U.S. DEPARTMENT OF ENERGY

Official Rules

American-Made Solar Forecasting Prize

The American-Made Solar Forecasting Prize is designed to accelerate the commercialization and adoption of probabilistic tools that predict the amount of energy solar power plants generate days in advance.

These rules are effective beginning October 25, 2021,

for the Solar Forecasting Prize

Modification 1: December 2021 - All Modification 1 Changes Highlighted in Blue.

Modification 2: February 2022 - All Modification 2 Changes Highlighted in Green.

The U.S. Department of Energy's (DOE's) American-Made Solar Forecasting Prize will be governed by these official rules. The prize administrator and DOE reserve the right to modify the official rules if necessary, will publicly post any such modifications, and will notify prize competitors of any modifications.

Modification Summary

Modification Number	Date	Summary of Changes
Modification 1	December 2021	• Extended the registration deadline to January 12, 2021, and updated the data use agreement submission deadline to February 7, 2021. • Updated the forecast evaluation period to February 14–March 13, 2022. • Extended the submission deadline for the commercialization plan to March 14, 2022.
Modification 2	February 2022	• Updated to allow teams the flexibility to focus their commercialization plan responses on either product-to-market commercialization or an accelerated market adoption strategy, regardless of whether they are currently providing forecast services commercially. • Updated final report timeline (from the Solar Forecast Arbiter tool to competitors) from 1 business day to 2–4 business days, pending full availability of observation data.

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I.   PROGRAM SUMMARY

1. INTRODUCTION

The American-Made Solar Forecasting Prize is designed to incentivize innovators to develop probabilistic tools that predict how much energy solar power plants will generate days in advance of the forecast, while rewarding bold commercialization plans and innovative ideas to accelerate the adoption of probabilistic forecasts. This prize offers a total of up to $375,000 in cash prizes, with five anticipated winners and five anticipated runners-up.

Building a clean energy economy and addressing the climate crisis is a top priority of the Biden administration. This prize will advance the Biden administration's goals to achieve carbon-pollution-free electricity by 2035, "deliver an equitable, clean energy future, and put the United States on a path to achieve net-zero emissions, economy-wide, by no later than 2050" to the benefit of all Americans.[1] The U.S. Department of Energy (DOE) is committed to pushing the frontiers of science and engineering; catalyzing clean energy jobs through research, development, demonstration, and deployment; and ensuring environmental justice and the inclusion of disadvantaged communities.

The activities incentivized by this prize will support the government-wide approach to the climate crisis by promoting innovation and early deployment that can lead to the wider adoption of clean energy technologies, which are critical for climate change mitigation. Specifically, DOE's Solar Energy Technologies Office (SETO) in the Office of Energy Efficiency and Renewable Energy (EERE) is launching the Solar Forecasting Prize to: (1) increase stakeholder awareness of the state of the art in solar forecasting; (2) accelerate the commercialization and adoption of probabilistic forecast models; and (3) promote the use of a common platform, such as the Solar Forecast Arbiter, to support transparent metrics and specifications for probabilistic solar forecasts.

Individuals, teams of individuals, institutions, companies, and nonprofit organizations based in the United States are eligible to compete. DOE expects to select five anticipated winners that will receive $50,000 in cash and five anticipated runners-up that will receive $25,000, based on the performance of their forecasting models and the strength of their commercialization plans.

Throughout the competition, competitors will have access to support from the American-Made Network, a diverse and powerful community of incubators, investors, philanthropists, fabrication facilities, and seasoned industry leaders who provide technical insight, business development expertise, product validation, and more.

Competitors will submit forecast model results for 10 locations in the contiguous United States and plans for accelerating the commercialization or adoption of probabilistic forecasting technologies.

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[1] Executive Order 14008, "Tackling the Climate Crisis at Home and Abroad" (Jan. 27, 2021).

The reviewers will use the Solar Forecast Arbiter (SFA)[2] platform to assess the models' performance; the reviewers will also evaluate the quality of the submitted plans.

Currently, the solar industry and its associated research community does not reflect the diversity of the United States. Women and minorities are underrepresented in the solar industry and in science, technology, engineering, and math (STEM) fields. STEM fields also lack diversity in geographical origin, with rural areas of the United States underrepresented relative to large population centers. Because STEM students and graduates support research and development activities, which can often result in the formation of companies, the lack of diversity in that pipeline adversely affects opportunities and potential outcomes in scientific and economic output. To achieve the administration's energy justice goals, SETO is working to ensure that the work SETO funds will support more equitable participation in the solar energy community. SETO recognizes the inherent advantages of diverse teams and encourages competitors to consider diversity and inclusion when developing their teams.

2. BACKGROUND

Today, solar accounts for about 3% of U.S. electricity,[3] which means that to combat climate change, the nation's solar capacity would likely need to grow by hundreds of gigawatts in the next 15 years, with an annual rate of deployment three to four times higher than today's rate.

Integrating large amounts of variable energy resources, such as solar and wind, is a challenge for a power grid that was designed and built around central-generation thermal plants and unidirectional power flows. Predicting the amount of power that solar energy generators could deliver over the next 24–48 hours will allow electric utilities and other grid operators to serve their customers reliably and cost-effectively. Given the uncertainty of future weather, probabilistic forecasts can be a powerful tool with large amounts of solar energy on the grid, as they allow for cost-efficient planning and dispatch of energy generation and storage.

SETO has funded the development of advanced solar forecasting models,[4] with an emphasis on predicting the formation, properties, and location of clouds over time horizons ranging from minutes to days. The office has also supported the development of probabilistic forecasts[5] as a technology better suited to the stochastic character of cloud cover.

Meanwhile, the increase of residential, commercial, and industrial solar installations—collectively described as behind-the-meter (BTM) solar—has shined a light on the importance of solar forecasting for the reliable and cost-efficient operation of the national power system. SETO is funding research and development projects that use artificial intelligence and machine learning[6] to

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[2] https://solarforecastarbiter.org
[3] EIA, Electricity Data Browser. Accessed August 25, 2020.
[4] https://www.energy.gov/eere/solar/improving-accuracy-solar-forecasting-funding-opportunity
[5] https://www.energy.gov/eere/solar/funding-opportunity-announcement-solar-forecasting-2
[6] https://www.energy.gov/eere/solar/funding-opportunity-announcement-solar-energy-technologies-office-fiscal-year-2020

improve the state-of-the-art forecasting of net load, which is the apparent load at a substation whose feeders contain a significant amount of BTM solar that "masks" the electric power demand.

To help grid operators respond quickly to the changing environment, SETO has supported the development of the Solar Forecast Arbiter (SFA): an open-source, cloud-ready platform that facilitates evaluation of forecasts for solar irradiance, solar power, and net load. The SFA can lower the cost and complexity of forecast evaluation for both end users and vendors. The platform was developed by the University of Arizona with the help of DOE funding under SETO's Solar Forecasting 2 funding program.[7]

SETO has supported grid operators as they learn to use probabilistic forecasts and adaptive reserve calculations. To this end, applicants have been encouraged to partner with balancing authorities and forecast vendors to boost the probability and pace of technology transfer. Prize competitors are encouraged to view presentations from the most recent SETO workshop[8] on solar forecasting research and development, which covered current state-of-the-art and upcoming advances in data collection, sub-grid modeling, multiday forecasting, and integration of forecasts into real-world electricity generation.

The Solar Forecasting Prize will help address SETO's goals for achieving increased awareness of the state of the art in solar forecasting, promoting a common platform and metrics for forecast evaluation, improving availability of probabilistic forecasting tools, and supporting faster adoption of those tools by grid operators.

3. THE PRIZE

Every day for four weeks (28 consecutive days), you will submit solar irradiance forecasts for each of the predetermined locations through the SFA platform. The SFA will compare the forecasts' performance against a benchmark forecast[9] using a time-of-day persistence ensemble model (see Appendix 3 for more details).

You must also submit a commercialization plan that describes innovative approaches to accelerate the commercialization of probabilistic forecasts or their adoption by end users, such as independent system operators, integrated utilities, and other balancing authorities. These submissions will be reviewed by a panel of expert reviewers from industry and the federal government using the criteria described in Section II.

The Solar Forecasting Prize offers a total prize pool of $375,000 in cash.

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[7] https://www.energy.gov/eere/solar/solar-forecasting-2

[8] https://www.energy.gov/eere/solar/articles/workshop-2021-seto-solar-forecasting-research-and-development

[9] https://solarforecastarbiter.org/benchmarks/

Prize funding:

	Number of Prizes Awarded	Prizes
Winners	Five anticipated winners	Each winner receives $50,000 in cash
Runners up	Five anticipated runners-up	Each runner-up receives $25,000 in cash

SETO anticipates making a total of 10 awards (five winners and five runners-up) but may award winners and runners-up depending on the performance of the competitors and at the discretion of the judge. However, the total prize purse will not exceed $375,000.

To learn more and sign up, go to https://www.herox.com/SolarForecasting.

4. IMPORTANT DATES

To see the program schedule and application deadlines for the Solar Forecasting Prize, please visit https://americanmadechallenges.org/solarforecasting/.

5. PRIZE ADMINISTRATOR

The National Renewable Energy Laboratory (NREL) will support competitors by cultivating resources and building connections through the American-Made Network that enhance, accelerate, and amplify their efforts. The objective is to link competitors with potential new team members, resources, financing, perspectives, and relevant industry expertise necessary for long-term success.

6. ELIGIBILITY REQUIREMENTS

To compete in the Solar Forecasting Prize, you must comply with the eligibility requirements below. By uploading a submission package, a competitor certifies that they are in compliance with these eligibility requirements. Eligibility is subject to verification before prizes are awarded. As soon as the prize administrator becomes aware that a competitor is not eligible to win the prize, the competitor may be disqualified. The registered competitor is the individual or entity that registers in HeroX to compete.

In keeping with the goal of growing a community of innovators, you are encouraged to form diverse, multidisciplinary teams while developing your concept. 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.

- Individuals, teams of individuals, private entities (for-profits and nonprofits), and nonfederal government entities (such as states, counties, tribes, municipalities, and academic institutions) are eligible to compete, subject to the following requirements:

    o An individual prize competitor (i.e., an individual who is not competing as a member of a group) must be a U.S. citizen or permanent resident.

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

    o Academic institutions must be based in the United States.

    o Private entities must be incorporated in and/or maintain a primary place of business in the United States with majority domestic ownership and control. This includes U.S.-based subsidiaries of entities incorporated in foreign countries.

    o If an entity seeking to compete does not have majority domestic ownership and control, EERE may consider issuing a waiver of that eligibility requirement where (1) the entity submits a compelling justification; (2) the entity is incorporated in and maintains a primary place of business in the United States; and (3) the entity otherwise meets the eligibility requirements. EERE may require additional information before making a determination on the waiver request. There are no rights to appeal DOE's decision on the waiver request. See Appendix 2 for more information on the waiver process.

- Federally Funded Research and Development Centers (FFRDCs) are not allowed to compete. However, individual researchers affiliated with FFRDCs may compete if the expenses for the submission are covered by a third party.

- Individuals affiliated with the same organization may form multiple competitor teams. However, the teams and their corresponding submissions must be substantially different from each other.

- Federal employees are not eligible to win any prizes in this program.

- Researchers at federal facilities may provide submissions as registered competitors in this prize and can receive honorable mentions but are not eligible to receive any cash prizes.

- Employees of an organization that cosponsors this program with DOE are not eligible to participate in this competition.

- Individuals who worked at DOE (federal employees or support service contractors) within six months prior to the submission deadline are not eligible to participate in this program. Additionally, members of their immediate families (i.e., spouses, children, siblings, or parents) and anyone who lives in their household, regardless of relation, are not eligible to participate.

- NREL employees directly involved in administration of this prize are not eligible to participate in this program.

- Entities and individuals publicly banned from doing business with the U.S. government, such as entities and individuals debarred, suspended, or otherwise excluded from or ineligible for participating in federal programs, are not eligible to compete.

- Entities identified by the Department of Homeland Security, Binding Operational Directives as an entity publicly banned from doing business with the U.S. government are not eligible to compete. See https://cyber.dhs.gov/directives/.

- Entities and individuals identified as a restricted party on one or more screening lists of Department of Commerce, State, and the Treasury are not eligible to compete. See the Consolidated Screening List: https://www.trade.gov/consolidated-screening-list.

- This prize is expected to positively impact U.S. economic competitiveness. Participation in a foreign government talent recruitment program[10] could conflict with this objective by resulting in unauthorized transfer of scientific and technical information to foreign government entities. Therefore, individuals participating in foreign government talent recruitment programs of foreign countries of risk are not eligible to compete. Further, teams that include individuals participating in foreign government talent recruitment programs of foreign countries of risk[11] are not eligible to compete.

- As part of your submission to this prize program, you will be required to sign the following statement:

  o I am providing this submission package as part of my participation in this prize. I understand that in providing this submission to the Federal Government, I certify under penalty of perjury that the named competitor meets the eligibility requirements for this prize 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

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[10] A foreign government talent recruitment program is defined as an effort directly or indirectly organized, managed, or funded by a foreign government to recruit science and technology professionals or students (regardless of citizenship or national origin, and 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 physically relocate to the foreign state for the above purpose. Some programs allow for or encourage continued employment at U.S. 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.
[11] Currently, the list of countries of risk includes Russia, Iran, North Korea, and China.

misrepresentations to the Federal Government may result in civil and/or criminal penalties under 18 U.S.C. § 1001 and § 287.

7. PROGRAM GOAL REQUIREMENTS

Only submissions relevant to the goals of this program are eligible to compete. DOE will review all submissions to ensure that the following statements are **true**:

- The submitted forecasts are probabilistic forecasts of solar irradiance and are submitted in a manner compliant with the submission requirements of the SFA platform (see Section II.5.2).

- The submitted commercialization plans comply with requirements described in Section II.

- The proposed solution is based on fundamental technical principles and is consistent with a basic understanding of the U.S. market economy.

8. ADDITIONAL REQUIREMENTS

Please read and comply with additional requirements in Appendix 1.

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

II. SOLAR FORECASTING PRIZE RULES

1. INTRODUCTION

The Solar Forecasting Prize is a single-contest program with $375,000 in cash prizes. This competition is designed to identify probabilistic models for solar forecasting and innovative commercialization plans for probabilistic forecasting products.

The following rules are for potential and actual competitors in the Solar Forecasting Prize. "You" and "your" reference competitors.

The Solar Forecasting Prize focuses on three key areas:

- Identifying the best-performing probabilistic forecasting models.

- Identifying strong commercialization plans that could increase the availability of probabilistic solar forecasting algorithms on the market.

- Identifying innovative plans to accelerate adoption of probabilistic forecasting products by end users, such as independent system operators, integrated utilities, and other balancing authorities.

Cash Prizes

- Five anticipated winners
- Five anticipated runners-up
- Each winner receives $50,000
- Each runner-up receives $25,000

2. PRIZES TO WIN

The prize offers cash prizes of $50,000 for five anticipated winners and $25,000 for five anticipated runners-up.

3. HOW TO ENTER

View the timeline at https://www.herox.com/solarforecasting/timeline to determine when applications to compete will be accepted. You must register on both the HeroX and SFA platforms by their respective deadlines. Use the same email address to register on both platforms to ensure SFA will evaluate your submissions.

4. PRIZE PROCESS

The prize requires the following steps:

1. **Registration** – Follow the prize website for updates and, if desired, determine appropriate partners for your team. Register to participate using the HeroX platform before the registration

deadline. After registering on HeroX, create an account on the Solar Forecast Arbiter (SFA) platform using the same email you used on HeroX. Competitors will also be required to submit a signed SFA Data Use Agreement before Feb. 7, 2022.

2. **Submissions** – There are two submissions required for the prize:

   - **Forecast Submission** – For each of the 28 days of the forecast evaluation period, (anticipated to last from Feb. 14, 2022 until March 13, 2022), you must upload to the SFA platform a day-ahead probabilistic forecast for solar irradiance for each of the locations specified in Section II.5.2 of this rules document. Reports will be generated nightly to allow you to understand your performance as the competition progresses.

   - **Plan Submission –** You must upload to the HeroX website a written narrative describing how to accelerate the commercialization or adoption of probabilistic forecast products. The contents and format of the plan are defined in Section II.5.1 of this rules document. The submission deadline for the commercialization plan is March 14, 2022, at 5 p.m. ET.

3. **Evaluation** – You will be evaluated on the accuracy of your forecasts and the quality of your commercialization plans.

4. **Final Report -** Pending full availability of observation data, which is anticipated 2–4 days after the end of the forecast competition, the SFA platform operator will generate a final report with the calculated metrics for the submitted forecasts for each competitor. You will receive a copy of your report.

   - The final reports and written narratives will be reviewed by a team of reviewers comprising industry experts and DOE staff. Reviewers will evaluate the commercialization plans by agreeing or disagreeing with assigned statements on a 1–6 scale. The statements, grouped under three questions, are the criteria. Any other documentation provided (i.e., letters of support or intellectual property (IP) licenses) should support the commercialization plan.

5. **Ranking** – All competitors whose forecasts perform better than the time-of-day persistence ensemble benchmark (see Appendix 3) in each location will be displayed with their anonymized handles on the HeroX website, ranked by forecast skill. Details about the forecast skill calculation are in Section II.6.

6. **Announcement** – Approximately one month after the competition closes, the prize administrator notifies winners and runners-up and requests the necessary information to distribute cash prizes. The prize administrator will then publicly announce winners and runners-up.

5. WHAT TO SUBMIT

A complete submission package includes the following items:

Item	Content	Will Be Made Public?	Scored?
HeroX Submission Package	Cover page	No	No
	Commercialization plan (not to exceed 2,000 words)	No	Yes
	One summary PowerPoint slide	Yes	No
	Letters of commitment or support (optional)	No	No
	Intellectual property licensing agreements (if applicable)	No	No
Solar Forecast Arbiter Submissions	See Section II.5.2 for details	No	Yes

Note: Portions of the submission package are made available to the public. These have been denoted as such, and DOE does not intend to release the remaining parts of the submission to the public. See Appendix 1 for additional details.

All documents must be uploaded as a PDF.

5.1 HEROX SUBMISSION PACKAGE DETAILS

Competitors are required to submit a plan that addresses three questions.

Question 1: Is the proposed solution innovative compared to the current state of the art?
Question 2: Is the proposed plan specific and complete?
Question 3: Is the proposed plan feasible and effective, and does the team have the experience to make the plan succeed?

The individual responses to the three questions do not have word limits; however, **the aggregate response to these three questions must not exceed 2,000 words (single-spaced, 12-point font)**, not including captions, figures/graphs, or references. **You must include a word count** at the end of your submission. You may also include **up to five supporting images, figures, or graphs**. The reviewers will score the plans based on the content you have provided. Competitors may choose **one** of two commercialization plan options:

- **Product-to-Market Commercialization Plan:** Your plans should focus on your product-to-market approach for your probabilistic forecasting algorithm or model.

- **Probabilistic Forecasting Accelerated Market Adoption Plan:** Your plans should focus on innovative approaches to accelerating the adoption of probabilistic forecasts by the broader industry.

Reviewers and the prize judge will evaluate your commercialization plan by agreeing or disagreeing with assigned statements on a 1–6 scale, as shown below. The statements are the criteria. The other documentation provided (i.e., letters of support or IP licenses) should support statements that are made in the commercialization plan.

1	2	3	4	5	6
strongly disagree	disagree	slightly disagree	slightly agree	agree	strongly agree

The following table explains the calculation of the scores for each question and of the plan score.

	Number of Scored Statements	Total Possible Points (# of Statements x 6)
Question 1	3	18
Question 2	2	12
Question 3	5	30
Total	10	60

Cover Page   List basic information about your submission

- Team name
- Key team members (names, contacts, and links to their professional websites or LinkedIn profiles)
- Your city, state, and nine-digit zip code
- Whether you or your organization currently provide forecasting services commercially
- The partners and affiliates who significantly helped you develop the plan for your product (if applicable).

Commercialization Plan (PDF)
Maximum 2,000 words and five supporting images or figures

Question 1: Is the proposed solution innovative compared to the current state of the art?

Suggested content to include in the plan:
- Describe the state of the art for probabilistic forecasts, including existing commercially available solutions and their rate of adoption by the industry.
- Depending on your perspective, briefly describe either the solution you plan to commercialize or the strategy you propose for the increased adoption of probabilistic

Statements scored on 1–6 scale:
- The competitor shows a solid understanding of the current market conditions, limitations, and opportunities.
- The competitor describes the innovation in their solution or proposed strategy.
- The competitor's approach has a realistic potential to disrupt the existing market conditions.

forecasts.

Question 2: Is the proposed plan specific and complete?	
Suggested content to include in the plan: • Describe the distinct phases of your plan along with their corresponding goals and timelines. • Describe the actions necessary to meet each listed goal and their allocation among team members. • Include a preliminary cost analysis of the path to a commercial product offering or to a broad adoption of probabilistic forecasting products, depending on your perspective.	Statements scored on 1–6 scale: • The competitor describes their plan in sufficient detail, with clear phases, action owners, goals, and target dates. • The competitor provides a realistic assessment of the costs involved in the realization of the plan.
Question 3: Is the proposed plan feasible and effective, and does the team have the experience to make the plan succeed?	
Suggested content to include in the plan: • Describe the major risks you anticipate in the implementation of your plan. • Describe realistic mitigations for the risks you have identified. • Describe the roles of each key participant in the plan. • Describe the project management and decision processes during the implementation phase. • Describe plausible business agreements between collaborating entities. • Describe (ideally with letters of support) the support from collaborators or partners and other stakeholders toward the implementation of the plan. • Describe prior circumstances where team members have executed on plans with similar goals for commercialization or market adoption. • Include, as applicable, a description of your IP position, the owner of the IP, and the agreements established with any third-party owners of IP.	Statements scored on 1–6 scale: • The competitor has clearly identified risks and corresponding realistic mitigations. • The competitor has established effective decision-making and project management processes. • The competitor has demonstrated necessary support from key partners and stakeholders to achieve their plans. • The competitor describes the team's unique qualifications and expertise, including those of partner entities, and the team is well suited to achieve the plans. • The competitor includes relevant, previous work efforts that show the team's capability for achieving the plan's goals.

Special instructions for Question 2

- Use only specific, measurable, achievable, relevant, and timely (SMART) outcome-based goals, not activity-based goals, so that a neutral third party can validate them (if possible).

  - For example: Demonstrate a definitive achievement of progress (e.g., "X letters of interest signed" or "achieve X% efficiency"). **Do not** describe how you spent your time (e.g., "provided a report," "talked to customers," or "performed experiments").

- Include SMART goals for the next 90, 180, and 365 days.

- In defining your SMART goals, include quantified, risk-reducing, meaningful, practical, and testable interim milestones.

- SMART goals should include assessment and feedback from many relevant stakeholders (e.g., possible investors, customers, and experts in the solution space, and entities that would be the eventual customers or end users of the product).

- Members of the American-Made Network may be able to help you formulate your SMART goals.

Submission Summary Slide (a PowerPoint slide as a PDF will be made public)

Make your own public-facing, one-slide submission summary containing technically specific details that can be understood by most people. There is no template, so feel free to present the information as you see fit. Please make any text readable in a standard printout and conference room projection.

Letters of Commitment or Support (optional, as a PDF)

Attach one-page letters of support, intent, or commitment from other relevant entities (e.g., partner forecast vendors or other organizations supporting the applicant) to provide context and evidence to support your written application. Provide the strongest possible evidence that you have the necessary resources and partners lined up to execute on your plan. 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.

Intellectual Property Licensing Agreements (required if applicable, as a PDF)

Provide documentation showing that you have secured access to the IP underlying your forecasting algorithm from the relevant institution where it was originally developed, where applicable.

5.2 SOLAR FORECAST ARBITER SUBMISSION PACKAGE DETAILS

You must submit day-ahead probabilistic forecasts to the SFA that meet the following requirements:

- Issue time of day: 10 a.m. local at each site

- Lead time to start: 14 hours

- Run length: 24 hours

- Interval length: 1 hour

- Interval label: Beginning

- Interval value type: Average

- Variable: Global Horizontal Irradiance (GHI)

- Percentiles: 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100.

Before 10 a.m. in the applicable forecast location, the GHI percentiles for each of the 24 hourly intervals beginning at midnight on Day+1, through hour 23 on Day+1 must be sent to SFA in the required format. Forecasts will be time-stamped with the beginning of each interval.

See the SFA documentation[12] for definitions of the terms used above.

Failure to upload forecasts by the daily submission deadline will result in all percentiles being set to zero for the corresponding evaluation period.

In the event that the SFA is offline for the hour before a submission deadline, the corresponding evaluation period will not be included in the scores.

The SFA will reject forecasts uploaded after the daily submission deadline. You may, however, upload forecasts for future days and then overwrite these values until the daily deadline. For example, until Day 4 at 10:00 local time at a given site, you may submit forecasts for Day 5 00:00 through 23:00 *and later*.

The SFA will compute the continuous ranked probability skill score (CRPSS, or forecast skill), as shown below, of your submitted forecasts with respect to the persistence ensemble benchmark forecast. The CRPSS will be calculated at the end of each day.

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[12] https://solarforecastarbiter.org/definitions/

You will receive daily a performance report that includes your forecast, the reference forecast, and the metrics for each. The report will not include forecast time series of other competitors.

The SFA will exclude nighttime from the analysis. Nighttime hours are the hours for which the solar zenith angle is greater than 87 degrees for each minute of the hour. Hours that have any minutes of daylight (solar zenith angle is less than 87 degrees) will be included in the analysis.

The SFA provides an example script[13] to help users become acquainted with using the application programming interface for operational evaluations.

6. HOW WE SCORE

- The scoring of forecast will proceed as follows:

  - The continuous ranked probability score (CRPS, see Appendix 4) will be calculated for each set of the 28 submitted forecasts—e.g., $CRPS_{i,k}$ for the *i*-th location and the *k*-th competitor. The forecast skill will be calculated against the CRPS of the baseline persistence ensemble forecast, which will be designated as $CRPS^{PEF}_i$ for the *i*-th location:

$$Forecast\ Skill_{i,k} = CRPSS_{i,k} = 1 - \frac{CRPS_{i,k}}{CRPS_i^{PEF}}$$

  - Your final forecast score will be calculated as follows: your forecast skill values will be averaged across all locations and then rounded to two decimal points. This value will then be multiplied by 100 and then multiplied by a factor of three. The result of this multiplication will be your final forecast score, which will then be added to the plan score to determine your total score.

- A panel of expert reviewers reads, scores, and comments on each submitted plan. Each statement listed in the review criteria under the three questions receives a score from 1 to 6. The statements have equal weight, so questions that have more statements have a greater influence on the final score. The final score from an individual reviewer for a submitted plan equals the total sum of the scores for all the statements. All reviewers' scores will then be averaged for a final reviewer score for the submitted plan. The prize judge considers reviewer scores when deciding the winners of the prize.

  - Reviewers may not have personal or financial interests in, or be an employee, officer, director, or agent of any entity that is a registered participant in this competition, or have a familial or financial relationship with an individual who is a registered competitor.

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[13] https://solarforecastarbiter.org/documentation/dashboard/trials/#example-script

> **Note:** Expert reviewers also provide comments on the submissions they review. The prize administrator intends to provide comments to competitors after the winners are announced. These comments are intended to help competitors to continue to improve and iterate on their submissions. The comments are the opinions of the expert reviewers and do not represent the opinions of DOE.

- Interviews: The prize administrator, at its sole discretion, may decide to hold a short interview with the competitors. Any interviews will be held prior to the announcement of winners and will serve to help clarify questions the reviewers may have. Attending interviews is not required, and interviews are not an indication of winning.

- The judge's final determination of winners will take into account forecast skills, reviewer scores, interview findings (if applicable), and program policy factors listed in Appendix 1. DOE is the judge and final decision maker and may elect to award all, none, or some of the submissions accepted.

- All competitors that submitted an eligible entry will receive comments on their submission.

7. ADDITIONAL REQUIREMENTS

Please read and comply with additional requirements in Appendix 1.

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

III. APPENDIX 1: ADDITIONAL TERMS AND CONDITIONS

1. UNIVERSAL PRIZE REQUIREMENTS

Your submission for the Solar Forecasting Prize is subject to the following terms and conditions:

- If any team member is actively receiving funding from SETO at the submission deadline, SETO will review any potential prize awards, as well as other DOE funding, and make a decision as to whether awarding a prize to individuals or entities already receiving funding is in line with the program policy factors stated later in these rules (Section V.13).

- You must post the final content of your submission or upload the submission form online at https://www.herox.com/SolarForecasting before the prize closes. Late submissions or any other form of submission do not qualify.

- The summary slide will be made public.

- The cover page, narrative, and letters of commitment/support are not intended to be made public; however, see Section V.10 regarding the Freedom of Information Act (FOIA).

- You must include all the required submission elements. The prize administrator may disqualify your submission after an initial screening if you fail to provide all required submission elements. Competitors may be given an opportunity to rectify submission errors due to technical challenges.

- Your submission must be in English and in a PDF readable and searchable format. Scanned handwritten submissions will be disqualified.

- You will be disqualified if any engagement during the Solar Forecasting Prize—including but not limited to the submission, the online forum, emails to the prize administrator, or other forms of communication—contains any matter that, in the discretion of DOE, is indecent, lacking in professionalism, or demonstrates a lack of respect for people or life on this planet.

- If you click "Accept" on the HeroX platform and proceed to register for the competition described in this document, these rules will form a valid and binding agreement between you and DOE and is in addition to the existing HeroX Terms of Use for all purposes relating to this competition. You should print and keep a copy of these rules. These provisions apply only to the competition described here and no other competitions on the HeroX platform or anywhere else.

- The prize administrator, when feasible, may give competitors an opportunity to fix non-substantive mistakes or errors in their submission packages.

2. VERIFICATION FOR PAYMENTS

The prize administrator will verify the identity and the role of a participant entity potentially qualified to receive the 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 after the date that results are announced. Each competitor (or parent/guardian if under 18 years of age) will be required to sign and return to the prize administrator, within 30 days of the date the notice is sent, a completed NREL Request for ACH Banking Information form and a completed W9 form (https://www.irs.gov/pub/irs-pdf/fw9.pdf). At 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 cannot be contacted; (ii) the person/entity fails to sign and return the required documentation within the required time period; (iii) the notification is returned as undeliverable; or (iv) the submission or person/entity is disqualified for any other reason.

3. TEAMS AND SINGLE-ENTITY AWARDS

The prize administrator will award a single dollar amount to the business entity designated by the primary submitter, whether it consists of a single or multiple entities. The winning business entity is solely responsible for allocating any prize funds among its member competitors as it deems appropriate.

4. SUBMISSION RIGHTS

By making a submission and consenting to the rules of the competition, a competitor is granting to DOE, the prize administrator, and any other third parties supporting DOE in the competition, a license to display publicly and use the parts of the submission that are designated as "public" for government purposes. This license includes posting or linking to the public portions of the submission on the prize administrator's or HeroX's applications, on the competition website, on DOE websites, and on partner websites, and including the submission in any other media worldwide. The submission may be viewed by DOE, the prize administrator, and reviewers for purposes of this competition, including, but not limited to, screening and evaluation purposes. The prize administrator and any third parties acting on their behalf will also have the right to publicize the competitors' names and, as applicable, the names of competitors' team members and organizations that participated in the submission, on the competition website indefinitely.

By entering, the competitor represents and warrants that:

> The competitor is the sole, original author and copyright owner of the submission or that the applicant has acquired sufficient rights to use and to authorize others, including DOE, to use the submission as specified throughout the rules; that the submission does not infringe upon any copyright, trade secret, trademark, nondisclosure agreement, patent, or upon any other third-party rights; and that the submission is free of malware.

5. COPYRIGHT

Each competitor represents and warrants that the competitor is the sole author and copyright owner of the submission; that the submission is an original work of the applicant or that the applicant has acquired sufficient rights to use and to authorize others, including DOE, to use the submission, as specified throughout the rules; that the submission does not infringe upon any copyright or any other third-party rights of which the applicant is aware; and that the submission is free of malware.

6. PRIZE SUBJECT TO APPLICABLE LAW

This competition is 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 competition. This notice is not an obligation of funds; the final awards are contingent upon the availability of appropriations.

7. RESOLUTION OF DISPUTES

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

In the event of a dispute, 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. Competitors and potential winners may be required to show proof of being the authorized account holder.

The prize administrator will not arbitrate, intervene, advise on, or resolve any matters between team members or any disputes between competitors.

8. PUBLICITY

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

Except where prohibited, participation in the competition 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.

9. LIABILITY

Upon registration, all participants agree to assume and, thereby, have assumed, any and all risks of injury or loss in connection with or in any way arising from participation in this competition or development of any submission. 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 competition, whether the claim or cause of action arises under contract or tort.

In accordance with the delegation of authority to run this competition delegated to the director of SETO, the director has determined that no liability insurance will be required of competitors to compete in this competition, per 15 USC 3719(i)(2).

10. RECORDS RETENTION AND FREEDOM OF INFORMATION ACT (FOIA)

All materials submitted to DOE as part of a submission become DOE records. Any confidential commercial information contained in a submission should be designated at the time of submission.

Competitors are encouraged to employ protective markings in the following manner:

- The cover sheet of the submission must be marked as follows and must identify the specific pages containing trade secrets or commercial or financial information that is privileged or confidential:

  Notice of Restriction on Disclosure and Use of Data:

  Pages [list applicable pages] of this document may contain trade secrets or commercial or financial information that is privileged or confidential and is exempt from public disclosure. Such information shall be used or disclosed only for evaluation purposes. The Government may use or disclose any information that is not appropriately marked or otherwise restricted, regardless of source. [End of Notice]

- The header and footer of every page that contains trade secrets or privileged commercial or financial information must be marked as follows: "May contain trade secrets or commercial or financial information that is privileged or confidential and exempt from public disclosure."

- In addition, each line or paragraph containing trade secrets or commercial or financial information that is privileged or confidential must be enclosed in brackets.

Competitors will be notified of any FOIA 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 FOIA representative prior to the release of materials.

11. PRIVACY

If you choose to provide HeroX with personal information by registering or completing the submission package through the competition website, you understand that such information will be

transmitted to DOE and may be kept in a system of records. Such information will be used only to respond to you in matters regarding your submission and/or the competition, unless you choose to receive updates or notifications about other competition or programs from DOE on an opt-in basis. DOE and NREL are not collecting any information for commercial marketing.

12. GENERAL CONDITIONS

DOE reserves the right to cancel, suspend, and/or modify the competition, or any part of it, at any time. If any fraud, technical failures, or any other factors beyond DOE's reasonable control impair the integrity or proper functioning of the competition, as determined by DOE in its sole discretion, DOE may cancel or modify the competition.

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

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

13. PROGRAM POLICY FACTORS

While the scores of the expert reviewers will be carefully considered, it is the role of the prize administrator to maximize the impact of competition 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 following program policy factors may be considered in determining winners:

- Geographic diversity and potential economic impact of projects in a variety of markets

- Whether the use of additional DOE funds and provided resources continues to be nonduplicative and compatible with the stated goals of this program and DOE's 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 level of industry involvement and demonstrated ability to accelerate commercialization and overcome key market barriers

- The degree to which the submission is likely to lead to increased employment and manufacturing in the United States or provide other economic benefit 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 efforts or projects, which, when taken together, will best achieve the research goals and objectives

- The degree to which the submission expands DOE's funding to new competitors and recipients that have not been supported by DOE in the past

- The degree to which the submission exhibits team member diversity and the inclusion of underrepresented groups, with participants including but not limited to graduates and students of historically Black colleges and universities (HBCUs) and other minority-serving institutions (MSIs) or members operating within Qualified Opportunity Zones or other disadvantaged communities[14]

- The degree to which the submission enables new and expanding market segments

- Whether the project promotes increased coordination with nongovernmental entities for the demonstration of technologies and research applications to facilitate technology transfer.

14. DEFINITIONS

Prize Administrator means both the Alliance for Sustainable Energy operating in its capacity under the Management and Operating Contract for NREL, and SETO. When the prize administrator is referenced in this document, it refers to staff from both the Alliance for Sustainable Energy and SETO. Ultimate decision-making authority regarding competition matters rests with the director of SETO.

Solar Forecast Arbiter (SFA) Operator means the developers of the SFA platform from the University of Arizona, who run and maintain the SFA.

Reviewers are the industry and federal government experts who review the competitor submissions and evaluate and score the plans.

Judge is the DOE official who makes the final decision for the winners and runners-up, taking into consideration forecast skills, reviewer scores, interview findings (if applicable), and program policy factors listed in Appendix 1.

Competitor is an individual, organization, or team that registers to compete in the prize and submits the required items to be considered eligible for a cash prize.

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[14] DOE defines "disadvantaged communities" as areas that most suffer from a combination of economic, health, and environmental burdens, such as poverty, high unemployment, air and water pollution, and presence of hazardous wastes, as well as high incidence of asthma and heart disease. Examples include but are not limited to: economically distressed communities identified by the Internal Revenue Service as Qualified Opportunity Zones; communities identified as disadvantaged communities by their respective states; communities identified on the Index of Deep Disadvantage referenced at https://news.umich.edu/new-index-ranks-americas-100-most-disadvantaged-communities/; and communities that otherwise meet the DOE definition of a disadvantaged community.

Forecast Skill is the metric used to evaluate the performance of each competitor's submitted forecasts.

Continuous Ranked Probability Score (CRPS) is a metric that is designed to measure both the reliability and accuracy of a probabilistic forecast (see Appendix 4).

IV. APPENDIX 2: REQUEST TO WAIVE THE "DOMESTIC OWNERSHIP AND CONTROL" ELIGIBILITY REQUIREMENT

Waiver

If an entity seeking to compete does not have majority domestic ownership and control, the Office of Energy Efficiency and Renewable Energy (EERE) may consider issuing a waiver of that eligibility requirement where (1) the entity submits a compelling justification; (2) the entity is incorporated in and maintains a primary place of business in the United States; and (3) the entity otherwise meets the eligibility requirements. EERE will not waive the eligibility requirement that all competing entities must be incorporated in and maintain a primary place of business in the United States. Entities seeking a waiver should include a justification along with their submission. EERE may require additional information before making a determination on the waiver request. There are no rights to appeal DOE's decision on the waiver request.

The justification must address the following waiver criteria and content requirements:

Waiver Criteria

Entities seeking a waiver must demonstrate to the satisfaction of EERE that its participation: (1) has a high likelihood of furthering the objectives of this prize competition and (2) aligns with the best interest of the U.S. industry and U.S. economic development.

Content for Waiver Request

A waiver request must include the following information:

1. Entity's name and place of incorporation

2. The location of the entity's primary place of business

3. A statement describing the extent to which the entity is owned or controlled by a foreign government, agency, firm, corporation, or person who is not a citizen or permanent resident of the United States, including the applicable percentage of ownership/control

4. A compelling justification that addresses the waiver criteria stated above

5. A description of the project's anticipated contributions to the U.S. economy

6. A description of how the entity has benefitted U.S. research, development, and manufacturing, including contributions to employment in the United States and growth in new U.S. markets and jobs.

V. APPENDIX 3: TIME-OF-DAY PERSISTENCE ENSEMBLE BENCHMARK FORECAST

Persistence is among the simplest forecasting methods. The method takes observed data from a set time period prior to the forecast, and forecasts that the future data values will be the same as the previous observed data value. In this prize, the time-of-day persistence ensemble benchmark forecast calculates the forecast by aggregating the observed irradiance in W/m^2 on an hourly basis from the last 30 days and calculates the probability of irradiance values for every hour of the next day.

A more detailed description of the implementation of the time-of-day persistence ensemble can be found in https://solarforecastarbiter-core.readthedocs.io/en/latest/generated/solarforecastarbiter.reference_forecasts.persistence.persistence_probabilistic_timeofday.html.

For an overview of benchmark forecasts, including probabilistic forecasts, please refer to the work by Doubleday, Van Scyoc Hernandez, and Hodge linked in https://www.osti.gov/biblio/1762478-benchmark-probabilistic-solar-forecasts-characteristics-recommendations.

VI. APPENDIX 4: CONTINUOUS RANKED PROBABILITY SCORE (CRPS)

The CRPS is a score that is a designed to measure both the reliability and accuracy of a probabilistic forecast.[15] For a time series of forecasts comprising a cumulative distribution function (CDF)—a function that gives the probability that a random variable is less than or equal to the independent variable of the function—at each time point, the CRPS is:

$$CRPS = \frac{1}{n}\sum_{i=1}^{n}\int (F_i(x) - O_i(x))^2 dx$$

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[15] J. E. Matheson and R. L. Winkler, "Scoring Rules for Continuous Probability Distributions", Management Science, vol. 22, no. 10, pp. 1087–1096, 1976. DOI: 10.1287/mnsc.22.10.1087

Here, n is the number of forecast timestamps, x is the forecast quantity (GHI in the case of this competition), $F_i(x)$ is the CDF of the forecast quantity x at timestamp i, $O_i(x)$ is the CDF associated with the observed value x_i, and dx is the change in x:

$$O_i = \begin{cases} 0, & x < x_i \\ 1, & x \geq x_i \end{cases}$$

The CRPS reduces to the mean absolute error if the forecast is deterministic.

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