

# American-Made Challenges Video



Link: <https://www.youtube.com/watch?v=a2S00Z47VXw>

This webinar will be recorded.

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American-Made Challenges  
**SOLAR  
FORECASTING PRIZE**  
Informational Webinar



U.S. DEPARTMENT OF ENERGY

# Agenda

- 1 Background on the American-Made Challenges Program

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- 2 Solar Forecasting Prize Background

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- 3 Prize Overview, Registration Process and Winner Selection

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- 4 Solar Forecast Evaluation Period and Solar Forecast Arbiter Program

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- 5 How to Use HeroX

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# Housekeeping

## Two Options for Audio (select audio mode):

1. Listen through your computer:  
Click the 'up arrow' next to the "mute" button in the bottom left corner.  
Under "Select a Speaker," click "Same as System."
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## To Ask a Question:

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## Having Trouble with the Webinar?

Technical difficulties - contact Zoom Support at: 888-799-9666.

A video/audio recording of this webinar and the slide deck will be made available.

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# Background on the American-Made Challenges Program



U.S. DEPARTMENT OF ENERGY

# American-Made Challenges

## PURPOSE



### **Energize American ingenuity**

*in American  
innovation and  
manufacturing*



### **Empower innovators**

*with knowledge, resources,  
and access to rapidly  
transform ideas into  
prototypes*



### **Provides Network- powered pathway to disruptive innovation**

*so ideas can become  
real products in  
months, not years*



# Our Prizes

<https://americanmadechallenges.org>

View prizes by status: *all*



**Solar Forecasting Prize**

up to \$375,000 in prizes

[enter now](#)  
enter by 12/15/2021



**L-Prize**

up to \$12.2 million in prizes

[enter now](#)  
enter by 11/19/2021



**Hydrogen Business Case Prize**

up to \$250,000 in prizes

[enter now](#)  
register by 10/29/2021



**Inclusive Energy Innovation Prize**

up to \$2.5 million in prizes

[enter now](#)  
enter by 02/25/2022



**EnergyTech University Prize**

over \$100,000 in prizes

[coming soon](#)



**Perovskite Startup Prize**

up to \$3 million in prizes

[coming soon](#)



**Solar Prize**



**Geothermal Prize**



**Manufacturing Prize**

# Grants vs. Prizes

## Financial Award

### Process

Write and submit  
concept papers

Concept paper review

Applicants write and  
submit full applications

Full applications review

Selections and  
negotiations

**Begin performing**

Prepare and submit  
reimbursement request

**Request reviewed and  
reimbursement issued**

## Prize Award

### Process

Register for the Prize

**Perform  
(submit forecasts and plan)**

Reviewers score  
submissions

**Winners receive  
payment**



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# Solar Forecasting Prize Background



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# What is the Solar Forecasting Prize?

The American-Made Solar Forecasting Prize incentivizes 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.



# Improvements to Solar Forecasting and Prize Goals

Solar accounts for about 3% of U.S. electricity, 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.

## Improvements in solar forecasting would:

- Support solar stakeholders such as electric utilities and other grid operators to serve their customers more reliably and cost-effectively.
- Support cost-efficient planning and dispatch of energy generation and storage.

## Solar Forecasting Prize goals:

- Identify the best-performing probabilistic forecasting models.
- Generate strong commercialization plans that could increase the availability of probabilistic solar forecasting algorithms on the market.
- Solicit innovative plans to accelerate adoption of probabilistic forecasting products by end users, such as independent system operators, integrated utilities, and other balancing authorities.
- Support the use of transparent metrics and specifications of probabilistic solar forecasts, through an open platform, such as the Solar Forecast Arbiter.

# Solar Forecast Arbiter Background

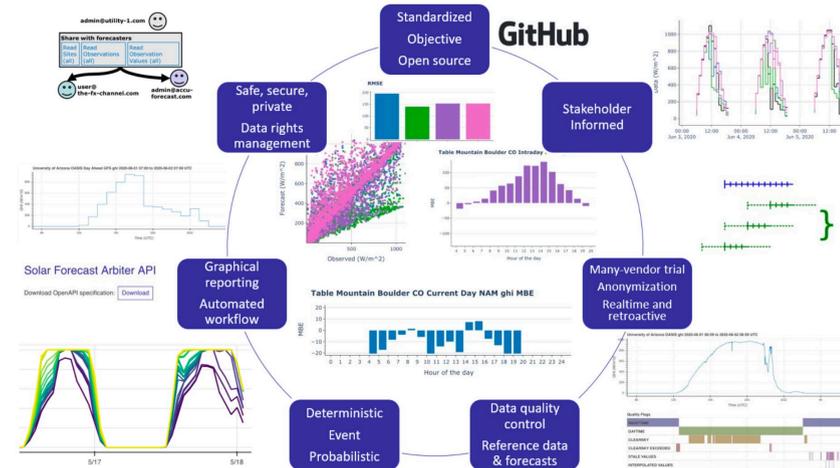
Solar Forecast Arbiter (SFA) is an open-source, cloud-ready platform that facilitates evaluation of forecasts for solar irradiance, solar power, and net load.

University of Arizona led the development of the platform under the U.S. Department of Energy Solar Energy Technologies Office's Solar Forecasting II funding program.



## Solar Forecast Arbiter

*A paradigm shift in forecast evaluation*



The Solar Forecast Arbiter supports a paradigm shift in the way we evaluate solar and net-load forecasts. For too long we have been unclear with each other and even with ourselves about what, exactly, we are evaluating and how the evaluation is done. Whether you're a forecast user, vendor, or researcher, the Solar Forecast Arbiter will force you to think about your analysis and what really matters before you start parsing data and calculating

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# Solar Forecasting Prize Overview and Registration Process



U.S. DEPARTMENT OF ENERGY

# Prizes

This prize offers a total of \$375,000 in cash prizes, with five anticipated winners and five anticipated runners-up.

	<b>Number of Prizes Awarded</b>	<b>Prizes</b>
<b>Winners</b>	5 anticipated winners	Each winner receives \$50,000 in cash
<b>Runners up</b>	5 anticipated runners-up	Each runner-up receives \$25,000 in cash

# WHO?

Any U.S.-based individual or team with a desire to transform ideas into impactful new solutions

CAN COMPETE



**Scientists**



**Students &  
Faculty**



**Businesses  
(of any size)**



**Anyone with a  
BIG! idea**

# Read the Rules



## 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**

The U.S. Department of Energy (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.

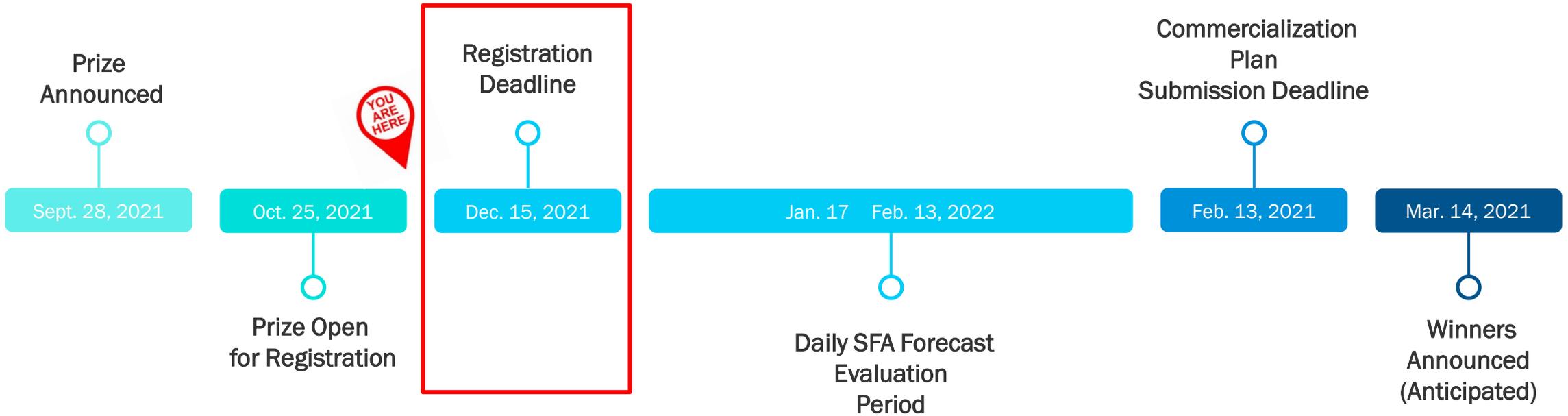
Official rules of the  
Solar Forecasting Prize  
are available online

[americanmadechallenges.org/solarforecasting/docs/rules/Solar\\_Forecasting\\_Prize\\_Official\\_Rules.pdf](https://americanmadechallenges.org/solarforecasting/docs/rules/Solar_Forecasting_Prize_Official_Rules.pdf)

or

[Solar Forecasting HeroX Page](#) > Resources Tab

# Prize Process Overview and Timeline



# How to Sign Up: HeroX Registration Form

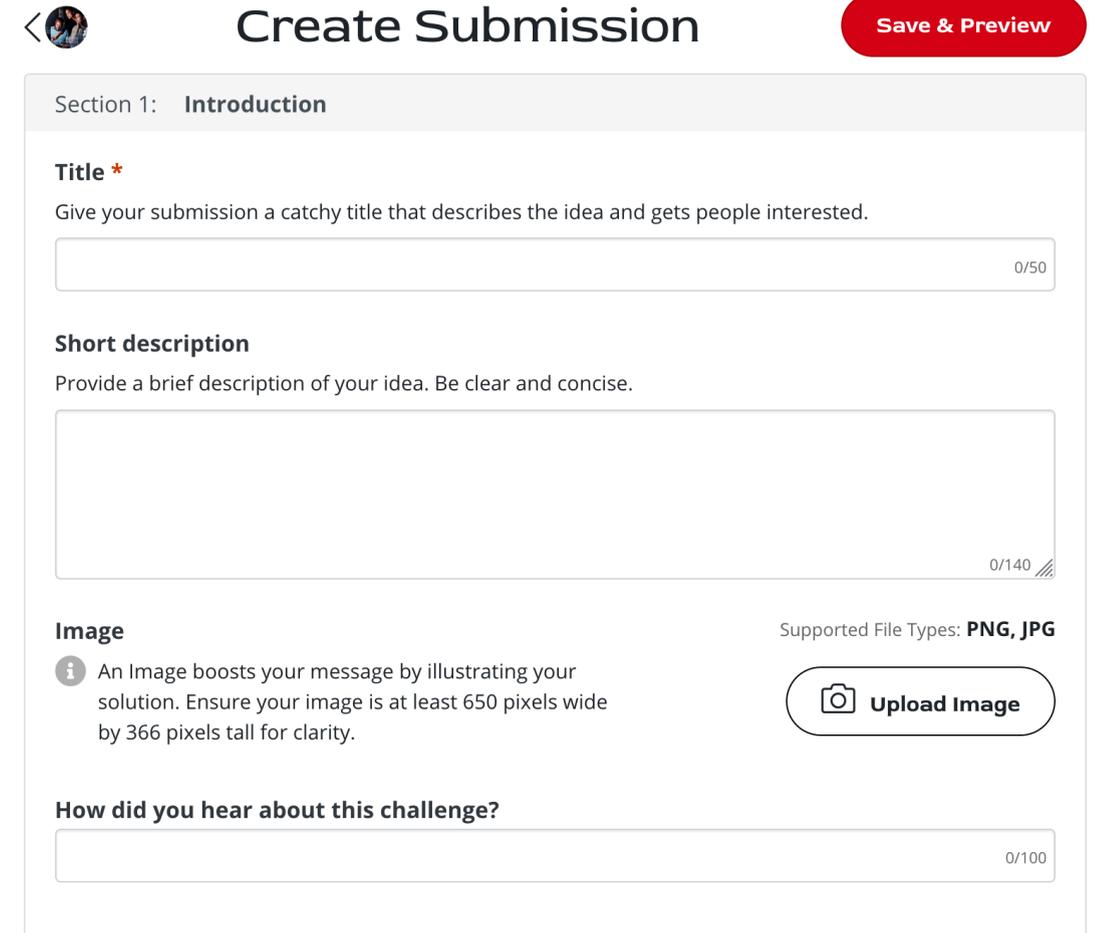
1. Go to HeroX.com/SolarForecasting
2. Click on “Solve This Challenge”
3. Sign-In or Create HeroX Account
4. Follow Prompts to Create Entry
5. You can adjust your registration until Dec. 15



The screenshot shows the 'American-Made Challenges' page for the 'Solar Forecasting Prize'. The page features a header with the challenge title, a description 'Enabling solar industry stakeholders with state-of-the-art solar forecasting capabilities', and a 'Solve This Challenge' button highlighted with a yellow arrow. The prize amount is listed as \$375,000. The page also includes a navigation menu with tabs for Overview, Guidelines, Timeline, Updates (1), Forum (1), Teams (50), Resources, and FAQ.

Challenge Overview

(Registration Form)



The screenshot shows the 'Create Submission' form for the challenge. The form is titled 'Section 1: Introduction' and includes a 'Title' field (0/50), a 'Short description' field (0/140), an 'Image' field (Supported File Types: PNG, JPG), and a 'How did you hear about this challenge?' field (0/100). A 'Save & Preview' button is located in the top right corner.

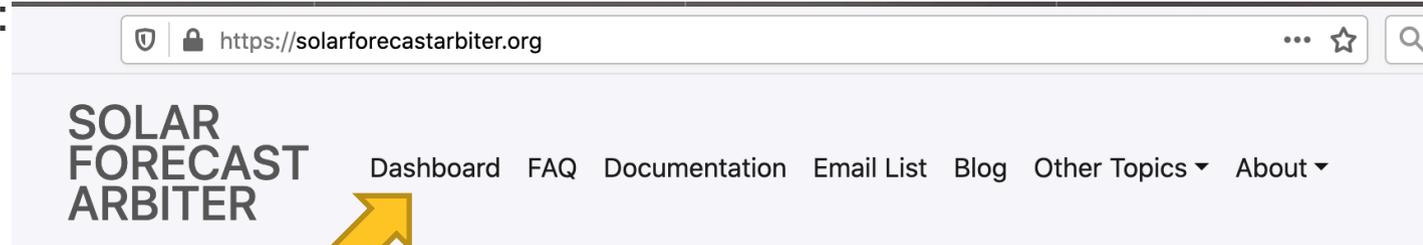
# How To Sign Up – SFA Registration

As a part of the registration process, you will be asked to create an account on the Solar Arbiter Forecast platform.

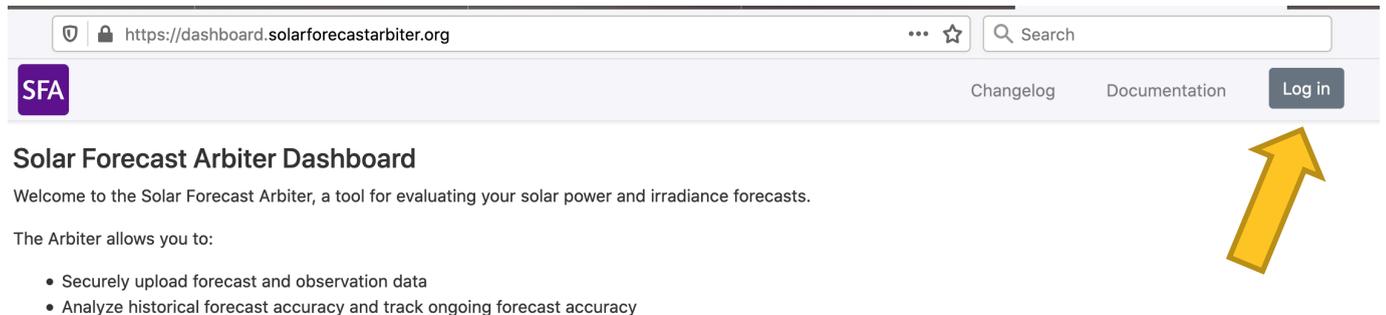
To create your account on the SFA platform:

1. Go to <https://solarforecastarbiter.org/>
2. Click on “Dashboard”
3. Click on “Log In”
4. Follow Prompts to Create an Account
5. Sign the [SFA Data Use Agreement](#) (if not already done) and upload it to your HeroX registration form

**Important! In the HeroX registration form, you must enter in your e-mail EXACTLY how it appears on your SFA account registration.**



## Solar Forecast Arbiter



# How to Sign-Up as a Team or Find New Team Members

When you sign up on HeroX, you have the option of signing up as in individual or a team.

< Competitor registration

Would you like to compete as a team? \*

Yes, I want to create my own team

Yes, I want to join a team

No, I want to compete individually

You still will be able to create or join other teams later.

< Invite team members

Who would you like to invite to your team?

E-mail

E-mail

E-mail

+ Add Another

Leave fields blank if you don't want to invite anyone right now.

I accept the terms of the [Team Agreement](#)

Continue

You can also use the HeroX Team Matching Tool to find new team members

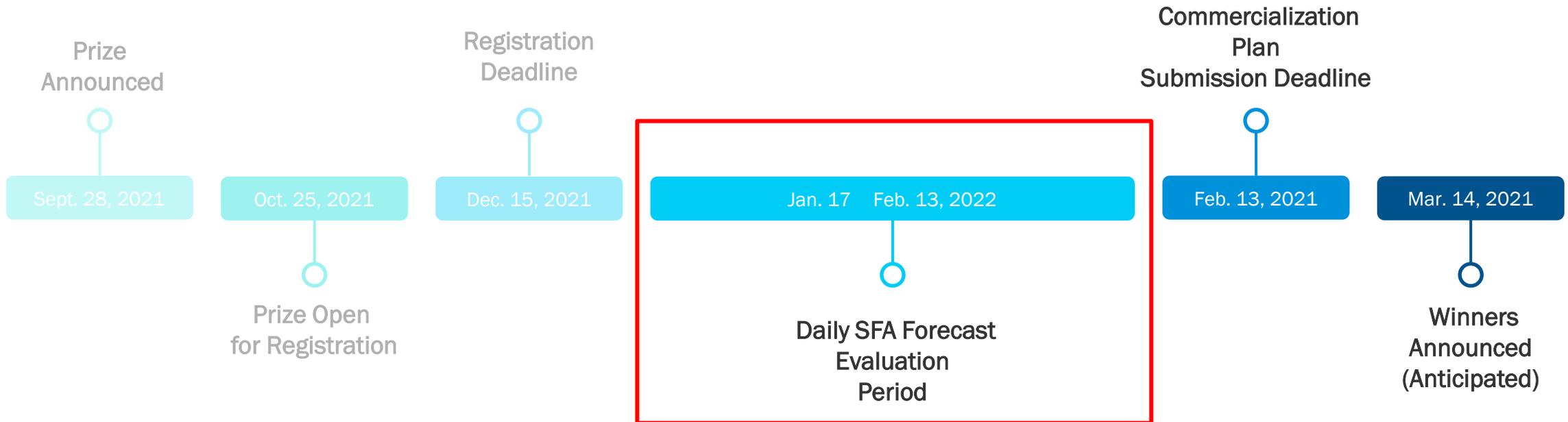
Overview Guidelines Timeline Updates Forum Teams Resources FAQ

Create a team & start collaborating

Work with each other and share the credit.

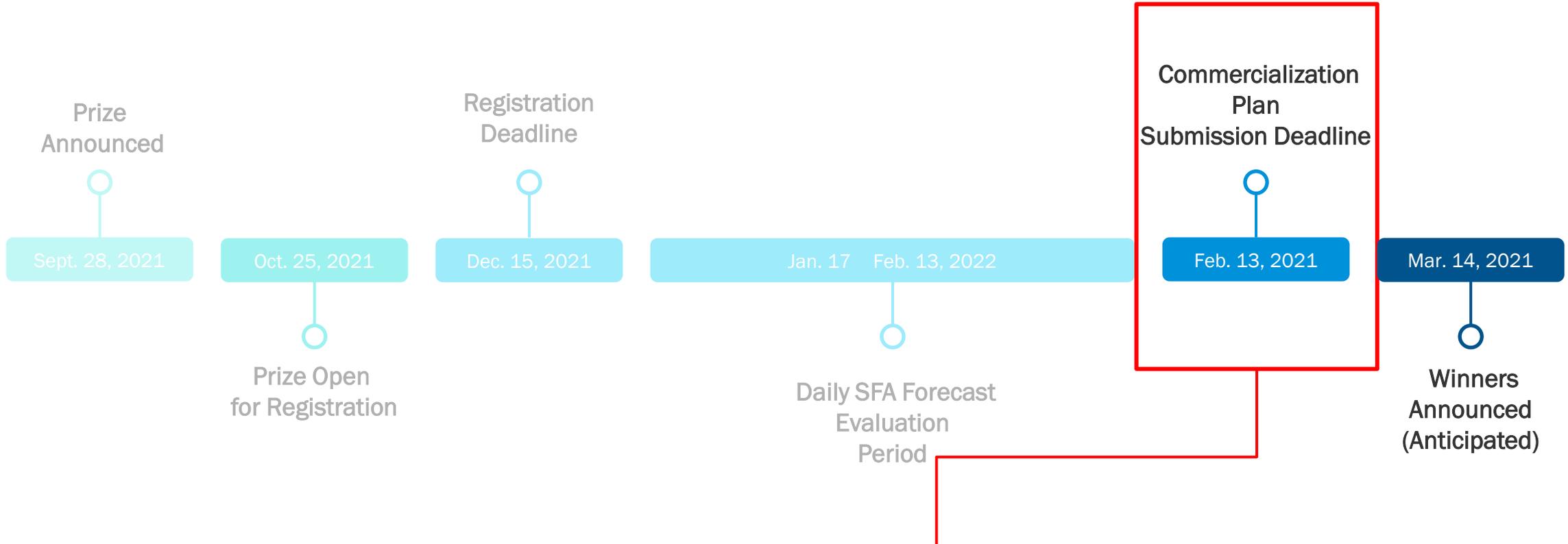
Leave challenge Find a Team

# Prize Process Overview and Timeline



After registration, the next step of the prize will be to upload daily solar forecasts to the SFA platform.

# Prize Process Overview and Timeline



After registering for the prize, you will have until Feb. 13, 2022 to upload your commercialization plan in HeroX

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# Commercialization Plan and Scoring



U.S. DEPARTMENT OF ENERGY

# Final HeroX Submission

By Feb. 13 (last day of SFA evaluations), teams will need to upload 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

## Commercialization Plan

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

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

Commercialization plans should be tailored as follows:

- **If you are NOT currently providing forecast services commercially**, your plans should focus on your product-to-market approach for your probabilistic forecasting algorithm or model.
- **If you do currently provide forecast services commercially**, your plans should focus on innovative approaches to accelerating the adoption of probabilistic forecasts by the broader industry.

# Commercialization Plan Scoring Criteria

The commercialization plan judging criteria can be found in the official rules document. Each statement is scored on a 1-6 scale:

Commercialization Plan (PDF) Maximum 2,000 words and 5 supporting images or figures	
<b>Question 1:</b> Is the proposed solution innovative compared to the current state of the art?	
<b>Suggested content to include in the plan:</b> <ul style="list-style-type: none"><li>Describe the state of the art for probabilistic forecasts, including existing commercially available solutions and their rate of adoption by the industry.</li><li>Depending on your perspective, briefly describe either the solution you plan to commercialize or the strategy you propose for the increased adoption of probabilistic forecasts.</li></ul>	<b>Statements scored on 1–6 scale:</b> <ul style="list-style-type: none"><li>The competitor shows solid understanding of the current market conditions, limitations, and opportunities.</li><li>The competitor describes the innovation in their solution or proposed strategy.</li><li>The competitor's approach has a realistic potential to disrupt the existing market conditions.</li></ul>

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

# How We Score Submissions and Select Winners

**SFA Forecast Evaluation Scoring:** The continuous ranked probability score (CRPS) 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:

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

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 be then multiplied by 100 and then multiplied by a factor of three. The result of this multiplication will be your final forecast score.

**Commercialization Plan Scoring:** 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. All reviewers' scores will then be averaged for a final reviewer score – the plan score – for the submitted plan.

**Total score:** Your total score is the sum of your plan score and your final forecast score.

**The prize judge (DOE) will consider overall SFA performance, commercialization plan scores and comments, and program policy factors when deciding the winners of the prize.**

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# Solar Forecast Evaluation Period and Solar Forecast Arbiter Program



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# SFA Components

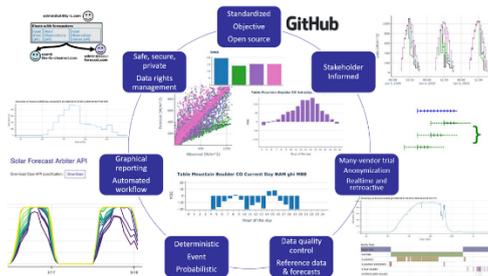
## Informational Page

[solarforecastarbiter.org](https://solarforecastarbiter.org)



## Solar Forecast Arbiter

### A paradigm shift in forecast evaluation



The Solar Forecast Arbiter supports a paradigm shift in the way we evaluate solar and net-load forecasts. For too long we have been unclear with each other and even with ourselves about what, exactly, we are evaluating and how the evaluation is done. Whether you're a forecast user, vendor, or researcher, the Solar Forecast Arbiter will force you to think about your analysis and what really matters before you start parsing data and calculating statistics. This can be an unfamiliar and uncomfortable process. Stick with it and we think you'll see the value in this approach. **So what's the value? Clear, transparent communication of the skill of a precisely-defined forecast.**

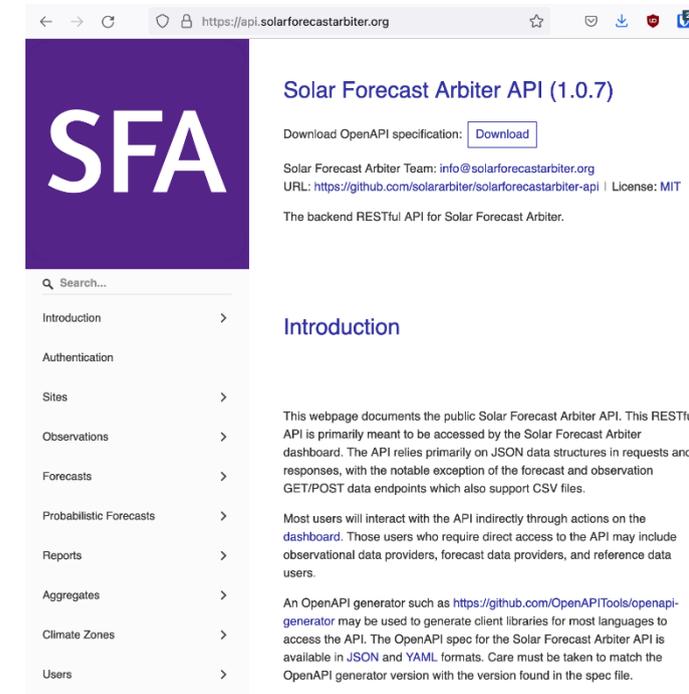
## Dashboard

[dashboard.solarforecastarbiter.org](https://dashboard.solarforecastarbiter.org)



## API

[api.solarforecastarbiter.org](https://api.solarforecastarbiter.org)

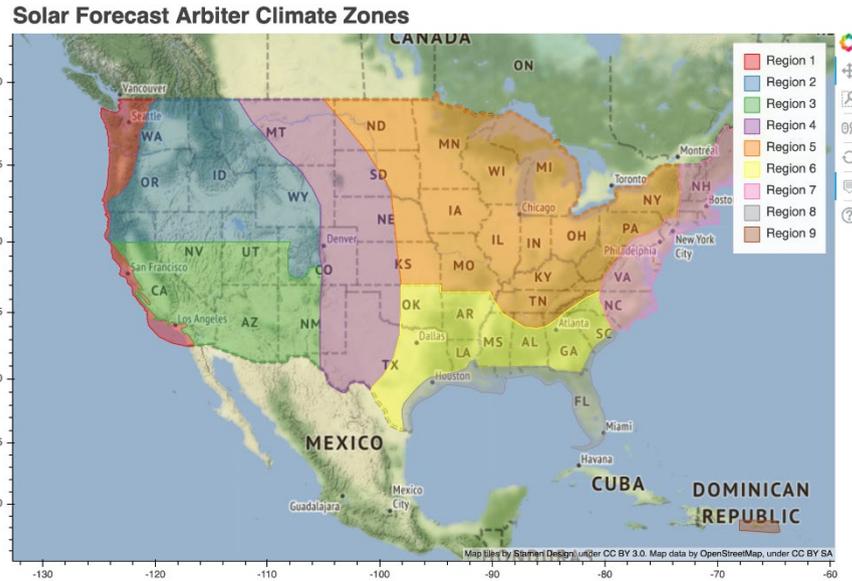


Code: [github.com/SolarArbiter/](https://github.com/SolarArbiter/)

# SFA Background

[solarforecastarbiter.org](https://solarforecastarbiter.org)

## Climate Zone Definitions



## FAQ Page

### Q. Can I use the Solar Forecast Arbiter to analyze wind power forecasts?

A. Yes! When creating a new Site, select Power Plant and simply ignore the solar-specific information such as surface tilt. Then proceed to use the Arbiter as normal. We are exploring what would need to be done to better support wind forecasts in [this issue](#).

## Metrics

The screenshot shows the web interface for the Solar Forecast Arbiter metrics page. The browser address bar displays the URL <https://solarforecastarbiter.org/metrics/>. The page header includes the site name "SOLAR FORECAST ARBITER" and navigation links for Dashboard, FAQ, Documentation, Email List, Blog, Other Topics, and About. The main content area is titled "Metrics" and contains a list of metrics categorized into Deterministic, Probabilistic, and Value Metrics. The "Metrics for Deterministic Forecasts" section lists metrics A through L, including Mean Absolute Error (MAE), Mean Bias Error (MBE), Root Mean Square Error (RMSE), Forecast Skill, Mean Absolute Percentage Error (MAPE), Normalized Mean Absolute Error (NMAE), Normalized Mean Bias Error (NMBE), Normalized Root Mean Square Error (NRMSE), Centered (unbiased) Root Mean Square Error (CRMSE), Pearson Correlation Coefficient (r), Coefficient of Determination (R<sup>2</sup>), Relative Euclidean Distance (D), Kolmogorov-Smirnov Test Integral (KSI), OVER, Combined Performance Index (CPI), and Metrics for Deterministic Forecast Events (Probability of Detection (POD), False Alarm Ratio (FAR), Probability of False Detection (POFD), Critical Success Index (CSI), Event Bias (EBIAS), Event Accuracy (EA)). The "Metrics for Probabilistic Forecasts" section lists metrics A through I, including Brier Score (BS), Brier Skill Score (BSS), Reliability (REL), Resolution (RES), Uncertainty (UNC), Quantile Score (QS), Quantile Skill Score (QSS), Sharpness (SH), and Continuous Ranked Probability Score (CRPS). The "Value Metrics" section lists Value as a Function of Error and Production Cost Modeling. A "References" link is also present at the bottom.

## Metrics

The Solar Forecast Arbiter evaluation framework provides a suite of metrics for evaluating deterministic and probabilistic solar forecasts. These metrics are used for different purposes, e.g., comparing the forecast and the measurement, comparing the performance of multiple forecasts, and evaluating an event forecast.

## Metrics for Deterministic Forecasts

The following metrics provide measures of the performance of deterministic forecasts. Each metric is computed from a set of  $n$  forecasts  $(F_1, F_2, \dots, F_n)$  and corresponding observations  $(O_1, O_2, \dots, O_n)$ .

In the metrics below, we adopt the following nomenclature:

- $n$  : number of samples
- $\hat{F}$  : forecasted value
- $O$  : observed (actual) value
- $norm$  : normalizing factor (with the same units as the forecasted and observed values)
- $\bar{F}, \bar{O}$  : the mean of the forecasted and observed values, respectively

For more information on these metrics and others, see [Zhang15](#), [Wilks11](#) and the references listed below.

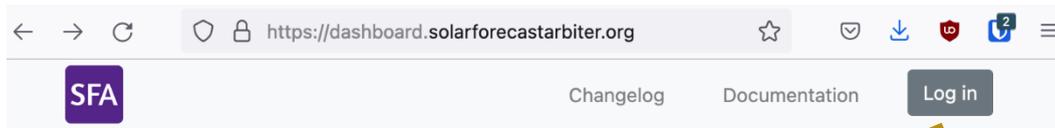
Note that for normalized metrics (NMAE, NMBE, NRMSE), the Solar Forecast Arbiter currently allows no user control over normalization via the dashboard. Instead, the Arbiter has the following behavior depending on the forecasted variable type:

# SFA Dashboard

[dashboard.solarforecastarbiter.org](https://dashboard.solarforecastarbiter.org)

Create free, no-obligation account to browse reference data, forecasts, reports

## 1. Click “Log in”



### Solar Forecast Arbiter Dashboard

Welcome to the Solar Forecast Arbiter, a tool for evaluating your solar power and irradiance forecasts.

The Arbiter allows you to:

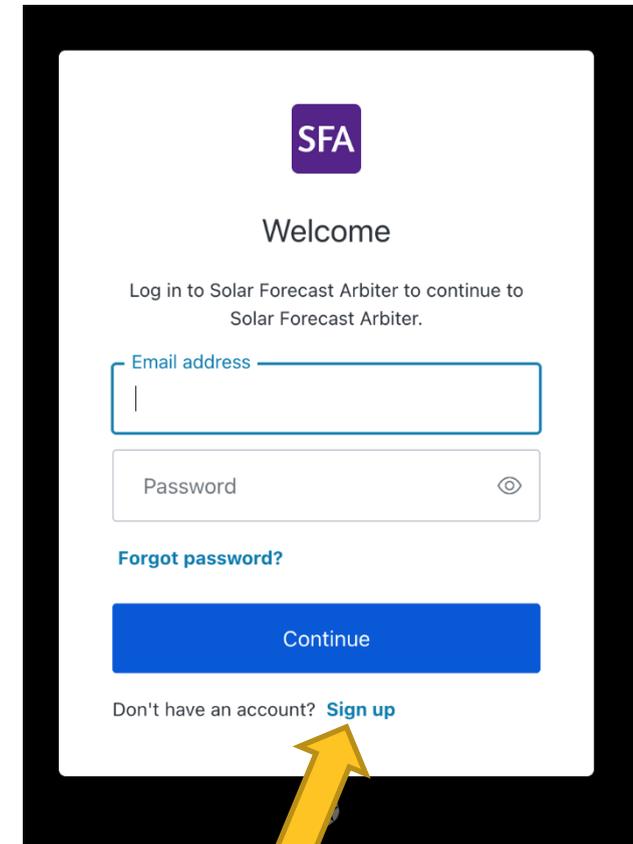
- Securely upload forecast and observation data
- Analyze historical forecast accuracy and track ongoing forecast accuracy
- Optionally share data and analysis reports with other users
- Participate in anonymous, multi-vendor, operational forecast trials

The Arbiter provides a large collection of [reference observations](#) from several distinct [climate zones](#) throughout the United States. A suite of [benchmark forecasts](#) are provided alongside these reference observations.

To get started with the reference dataset, follow the 'Sign up' link at the bottom of the [log in form](#). See [Getting Started](#) for more information on how to access the rest of the Solar Forecast Arbiter's features.

[Log in](#) to access the dashboard.

## 2. Click “Sign up”



# SFA Reference Data

SFA includes 226 reference data sites

## Observations

- All GHI
- Some DNI, DHI
- A few AC/DC power, POA
- Daily fetch for vast majority
- 2 – 4 years of data

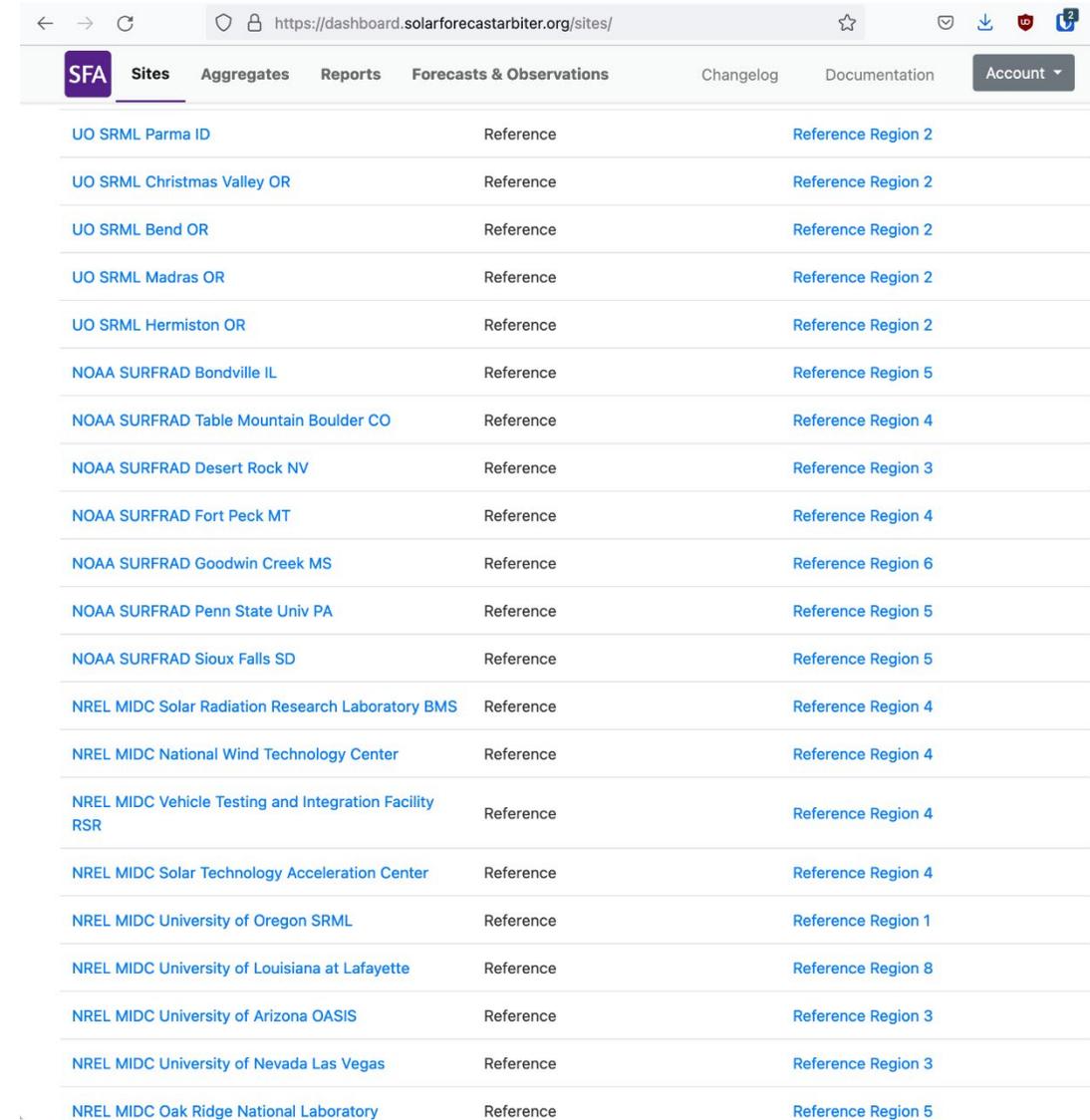
## Forecasts

- Intraday – day ahead based on NOAA models
- Intraday based on persistence

## Probabilistic Forecasts

- Day ahead based on NOAA GEFS
- Day ahead based on persistence ensemble

Nightly recomputed reports of reference fx performance



The screenshot shows a web browser displaying the SFA Reference Data dashboard. The URL is <https://dashboard.solarforecastarbiter.org/sites/>. The dashboard has a navigation menu with the following items: SFA, Sites, Aggregates, Reports, Forecasts & Observations, Changelog, Documentation, and Account. The main content area displays a table of reference data sites. The table has three columns: Site Name, Type, and Reference Region. The sites listed are:

Site Name	Type	Reference Region
<a href="#">UO SRML Parma ID</a>	Reference	<a href="#">Reference Region 2</a>
<a href="#">UO SRML Christmas Valley OR</a>	Reference	<a href="#">Reference Region 2</a>
<a href="#">UO SRML Bend OR</a>	Reference	<a href="#">Reference Region 2</a>
<a href="#">UO SRML Madras OR</a>	Reference	<a href="#">Reference Region 2</a>
<a href="#">UO SRML Hermiston OR</a>	Reference	<a href="#">Reference Region 2</a>
<a href="#">NOAA SURFRAD Bondville IL</a>	Reference	<a href="#">Reference Region 5</a>
<a href="#">NOAA SURFRAD Table Mountain Boulder CO</a>	Reference	<a href="#">Reference Region 4</a>
<a href="#">NOAA SURFRAD Desert Rock NV</a>	Reference	<a href="#">Reference Region 3</a>
<a href="#">NOAA SURFRAD Fort Peck MT</a>	Reference	<a href="#">Reference Region 4</a>
<a href="#">NOAA SURFRAD Goodwin Creek MS</a>	Reference	<a href="#">Reference Region 6</a>
<a href="#">NOAA SURFRAD Penn State Univ PA</a>	Reference	<a href="#">Reference Region 5</a>
<a href="#">NOAA SURFRAD Sioux Falls SD</a>	Reference	<a href="#">Reference Region 5</a>
<a href="#">NREL MIDC Solar Radiation Research Laboratory BMS</a>	Reference	<a href="#">Reference Region 4</a>
<a href="#">NREL MIDC National Wind Technology Center</a>	Reference	<a href="#">Reference Region 4</a>
<a href="#">NREL MIDC Vehicle Testing and Integration Facility RSR</a>	Reference	<a href="#">Reference Region 4</a>
<a href="#">NREL MIDC Solar Technology Acceleration Center</a>	Reference	<a href="#">Reference Region 4</a>
<a href="#">NREL MIDC University of Oregon SRML</a>	Reference	<a href="#">Reference Region 1</a>
<a href="#">NREL MIDC University of Louisiana at Lafayette</a>	Reference	<a href="#">Reference Region 8</a>
<a href="#">NREL MIDC University of Arizona OASIS</a>	Reference	<a href="#">Reference Region 3</a>
<a href="#">NREL MIDC University of Nevada Las Vegas</a>	Reference	<a href="#">Reference Region 3</a>
<a href="#">NREL MIDC Oak Ridge National Laboratory</a>	Reference	<a href="#">Reference Region 5</a>

# Site List for Solar Forecasting Prize

Site	Network
<a href="#">Kona, Hawaii</a>	NREL MIDC
<a href="#">Seattle, Washington</a>	NOAA SOLRAD
<a href="#">Hanford, California</a>	NOAA SOLRAD
<a href="#">Salt Lake City, Utah</a>	NOAA SOLRAD
<a href="#">Table Mountain Boulder, Colorado</a>	NOAA SURFRAD
<a href="#">Goodwin Creek, Mississippi</a>	NOAA SURFRAD
<a href="#">Bondville, Illinois</a>	NOAA SURFRAD
<a href="#">Titusville, Florida</a>	NOAA USCRN
<a href="#">Sterling, Virginia</a>	NOAA SOLRAD
<a href="#">Millbrook, New York</a>	NOAA USCRN

Detailed site list information can be found on [HeroX](#) under the [Resource tab](#).



<  **Solar Forecasting Prize Site List**

[https://americanmadechallenges.org/solarforecasting/docs/resources/Solar\\_Forecasting\\_Prize\\_Site\\_List.pdf](https://americanmadechallenges.org/solarforecasting/docs/resources/Solar_Forecasting_Prize_Site_List.pdf)

**Brief description**  
A list of locations for which competitors will submit their daily forecasts during the contest evaluation period.

**Key insights**

- The site names are linked to pages within the Solar Forecast Arbiter (SFA) where competitors can see the observations from the instruments installed at those sites.
- The region names are linked to the respective descriptions in SFA.
- Competitors need to have an Arbiter account (free) to access site information in SFA.

Submitted by [NREL Challenge](#) on Oct. 23, 2021 [Edit](#) [Delete](#)

# SFA Data Model

Concept 1: A **site** contains **observations** and **forecasts**.

Concept 2: **Observations** and **forecasts** are defined by their metadata.

Concept 3: Upload **time series** data to **observation** and **forecast** end points.

## /Sites/NOAA SOLRAD Hanford California

[Observations](#) [Forecasts](#) [Probabilistic Forecasts](#)

### Site Metadata

[Download Metadata](#)

**Name:** NOAA SOLRAD Hanford California  
**UUID:** c291964c-7e49-11e9-af46-0a580a8003e9  
[Copy UUID](#)  
**Latitude:** 36.31357 (°N)  
**Longitude:** -119.63164 (°E)  
**Timezone:** America/Los Angeles  
**Elevation:** 73.0 (m)  
**Climate Zones:**

- [Reference Region 3](#)

[Extra parameters](#) ▾

## /Sites/NOAA SOLRAD Hanford California/Observations

[Observations](#) [Forecasts](#) [Probabilistic Forecasts](#)

[Create new Observation](#)

Name	Variable ▾	Provider ▾	Site
<a href="#">Hanford California ghi</a>	GHI	Reference	<a href="#">NOAA SOLRAD Hanford California</a>
<a href="#">Hanford California dni</a>	DNI	Reference	<a href="#">NOAA SOLRAD Hanford California</a>
<a href="#">Hanford California dhi</a>	DHI	Reference	<a href="#">NOAA SOLRAD Hanford California</a>

# SFA Data Model

Concept 1: A **site** contains **observations** and **forecasts**.

Concept 2: **Observations** and **forecasts** are defined by their metadata.

Concept 3: Upload/download **time series** data to/from **observation** and **forecast** objects.

[/Sites/NOAA SOLRAD Hanford California/Observations/Hanford California ghi](#)

## Observation Metadata

[Download Metadata](#)

**Name:** Hanford California ghi  
**UUID:** c2955cde-7e49-11e9-acd2-0a580a8003e9  
[Copy UUID](#)  
**Site:** [NOAA SOLRAD Hanford California](#)

**Variable:** GHI (W/m<sup>2</sup>)  
**Value type:** interval mean  
**Interval label:** ending  
**Interval length:** 1 minute  
**Uncertainty:** 0.0 (%)  
**Start:** 2016-12-29 00:00:00Z  
**End:** 2021-11-02 23:59:00Z

[Extra parameters](#) ▾

[Clone Metadata](#)

# SFA Data Model

Concept 1: A **site** contains **observations** and **forecasts**.

Concept 2: **Observations** and **forecasts** are defined by their metadata.

Concept 3: Upload/download **time series** data to/from **observation** and **forecast** objects.

/Sites/NOAA SOLRAD Hanford California/Observations/Hanford California ghi

## Observation Metadata

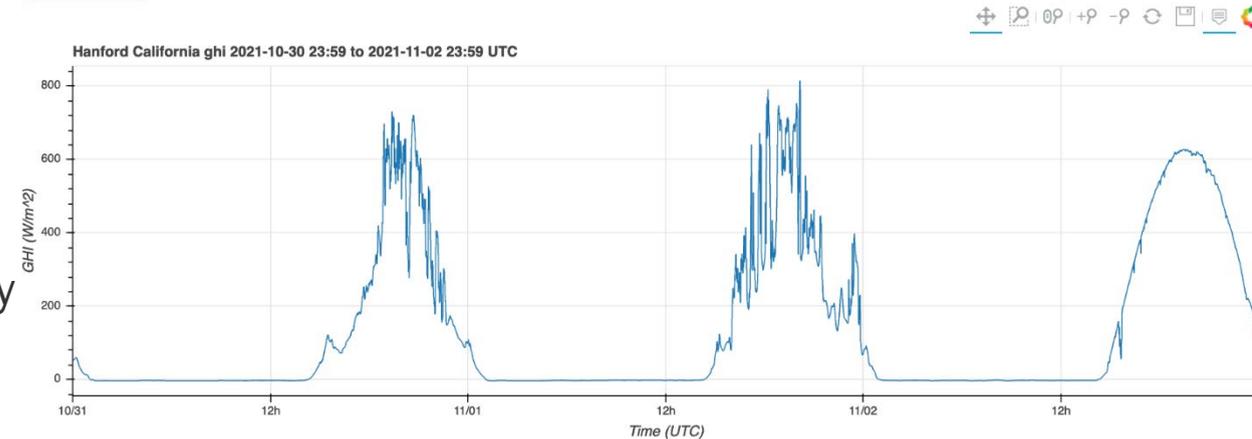
[Download Metadata](#)

**Name:** Hanford California ghi  
**UUID:** c2955cde-7e49-11e9-acd2-0a580a8003e9  
[Copy UUID](#)  
**Site:** [NOAA SOLRAD Hanford California](#)

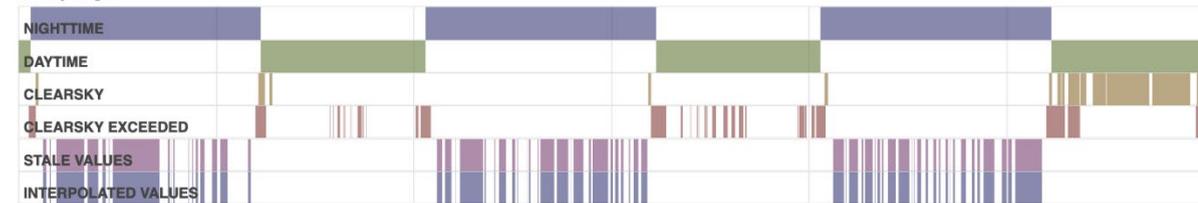
**Variable:** GHI (W/m<sup>2</sup>)  
**Value type:** interval mean  
**Interval label:** ending  
**Interval length:** 1 minute  
**Uncertainty:** 0.0 (%)  
**Start:** 2016-12-29 00:00:00Z  
**End:** 2021-11-02 23:59:00Z

[Extra parameters](#) ▾

[Clone Metadata](#)



## Quality Flags



Use the start and end selectors below to set the range of the plot above or download data. A maximum of one year of data may be downloaded.

Start (UTC)

2021 - 10 - 30 23 : 59

End (UTC)

2021 - 11 - 2 23 : 59

[Update graph](#)

[Download data](#)

Format:  CSV  JSON [\(format examples\)](#)

Observation data will include validation results in the **quality\_flag** field. See the [data validation documentation](#) for descriptions of these quality flags.

# SFA Forecasts

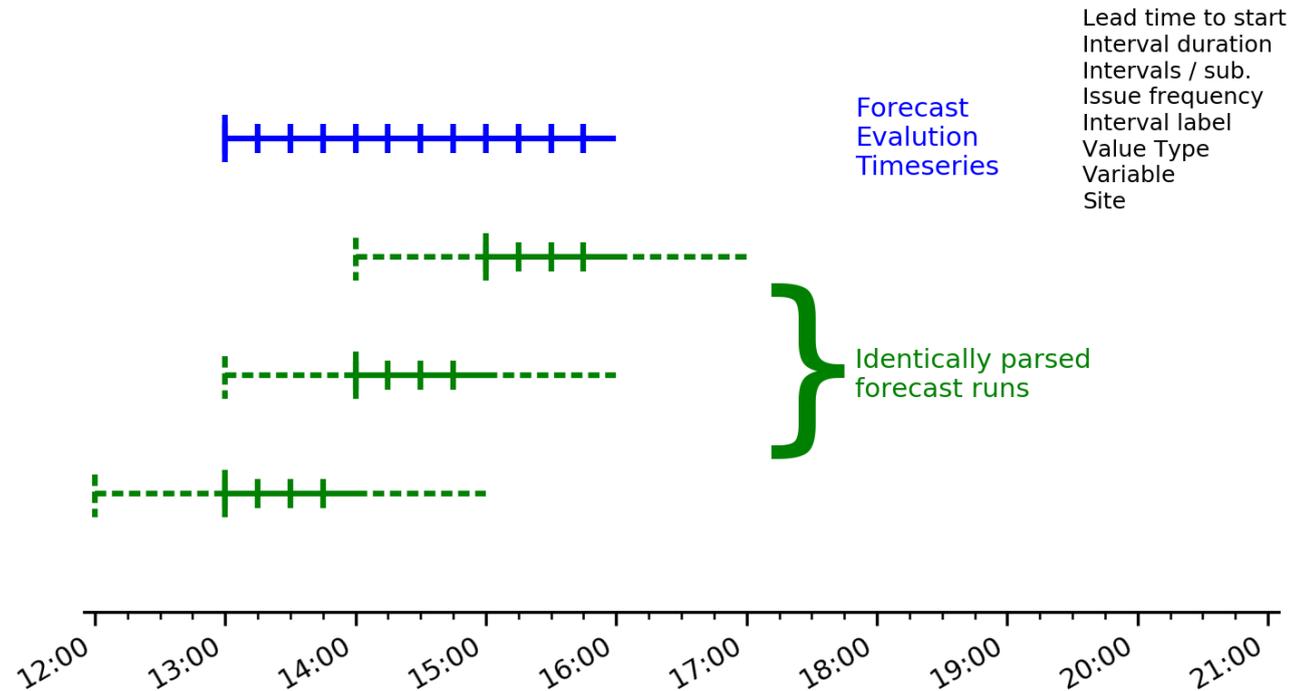
## Problem

1. Forecasters produce much more data than people can easily understand (many issue times x long length x multiple temporal resolutions)
2. Most of that data is redundant
3. Eventually, a person must decide what really matters when assessing a forecast

## SFA solution

- Decide what really matters before uploading data

*Stop and think about the application/analysis before you start it*



For Solar Forecasting Prize: the day ahead, midnight to midnight, forecast issued at 10 am local time

# SFA Forecasts

For Solar Forecasting Prize...

Day ahead, midnight to midnight, hourly forecast issued at 10 a.m. local time

Example at SURFRAD Table Mountain (UTC-7):

- Issue time of day: 17 UTC
- Lead time to start: 14 hours
- Run length/Issue frequency: 1 day
- Interval length: 1 hour
- Interval label: Beginning

## Create New CDF Forecast

See [forecast definitions](#) for detailed explanations of parameters.

### Site Metadata

**Name:** NOAA SURFRAD Table Mountain Boulder CO

**UUID:** 9dfa7910-7e49-11e9-b4e8-0a580a8003e9

[Copy UUID](#)

**Latitude:** 40.12498 (°N)

**Longitude:** -105.2368 (°E)

**Timezone:** Etc/GMT+7

**Elevation:** 1689.0 (m)

**Climate Zones:**

- [Reference Region 4](#)

[Extra parameters](#) ▾

Name

SURFRAD Table Mountain Gauss ?

Variable

GHI (W/m<sup>2</sup>) ▾

Issue time of day

17 ▾ : 00 ▾ UTC ?

Lead time to start

14 ▾ Hours ▾ ?

Run length/Issue frequency

1 ▾ Days ▾ ?

Interval length

1 ▾ Hours ▾ ?

Interval label

Beginning ▾ ?

Interval value type

Mean ▾

Axis

variable value  percentile ?

Constant values

0.0,10.0,20.0,30.0,40.0,50.0,60.0,70.0,80.0,90.0,100.0 ?

Extra parameters (optional)

This field will store any ASCII text. We recommend using it to store other parameters you have collected in a format such as YAML or JSON.

Submit

# Probabilistic Forecasts

Distributions may be described by forecasts of:

- Fixed percentiles (e.g., 1, 5, 10...90, 95, 99)
- Fixed thresholds (e.g., 1 MW, 5 MW...25 MW, 30 MW)

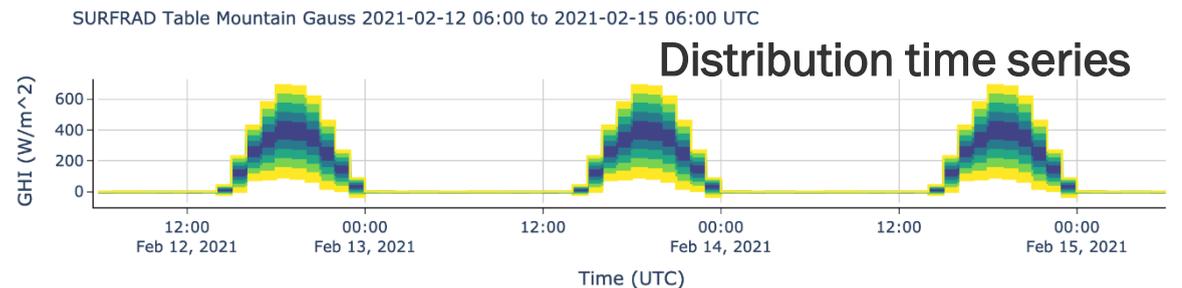
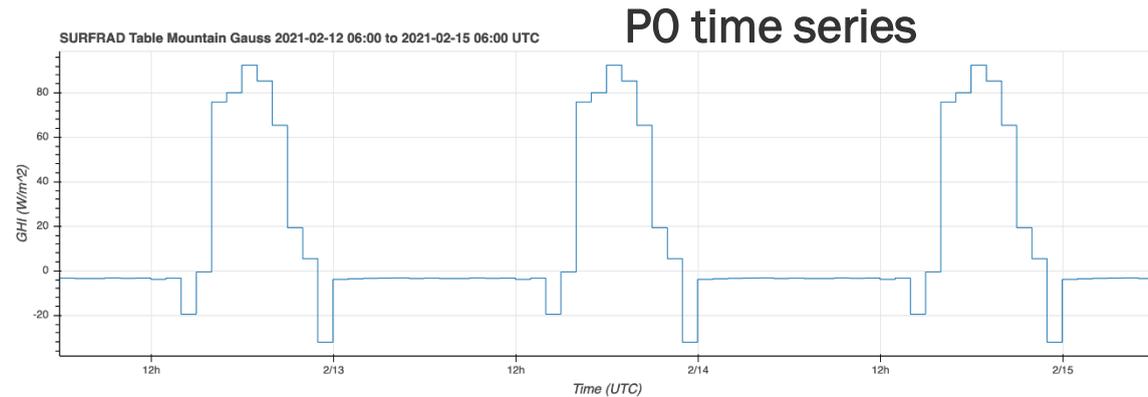
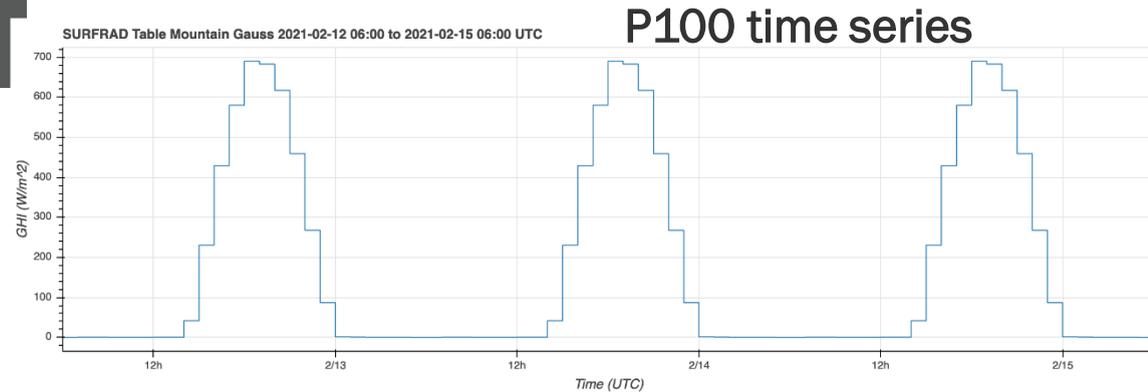
Solar Forecasting Prize uses fixed percentiles.

Each percentile is represented by a unique endpoint in the SFA API.

User posts a forecast to each percentile, so a forecast for each site requires 11 post operations...

...but file format is trivial!

```
timestamp,value  
2021-02-12T19:00:00Z,700  
2021-02-12T20:00:00Z,690
```



# SFA Reports

Reports structured for clear, reproducible analysis.

[dashboard.solarforecastarbiter.org/reports/](https://dashboard.solarforecastarbiter.org/reports/)

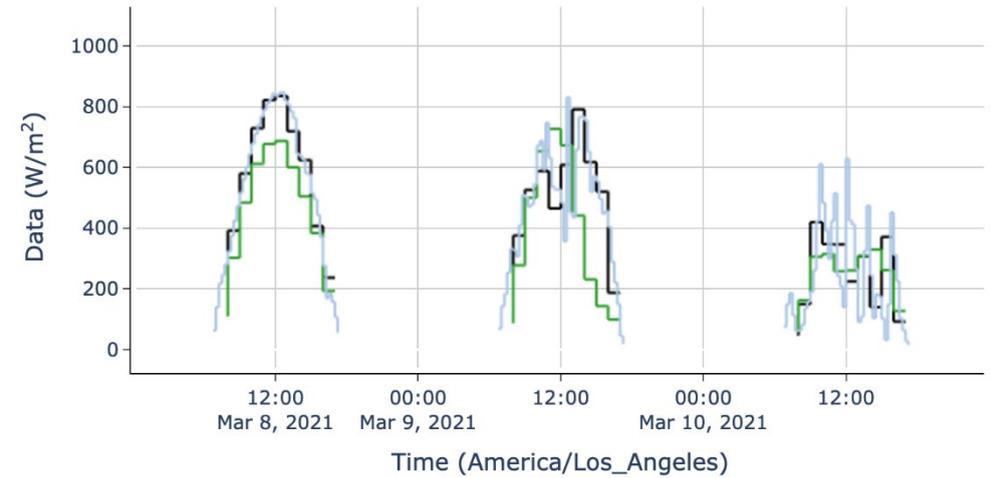
## Table of data validation filters

Quality flags	Discard before resample	Resample threshold (%)
NIGHTTIME, USER FLAGGED	True	10.0

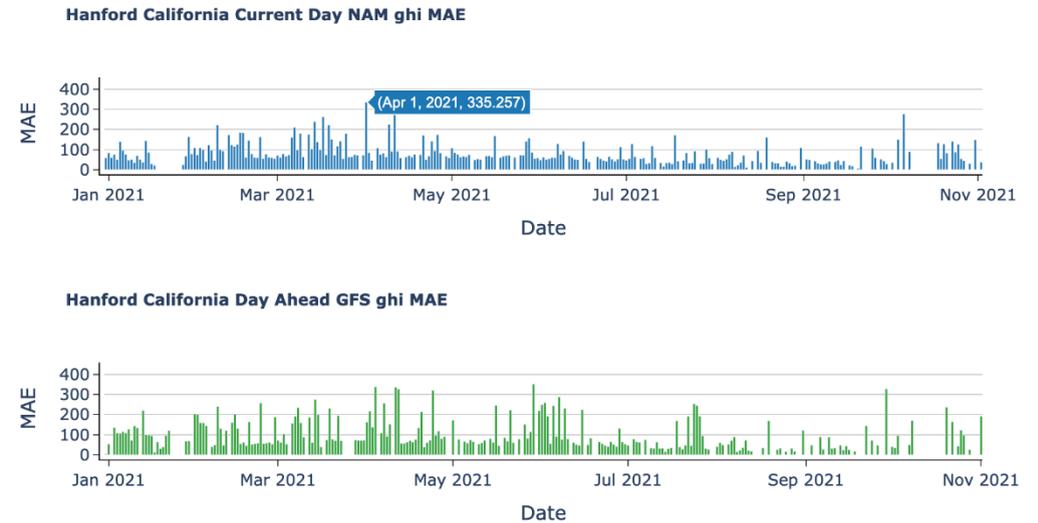
## Table of total metrics

Forecast	MBE	MAE	RMSE
Hanford California Day Ahead GFS ghi	-85.7	103	162
Hanford California Current Day NAM ghi	-62.9	79.4	114
Hanford California Intraday HRRR ghi	15.5	41	70.3
Hanford California Intraday RAP ghi	-101	113	171
Hanford California Hour Ahead Persistence ghi	5.18	60.7	99.7

## Time series



## Metrics by date, season, etc.



# SFA Reports for Prize

## Solar Fx Prize SURFRAD Table Mountain

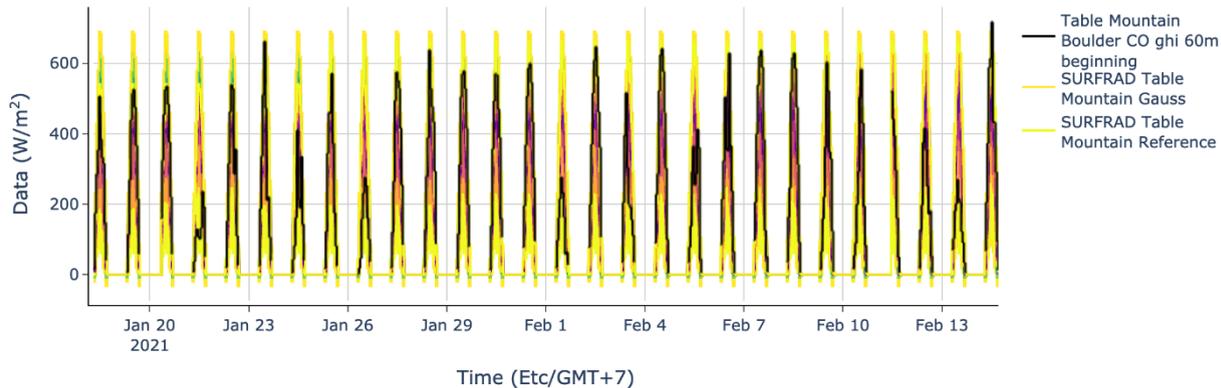
Recompute report

Clone report parameters

This report of forecast accuracy was automatically generated using the [Solar Forecast Arbiter](#).

This report can be downloaded as a [standalone HTML file](#), [standalone HTML file without timeseries](#) or [PDF file](#). The download is a ZIP archive that includes checksums for the report file and a PGP signature that can be used to verify the authenticity of the report. The Solar Forecast Arbiter PGP key ID is [0x22bd497c0930f8b0](#).

## Time series of your forecast, reference forecast, observation

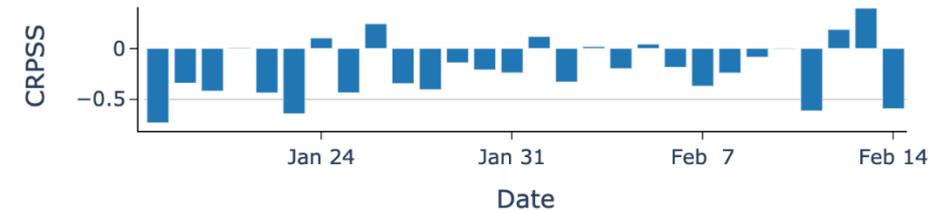


## Metrics for your forecast and reference

### Table of total metrics

Forecast	CRPS	CRPSS
<b>SURFRAD Table Mountain Gauss</b>	61.9	-0.145
<b>SURFRAD Table Mountain Reference</b>	54.1	nan

### SURFRAD Table Mountain Gauss CRPSS



Leaderboard on HeroX compiled from CRPSS metrics computed in SFA reports

# Data Upload/Download

Example data download and forecast upload script:

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

HTTP API documentation at [api.solarforecastarbiter.org](https://api.solarforecastarbiter.org)

## Add Probabilistic Forecast data for one constant value.

Add timeseries values to a Probabilistic Forecast constant value. Float values will be rounded to 8 decimal places before storage.

### PATH PARAMETERS

→ forecast\_id string <uuid>  
required Forecast's unique identifier.

REQUEST BODY SCHEMA: text/csv

### Responses

- 201 Resource created successfully.
- 400 Could not process request due to invalid syntax.
- 401 User must authenticate to access resource.
- 404 The resource could not be found.
- 413 Payload exceeds maximum of 16MB.

```
POST /forecasts/cdf/single/{forecast_id}

Request samples

Payload

Content type: text/csv

# comment line
timestamp,value
2018-10-29T12:00:00Z,32.93
2018-10-29T13:00:00Z,25.17
2018-10-29T14:00:00Z,# this value i
```

```
215 # for each constant value, make a random timeseries and upload
216 # the timeseries for that constant value
217 for num, prob_constant_value in enumerate(prob_forecast.constant_values):
218     # set this distribution value to an interpolation between high
219     # and low values determined above.
220     # assumes len(prob_forecast.constant_values) > 1
221     distribution_member_value = (
222         forecast_value_low
223         + (
224             num / (len(prob_forecast.constant_values) - 1)
225             * (forecast_value_high - forecast_value_low)
226         )
227     )
228     forecast_series = pd.Series(distribution_member_value, index=index)
229     # upload the probabilistic forecast constant value to the API
230     # catch and log errors so we can try uploading the other forecasts
231     try:
232         session.post_probabilistic_forecast_constant_value_values(
233             prob_constant_value.forecast_id, forecast_series)
234     except Exception:
235         logging.exception(
236             'Failed to upload prob. forecast constant value for %s',
237             prob_constant_value.name)
238     continue
```

trial\_random\_data\_forecast\_upload.py hosted with ❤️ by GitHub

[view raw](#)

# Data Upload/Download

## API gate closure

- Forecasts rejected if they contain valid times for which a gate has already closed
- Forecasts may contain valid times for additional days
- User may overwrite previously submitted forecasts up to the gate closure time.

# Reference Forecast

## Persistence ensemble (PeEn)

Time of day PeEn computes statistics from the past N days of observation data at the corresponding time of day.

1. Pull previous N days of data.
2. Resample data to desired interval length.
3. Bin data by desired times of day. Assuming no data gaps, there are N values in each bin.
4. For each bin, compute the desired percentiles.
5. Associate each bin with the forecast date time (e.g. first bin is midnight tomorrow, second bin is 1 am tomorrow, etc). This is the forecast.

SFA uses  $N = 30$ .

```
504
505 def persistence_probabilistic_timeofday(observation, data_start, data_end,
506                                       forecast_start, forecast_end,
507                                       interval_length, interval_label,
508                                       load_data, axis, constant_values):
509     r"""
510     Make a probabilistic persistence forecast using the *observation* from
511     *data_start* to *data_end*, matched by time of day (e.g. to forecast 9am,
512     only use observations from 9am on days between *data_start* and
513     *data_end*). This is a common variant of the Persistence Ensemble (PeEn)
514     method. [1]_ [2]_ [3]_
515
```

Reference forecast code on GitHub

[solarforecastarbiter/reference\\_forecasts/persistence.py](https://github.com/solarforecastarbiter/reference_forecasts/persistence.py)

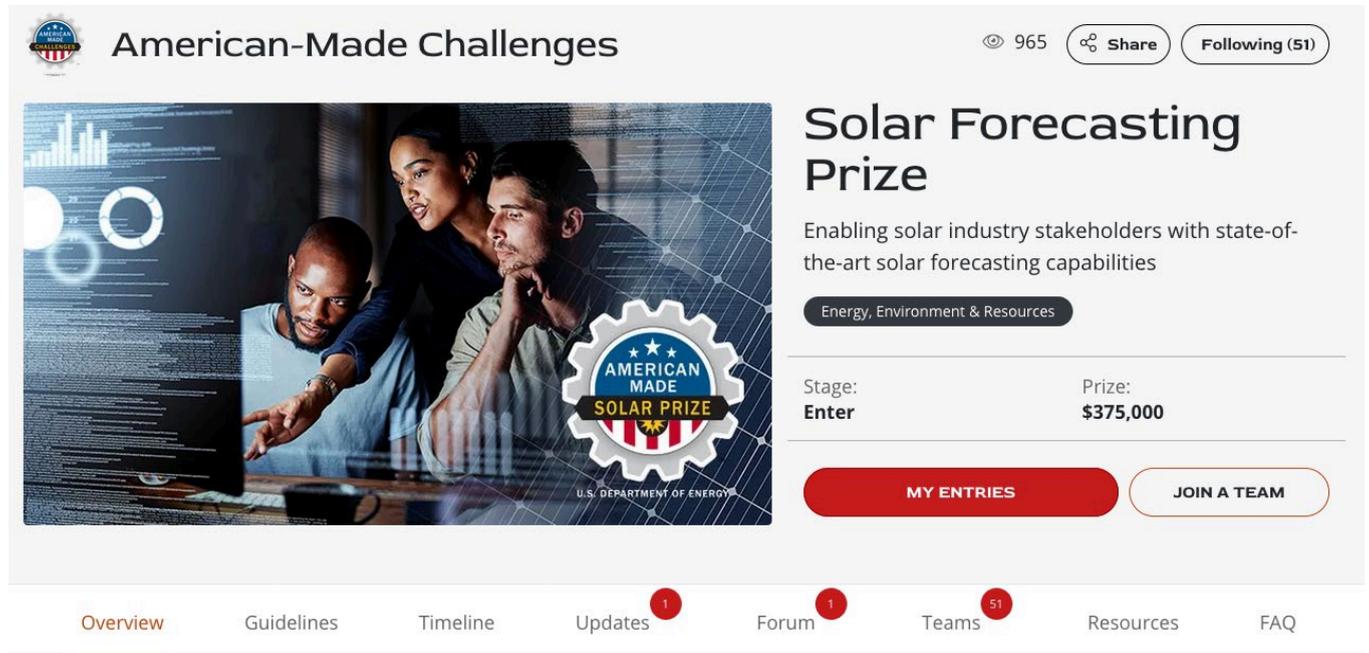
---

# Using HeroX



U.S. DEPARTMENT OF ENERGY

# HeroX Live Demo



The screenshot shows the HeroX interface for the "American-Made Challenges" section. The main header is "American-Made Challenges" with a view count of 965, a "Share" button, and a "Following (51)" button. The featured challenge is the "Solar Forecasting Prize", described as "Enabling solar industry stakeholders with state-of-the-art solar forecasting capabilities". It is categorized under "Energy, Environment & Resources". The challenge is in the "Enter" stage with a prize of "\$375,000". Below this, there are two buttons: "MY ENTRIES" and "JOIN A TEAM". A navigation bar at the bottom includes links for "Overview", "Guidelines", "Timeline", "Updates" (with 1 notification), "Forum" (with 1 notification), "Teams" (with 51 teams), "Resources", and "FAQ".

## Challenge Overview

The American-Made Solar Forecasting Prize is designed to better enable solar industry stakeholders with state-of-the-art solar forecasting capabilities. Sponsored by the U.S. Department of Energy Solar Energy Technologies Office, this prize aims to increase the use of the Solar Forecast Arbiter, an open platform developed by the University of Arizona, to allow for the transparent, rigorous, and consistent analysis and evaluation of solar forecasts.

# GET STARTED

Visit our website to learn more and register today!

<https://www.herox.com/SolarForecasting>  
For Questions: [Emily.Evans@nrel.gov](mailto:Emily.Evans@nrel.gov)

The image shows a composite of two screenshots. The top screenshot is a website banner for the American-Made Challenges Solar Forecasting Prize. It features a dark blue background with a grid pattern and a photo of three people looking at a computer screen. The text reads: "American-Made Challenges Solar Forecasting Prize. The American-Made Solar Forecasting Prize is designed to better enable solar industry stakeholders with state-of-the-art solar forecasting capabilities. Sponsored by the U.S. Department of Energy Solar Energy Technologies Office, this prize makes use of the Solar Forecast Arbiter, an open platform developed by the University of Arizona, to allow for the transparent, rigorous, and consistent analysis and evaluation of solar forecasts." A red button says "Join the Challenge". The American-Made Solar Prize logo is in the top right.

The bottom screenshot is a social media post from "American-Made Challenges". The post title is "Solar Forecasting Prize". The description says: "Enabling solar industry stakeholders with state-of-the-art solar forecasting capabilities". It includes a category "Energy, Environment & Resources", a stage of "Enter", and a prize of "\$375,000". There are buttons for "MY ENTRIES" and "JOIN A TEAM". The post has 965 views, a share icon, and 51 followers. A navigation bar at the bottom of the post includes links for Overview, Guidelines, Timeline, Updates (1), Forum (1), Teams (51), Resources, and FAQ. The main content area below the navigation bar is titled "Challenge Overview" and begins with the text: "The American-Made Solar Forecasting Prize is designed to better enable solar industry stakeholders with state-of-the-art solar forecasting capabilities. Sponsored by the U.S. Department of Energy Solar Energy Technologies Office, this prize aims to increase the use of the Solar Forecast Arbiter, an open platform developed by the University of Arizona, to allow for the transparent, rigorous, and consistent analysis and evaluation of solar forecasts."