum, alter it (like add nanocarbons or process it in a new way) and have the resulting material be cheaper than the base material. Hence, affordability metrics should focus on the long-term (>10-year) life cycle economic competitiveness of the material compared with existing conductors in major markets.

Q3: How did the RFI specifically affect rule development from the Stage 2 goals described in the Stage 1 rules?
A: As a result of RFI input, DOE's Advanced Manufacturing Office and the Prize Administration team made the following changes to the Stage 2 rules relative to the Stage 2 rules described in Stage 1. The team:

- Updated the Stage 2 material sample size testing requirements (see Section 5, Sample Testing of the official rules) to be dimensional rather that weight-based with separate requirements for non-superconductors and superconductors.

- Established specific data- and metric-calculation requirements for the test sample and additional guidance about describing the material in the form it would take if deployed at industrial scale and its economic competitiveness 10 years after such deployment.
- Established a room-temperature-equivalent conductivity to enable superconductors to compete with non-superconductors based on a testing lab measurement of their critical temperature and critical current, as well as sample preparation metrics and the economic competitiveness narrative that was judged to be fair by the vast majority of RFI respondents.

Q4: Why are the Stage 1 conductivity goals no longer in the Stage 2 rules?
A: The philosophy in Stage 2 was changed from an absolute contest-type of goal to that of beating current markets. Even if a conductor didn't meet the goal, it is still worthy of support if it beats a major market. In addition, the Stage 1 Table 2 conductivity goals (see below table) was relatively easy to meet with a silver conductor that would not be affordable, so bulk silver was explicitly excluded in the new threshold version of the pure conductivity goal.

Stage 1 Rules Excerpt: Table 1. Electrical Conductivity Metrics for Conductors
(NOTE: REFERENCE ONLY; NOT APPLICABLE IN STAGE 2)

Stage 1 Electrical Conductivity Enhancement Goals
• Conductivity-enhanced: >65 megaseimans per meter (MS/m) • Conductivity by density-enhanced[1]: >14 kiloseiman meters squared by kilogram (kSm^2/kg)

RFI respondents also pointed out that the second goal in Table 2 of the Stage 1 Rules (the conductivity by density goal) could be made artificially high by choosing a very low-density material that otherwise would not be a desirable conductor. Therefore, this goal was replaced in Stage 2 (see below table) by a threshold absolute conductivity value and a requirement that the density be the same as or less than aluminum. Similar to the first goal, in the second goal, bulk gold was also excluded. See question #Q5 and #Q6 below for additional information. A third goal was added to include a greater variety of materials.

[1] Baseline maximum conductivity by density—that for Al—was calculated to be 13.3 kSm^2/kg by dividing the Al conductivity of 36 MS/m by an Al density of 2,700 kg/m^2.

Stage 2 Rules Excerpt: Table 2. Stage 2 Electrical Conductivity and Other Contest Thresholds for Conductors,

Contest 1: Beat Copper!
Conductivity measured >59.3 MS/m, or 102% International Annealed Copper Standard (IACS): + No bulk silver (Ag) + Pathway to economic competitiveness with Cu + Parity with or better than Cu's nonconductivity properties.
Contest 2: Beat Aluminum!
Conductivity measured >37.7 MS/m or 65% IACS: + Density <2,710 kg/m^3 + No bulk gold (Au) + Pathway to economic competitiveness with Al1350 + Parity with or better than Al1350's nonconductivity properties.
Contest 3: Beat a Conductor System!
Conductivity measured greater than the conductor system comprising the primary conductor in **Error! Reference source not found.**: + Parity with or better than the primary conductor's nonconductivity system properties + Material that would replace an existing conductor system in a major market (refer to the example in **Error! Reference source not found.**) involving conductor(s) in **Error! Reference source not found.**.

The Prize Administrator realized that the testing aspect of Stage 2, unique to this stage, can support participants' narratives on the market impact of their material. This change keeps the intent of the original goals but expands the competition to include a wider variety of potential applications and materials that build on the benefits of Conductivity-enhanced materials for Affordable, Breakthrough Leapfrog Electric and thermal applications (CABLE). As part of these new thresholds, participants that set out to beat the original Stage 1 goals will be rewarded due to the size of the markets those goals represent and due to meeting the higher thresholds for conductivity.

In summary, in Stage 2, three new thresholds replaced the two goals in Stage 1.

Q5: In regard to contest 1: Beat Copper!, are trace amounts of silver acceptable? What about gold in Contest 2: Beat Aluminum!?

A: Similar to the Stage 1 nonmetal conductor requirement, a non-silver composite entering Contest 1: Beat Copper! may not contain bulk silver, but it may contain silver nanoparticles as an additive. Similarly, the nongold requirement for Contest 2: Beat Aluminum! means no bulk gold, but gold nanoparticles may be included.

For prize partners besides NREL and DOE, protecting IP is the sole responsibility of the competitor.

Q6: In the Beat a Conductor System contest, how does the Prize Administrator consider the conductivity of both the conductor and the nonconductor (which provides other properties)?

For example, in the ACSR conductor example, do the scores consider the conductivity of just aluminum or both steel and aluminum when finding conductor resistivity.

A: For Contest 3 (Beat a Conductor System!), the competitor must provide a baseline for a widely used conductor system that uses internationally accepted conductivity values for specified grades of conductor and nonconductor to calculate the baseline system resistivity and conductivity. This is similar to the values provided in figure 2 of the rules for the ASCR system in which both the conductivity of the aluminum and the steel are included. For the competing composite, only its conductivity is measured, regardless of whether the intent is to replace some or all of the of the nonconductor in the system. If the latter, the system conductivity then would be calculated by the Prize Administrator based on the same nonconductor values submitted by the competitor. The Prize Administrator would then provide information on both the new conductor and baseline system conductivities to the judges.

Q7: **How many points are available for Stage 2 submissions?**

A: The maximum score for the Stage 2 contest is 240, with 120 for the final written submission package and 120 for the sample testing results. Below is a summary of how points are distributed for each of the six scoring categories:

Goal	Criteria Points	Testing Points	Total Points	Percent (%)
Affordability	24	0	24	10%
Breakthrough	6	60	66	27.5%
Life Cycle Impacts	12	0	12	5%
Manufacturability	18	60	78	32.5%
Commercialization	36	0	36	15%
Diversity	24	0	24	10%
Total	120	120	240	100%

Q8 How were the stage 2 evaluation areas and available points decided on?

A: As with the Stage 1 goals, the Stage 2 goals are related to the words that comprise the CABLE acronym (see also question Q7 above). New to this stage, points for conductivity (the “c” in CABLE) were determined by testing rather than by technical narrative, as it was in Stage 1. It was clear that conductivity testing results had to receive a substantial number of points. Because of it’s importance, the CABLE Conductor Manufacturing Prize team decided that testing would account for 50% of the overall available points. Having 10% of the prize points attributed to diversity is a DOE Office of Energy Efficiency and Renewable Energy requirement.

The team then divided the remaining 40% of the points in an iterative process informed by the Stage 1 results and the RFI in consultation with management. For example, strict affordability (the “a” in CABLE) was reduced in importance due to the fact that all of the conductivity enhancements entered into Stage 1 required either or both additional materials or additional process treatment and, therefore, because of something akin to the second law of thermodynamics, none of them could actually cost less than the base material. Similar to how the team divided the testing and non-testing inputs, the prize’s administrative team divided the contribution of the testing results in an even split into manufacturability (the “m” in AMO) and breakthrough (the “b” in CABLE) categories because they both play an important role.

Sample Testing

Q9: What are the Stage 2 sample testing requirements?
A: Competitors are asked to, regardless of material type, submit **three (3) samples*** that meet the requirements for their respective materials as follows:

* Fewer than three samples may be submitted, but entries with lower numbers of samples will be at a disadvantage in the competition; see question #15 below.

Non-Superconducting (Metals and Nonmetals) Submissions
Sample Size Requirements:

- The sample must be a minimum of 1.5 inches (in.) long. The sample must have a circular or rectangular cross section of at least 0.21 in. in diameter or dimensions of at least 0.18 in. wide by 0.18 in. thick.
- It must have a uniform cross section, with a cross sectional area that may not vary by more than ±2% along the length.
- It must have a minimum electrical resistance of 20 microohms (μΩ).

Superconducting Submissions
Sample Size Requirements

- The submission must be a circular or square sample, with one face of film5 square millimeters or less in area.

You may send samples to the approved testing laboratory between Sept. 1, 2022, and Oct. 17, 2022. Early sample submission is highly encouraged because sample submissions postmarked after the deadline of Oct. 17, 2022, will not be accepted

Q10: Who are the approved CABLE Prize Stage 2 testing laboratories?
A: The approved testing laboratory for non-superconductors and for superconductors is **NTS** and the Materials Science Division at Argonne National Laboratory, respectively. These testing laboratories are required to ensure fairness and comparability across all submissions.

Q11: Do Stage 2 teams need to pay for sample testing?
A: The CABLE Conductor Manufacturing Prize will provide a testing stipend to all Stage 2 competitors, regardless of whether they won Stage 1 or not if they register in advance. Teams who wish to take advantage of the Stage 2 testing stipend must submit a registration form via HeroX no later than **Aug. 25, 2022, at 5 p.m. ET**. This stipend will cover the cost of conductivity testing three samples of competitors' conductivity-enhanced material at the approved CABLE

Conductor Manufacturing Prize laboratories. If competitors do not submit a registration form by the deadline, they can still compete; however, they may be required to self-fund their sample testing at the approved CABLE Conductor Manufacturing Prize laboratory.

Q12: Will the results of the sample conductivity testing be shared with competitors?
A: Yes. For both types of samples, results are anticipated to be provided to competitors via the Prize Administrator within approximately 1 month following the sample submission deadline of Oct. 17, 2022. See also question #17 below.

Q13: Can competitors submit additional samples?
A: If any of samples are deemed untestable by the testing laboratory, competitors may submit substitute samples at no charge. If, for any reason, competitors would like to test additional samples, those tests must be self-funded. The CABLE Conductor Manufacturing Prize will only pay for the testing of three samples per registered eligible competitor (i.e., met the HeroX registration deadline and overall prize eligibility, see Section 2.9 in the official rules).

Q14: Will competitors' samples be returned to them?
A: Yes. Samples will be returned to competitors. Return shipping is paid for by the CABLE Conductor Manufacturing Prize.

Q15: Is there any flexibility in the requirement for three samples for conductivity testing?
A: There are two reasons the prize requires three samples: 1) in case one or more samples is damaged or otherwise not able to be measured and 2) to reduce the statistical uncertainty in the measurement. Because of this, it is acceptable to submit fewer than three samples, but the statistical error associated with the measurement will be larger with fewer samples, and in cases where two competitors' sample(s) have similar values, the value with a lower error will score higher points.

Q16: Is there any flexibility in the sample size for conductivity testing?
A: The Prize Administrator recognizes that many applications use materials that are in the form of very thin strands of wire that are twisted together to create cables. However, because conductivity (in megasiemens per meter) is geometry dependent, allowing samples comprising twisted strands would complicate the requirements for fair comparisons among conductors. The larger the sample, the more accurate the conductivity measurement, so samples that are slightly larger than the minimum are acceptable, but samples that are smaller are not; that's why it's a minimum. Samples that are significantly larger than the minimum in any dimension may be machined down to fit the testing apparatus and for testing uniformity.

Q17: Will the results of the testing be shared publicly in refereed journals?
A: The testing organizations will share the results of the testing for each entry with the Prize Administration team (DOE and NREL), the Stage 2 Expert Review team, and individual competitors and will not otherwise disclose them. Competitors are free to publish their own

testing results. DOE and NREL reserve the right to publish metadata that does not personally identify competitors (i.e., if there are sufficient statistics in various categories) in peer-reviewed or other publications.

How to Compete in Stage 2

Q18: Is Stage 2 open to new competitors?
A: Yes. Stage 2 is open to new competitors regardless of their participation in Stage 1. Please note, however, that only Stage 2 winners may compete in Stage 3.

Q19: How can I compete in Stage 2?
To compete in Stage 2, competitors will need to: 1) submit a Stage 2 registration form by 5 p.m. ET on Aug. 25, 2022 (noting that, if competitors miss this deadline, they can still compete but will need to self-fund the required testing); 2) submit three sample materials to the approved CABLE Conductor Manufacturing Prize testing laboratory by Oct. 17, 2022; and 3) submit a final Stage 2 submission package by 5 p.m. ET on Dec. 1, 2022.

It is recommended (but not required) that competitors also attend or view the Stage 2 Informational Webinar (held on May 17, 2022) and/or the CABLE Big Idea Workshop (July 20–21, 2022)

Q20: What is the CABLE Big Ideas Workshop and why should I attend?
The second annual CABLE Big Ideas Workshop hosted by the DOE Office of Energy Efficiency and Renewable Energy's AMO will be held at Argonne National Laboratory near Chicago, Illinois, and visible virtually on July 20–21, 2022. Like the first CABLE workshop that was held April 7–9, 2021, this workshop will bring together the broader CABLE ecosystem to discuss materials and applications. In addition, all presentations—as was done for the first workshop—will be posted on the CABLE website. In addition to CABLE Conductor Manufacturing Prize competitors, the workshop will include CABLE Small Business Innovation Research and Small Business Technology Transfer program competitors and awardees, CABLE Lab seedling awardees, past judges and reviewers, CABLE subject-matter experts, and interested parties from industry, government, academia, finance, nonprofits and the general public.

Register here: https://web.cvent.com/event/8b860deb-a78b-465a-abb1-d3d1970ee974/summary.

Due to COVID restrictions, in-person attendance is limited but still available as of July 4, 2022. Virtual attendance is unlimited.

At this second workshop, CABLE Conductor Manufacturing Prize competitors will have a specific opportunity on the first day of the workshop to showcase their innovations to workshop participants and meet with researchers from national laboratories who can provide voucher

services in Stage 3. See the agenda for details and contact Emily.Evans@nrel.gov to reserve a spot.

While attendance at the CABLE Big Ideas Workshop is strongly encouraged for all Stage 2 competitors, it is not required. After the workshop, similar to the first CABLE workshop, presentations and additional references will be posted at cable-bigidea.anl.gov with updates on CABLE Small Business Innovation Research and Small Business Technology Transfer program awards and other funding opportunities.

Q21: What was the CABLE Conductor Manufacturing Prize informational webinar and why should I view the recording of it?

A: The informational webinar provided an overview of what is required for competitor submission, the voucher process, sample testing, how entries are scored, and how competitors can receive support from American-Made Challenges network connectors to help execute their plan.

The webinar was held on May 17, 2022, via Zoom. To see the recording, visit https://www.youtube.com/watch?v=EffwMn6KxeM

Vouchers

Q22: What is a voucher?
A: Prize vouchers allow winners from the Stage 2 contest to access tools, equipment, and expertise at national laboratories and approved organizations and facilities, in turn supporting the development, testing, and validation of their innovative solutions. Stage 2 contest winners will each receive a $100,000 voucher.

Q23: What is the Stage 2 voucher process?
A: In Stage 2, competitors are asked to identify a technical assistance voucher partner within either the American-Made Network or at a DOE national laboratory. As part of their Stage 2 submission, competitors are asked to complete a voucher work slide to provide a high-level summary of the proposed work and deliverables should they win Stage 2.

The CABLE Conductor Manufacturing Prize team will provide competitors with opportunities to engage with national lab researchers during Stage 2.

More details on the CABLE Conductor Manufacturing Prize vouchers can be found in the Voucher Guidelines (posted June 2022)

Q24: How can competitors use their vouchers?
A: Competitors are required to work with either an approved member of the American-Made Network or DOE national laboratory. Any interested organization not currently a part of the

American-Made Network can apply to be added to the list of approved organizations at https://americanmadechallenges.org/network.

Voucher capabilities at National Kabs and within the AMC Network will be posted to HeroX in the near future.

Q25: What is the Aug. 18, 2022, Virtual Networking Workshop and why should I attend?
A: On August 18, the CABLE Prize will hold a virtual networking event where Stage 2 CABLE Prize teams can network 1:1 with National Laboratory Researchers to ask questions and scope work their Stage 2 Voucher Work Slide which is due with their Stage 2 submission on December 1, 2022. See questions Q17 – Q19 for more information on Vouchers.

Other Questions

Q26: I am interested in becoming a co-sponsor of the prize! What do co-sponsors do and how do I learn more about becoming one?
A: The CABLE Conductor Manufacturing Prize is currently seeking co-sponsors for Stage 2 and Stage 3. Co-sponsors help in a variety of ways, including by providing both in-kind and financial support for the prize and its competitors.

If you are interested in learning more, please email the Prize Administrator at CABLEprize@nrel.gov

Q27: I know someone who might be interested in the CABLE Conductor Manufacturing Prize. How can I help get the word out?
A: The Prize Administrator would appreciate help with outreach. Please feel free to forward any information about this prize to your network or email the team at CABLEprize@nrel.gov.

Q28: If competitors enter the prize, do DOE or NREL retain any rights to their intellectual property (IP)? How do competitors protect their IP from other prize partners?
A: DOE and NREL do not have rights to any underlying inventions discussed in competitors' submission materials or developed while competing in this prize. See Appendix 1 in the official rules for more information regarding submission rights.

For prize partners besides NREL and DOE, protecting IP is the sole responsibility of the competitor.