

Solar Forecast Arbiter

An open source evaluation framework for solar forecasting



Sandia
National
Laboratories



ELECTRIC POWER
RESEARCH INSTITUTE



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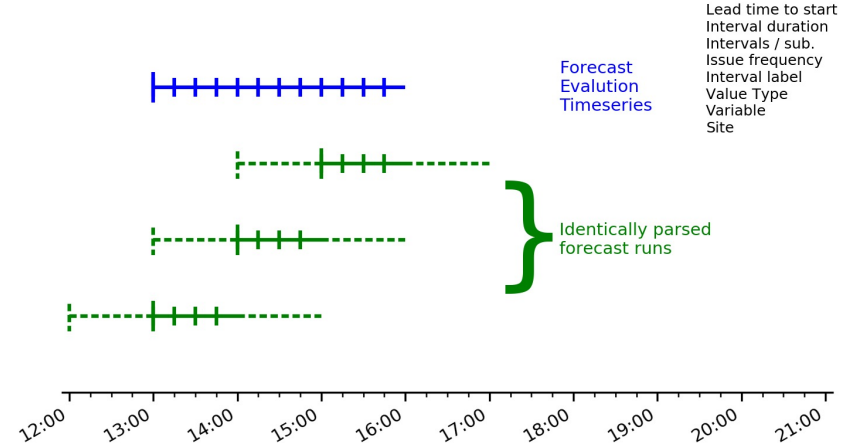


Office of **ENERGY EFFICIENCY
& RENEWABLE ENERGY**

What is a forecast?

Consider the "Vendor A Solar Power Forecast"...

- Each forecast extends **N** hours
- New forecast every **M** minutes
- If probabilistic, **P** percentiles
- $\text{values/day} = N * (1440/M) * P \sim 10k+$
- *Underdefined evaluation problem*
- *Metrics alone will not save you!*
- *"Big data" analytics will not save you!*
- *AI definitely will not save you!*

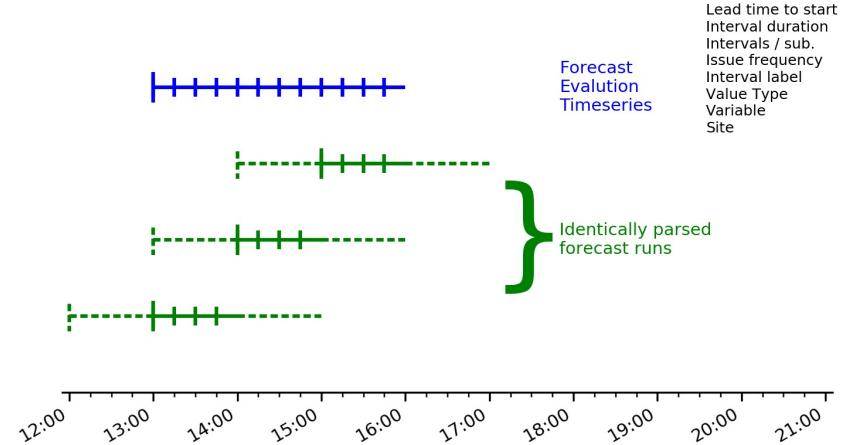


Stop and think about the problem/analysis before you start it.

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- $\text{values/day} = N * (1440/M) * P \sim 10k+$
- *But I mostly care about Day Ahead. Especially issued early in the day. And only 3 percentiles really matter.*
- $24 * 1 * 3 < 100$



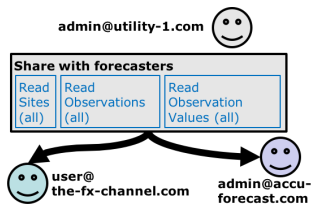
Stop and think about the problem/analysis before you start it.

solarforecastarbiter.org

Standardized
Objective
Open source

GitHub

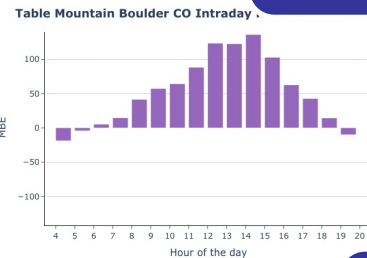
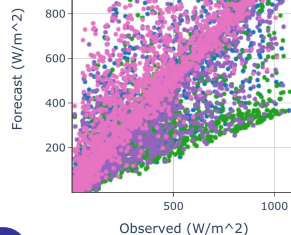
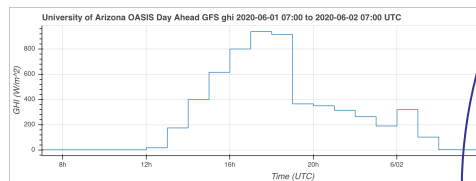
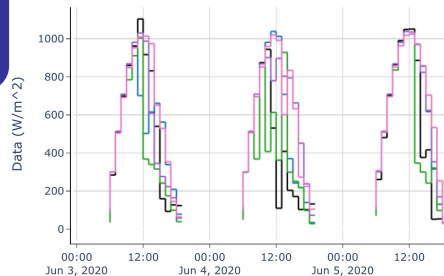
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Available now!



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private
Data rights
management



Stakeholder
Informed

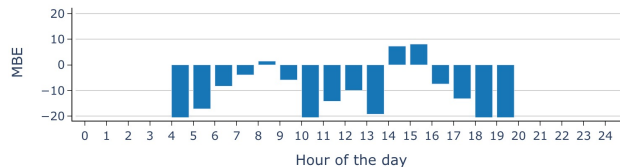


Solar Forecast Arbiter API

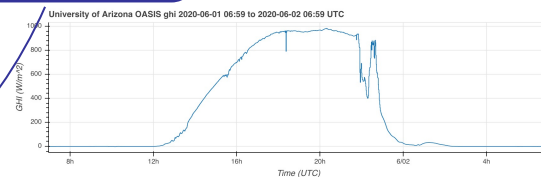
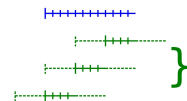
Download OpenAPI specification: [Download](#)

Graphical
reporting
Automated
workflow

Table Mountain Boulder CO Current Day NAM ghi MBE

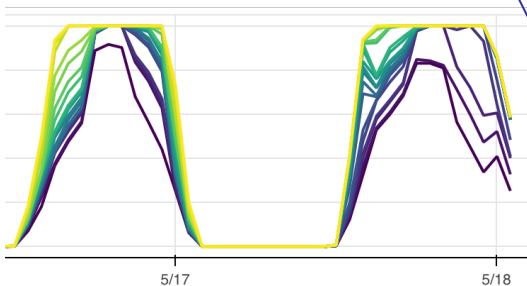
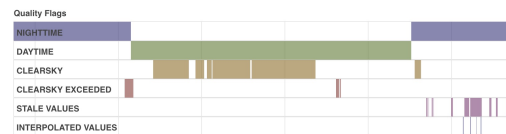


Many-vendor trial
Anonymization
Realtime and
retroactive



Deterministic
Event
Probabilistic

Data quality
control
Reference data
& forecasts



How do I use the Solar Forecast Arbiter?

1. Define site, observation and/or forecast metadata
2. Upload observation and/or forecast data
3. Optional: grant another user access to your metadata/data
4. Run analysis report

Create New CDF Forecast

Site Metadata

Name: Boulder power plant 2
UUID: 98fb7648-e941-11e9-8ad7-0a580a820002
[Copy UUID](#)
Latitude: 40.0 (°N)
Longitude: -105.0 (°E)
Timezone: America/Denver
Elevation: 1650.0 (m)
Climate Zones:

- [Reference Region 4](#)

Modeling parameters:

AC capacity: 10.0 (MW)
DC capacity: 14.0 (MW)
AC loss factor: 0.0 (%)
DC loss factor: 0.0 (%)
Temperature coefficient: -0.3 (%/C)
Tracking type: single axis
Axis tilt: 0.0 (°)
Axis azimuth: 0.0 (°)
Ground coverage ratio: 0.4
Backtrack: True
Max rotation angle: 45.0 (°)

Name

Variable

Issue time of day

 : UTC

Lead time to start

 Minutes

Run length/Issue frequency

 Minutes

Interval length

 Minutes

Interval label

Interval value type

Axis

Ox: variable value Oy: percentile

Constant values

How do I use the Solar Forecast Arbiter?

1. Define site, observation and/or forecast metadata
2. **Upload observation and/or forecast data**
3. Optional: grant another user access to your metadata/data
4. Run analysis report

My data is formatted in:

☒ CSV ☐ JSON

Forecast data in CSV format should follow the formatting of the example below.

```
# optional header, ignored by Solar Forecast Arbiter
timestamp,value
2018-11-22T12:00:00Z,10.23
2018-11-22T12:05:00Z,10.67
```

No file selected.

Solar Forecast Arbiter API (1.0.2)

Download OpenAPI specification:

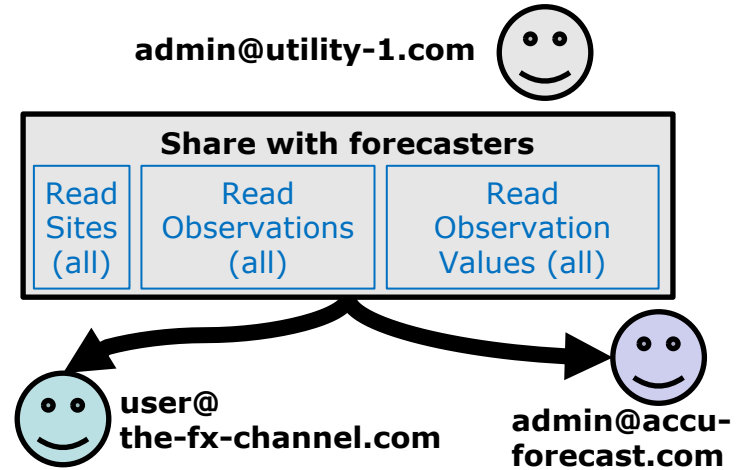
Solar Forecast Arbiter Team: info@solarforecastarbiter.org

URL: <https://github.com/solararbiter/solarforecastarbiter-api> | License: MIT

The backend RESTful API for Solar Forecast Arbiter.

How do I use the Solar Forecast Arbiter?

1. Define site, observation and/or forecast metadata
2. Upload observation and/or forecast data
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How do I use the Solar

1. Define site, observation and/or forecast metadata
2. Upload observation and/or forecast data
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Create New Report

Report type: [Deterministic](#) [Event](#) [Probabilistic](#)

Name:

Table Mountain Prob Fxs

Timezone

Infer timezone from selections

Start (UTC)

2021 - 7 - 25 0 : 0

End (UTC)

2021 - 7 - 29 0 : 0

Observation, Forecast pairs

Forecast: Table Mountain Boulder CO Day Ahead Prob Persistence ghi [remove](#)

Observation: Table Mountain Boulder CO ghi

Uncertainty: Ignore uncertainty

Distribution

Reference Forecast: Unset [remove](#)

Prob(x) = 10 %

Reference Forecast: Unset [remove](#)

Prob(x) = 90 %

Reference Forecast: Unset [remove](#)

[Create Forecast Evaluation pairs](#)

Distribution Metrics

☒ CRPS

☐ CRPSS

Binary Metrics

☐ BS

☐ BSS

☐ REL

☐ RES

☐ UNC

☒ QS

☐ QSS

Categories

☒ Total

☐ Year

☐ Season

☐ Month of the year

☒ Hour of the day

☒ Date

☐ Day of the week

Example Report

Table Mountain Prob Fxs

[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](#).

- [Report Metadata](#)
- [Data](#)
 - [Observations and Forecasts](#)
 - [Data Preprocessing](#)
 - [Summary](#)
 - [Validation and Resampling](#)
 - [Summary Statistics](#)
- [Metrics](#)
- [Versions](#)

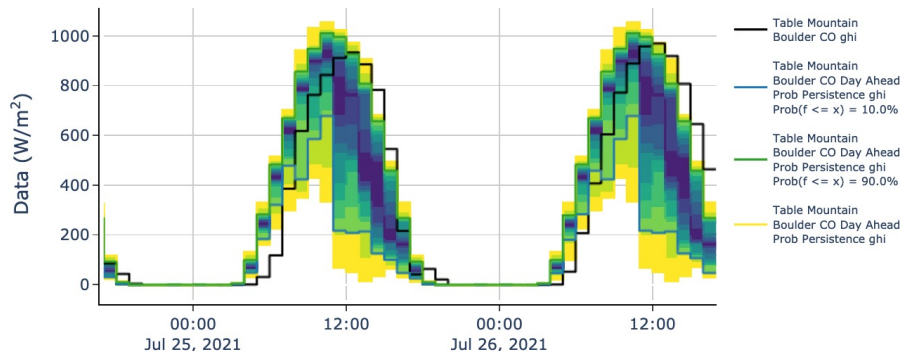
Report Metadata

- Name: Table Mountain Prob Fxs
- Start: 2021-07-25 00:00:00+00:00
- End: 2021-07-29 00:00:00+00:00
- Generated at: 2021-07-28 20:48:12+00:00

Data

This report includes forecast and observation data available from 2021-07-25 00:00:00+00:00 to 2021-07-29 00:00:00+00:00.

Time series plots



Time (Etc/GMT+7)

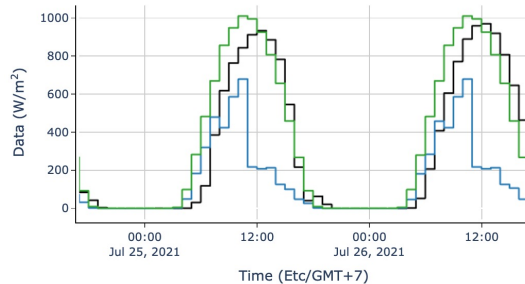
Plotly



Interactive



Downloadable



Example Report

Metrics Summary Table

Table of total metrics

Forecast	QS	CRPS
Table Mountain Boulder CO Day Ahead Prob Persistence ghi		62.2
Table Mountain Boulder CO Day Ahead Prob Persistence ghi Prob($f \leq x$) = 10.0%	160	
Table Mountain Boulder CO Day Ahead Prob Persistence ghi Prob($f \leq x$) = 90.0%	64.3	

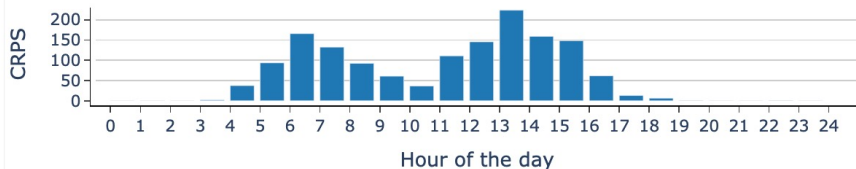
- + Forecast skill
- + Normalization
- + Deadband

Example Report

Plots of metrics by hour, date, etc.

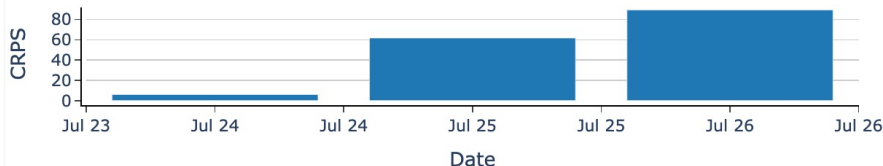
Category: Hour of the day

Table Mountain Boulder CO Day Ahead Prob Persistence ghi CRPS



Category: Date

Table Mountain Boulder CO Day Ahead Prob Persistence ghi CRPS



Category: Hour of the day

Table Mountain Boulder CO Day Ahead Prob Persistence ghi Prob(f <= x) = 10.0%

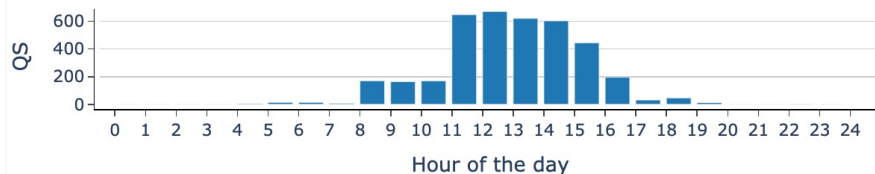
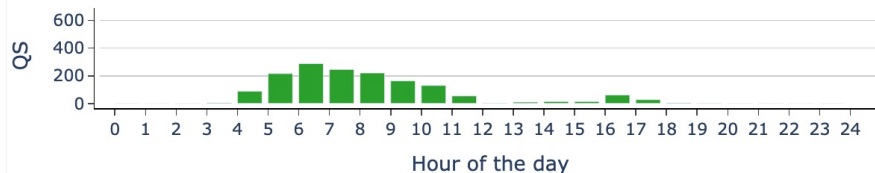


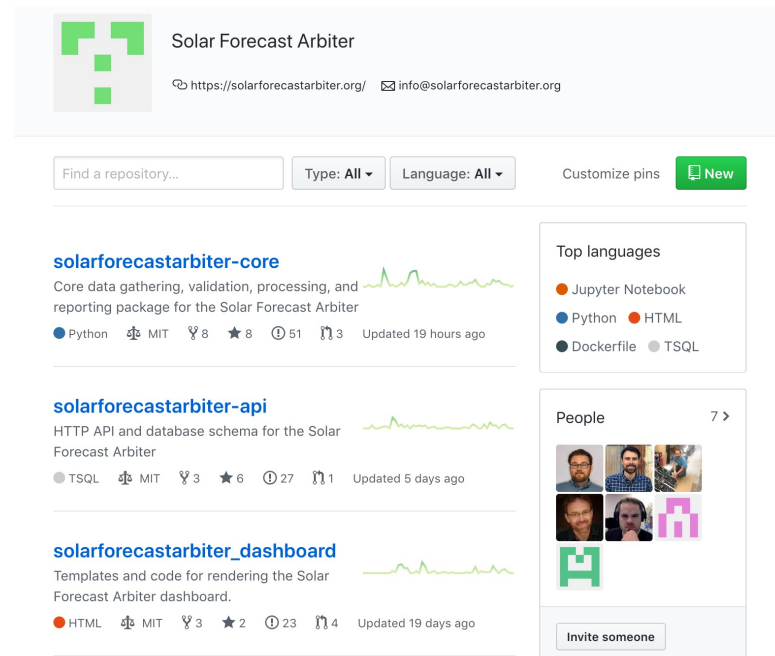
Table Mountain Boulder CO Day Ahead Prob Persistence ghi Prob(f <= x) = 90.0%



Solar Forecast Arbiter Components

Tool for analyzing accuracy of solar forecasts

- Web-based user interface
- Web-based API for scripting
- Python software package for analysis
- Scripts to redeploy entire software stack
- Detailed supporting documents
- Supported by stakeholder input, feedback



Open source. Transparently
developed on GitHub

How to get started

1. Make free user account
 - dashboard.solarforecastarbiter.org
 - Browse reference data, forecasts
2. If you like it
 - Sign the Use Agreement
 - Experiment with a small problem, upload some test data
3. If you love it
 - Help us test the operational forecast trial feature
 - Spread the word
 - Contribute to the open source code development on GitHub
4. Stay informed
 - solarforecastarbiter.org/emailist

*Just announced:
Operational forecast
trial with SRP*

Summary

- Open source, reproducible, transparent framework
- Use cases tailored to needs of forecast stakeholders
- Reference datasets
- Secure, private data upload. Sharing optional.
- Benchmark forecast capability
- Automated reports including bulk metrics, analysis filters
- Use dashboard, sign up for project updates at:

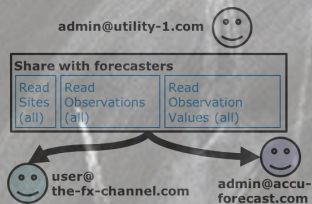
solarforecastarbiter.org

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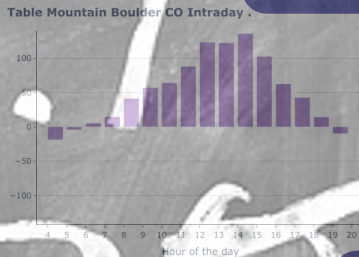
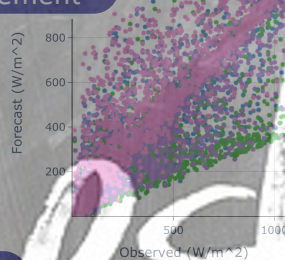
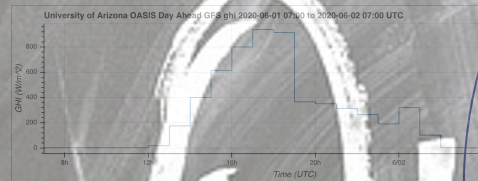
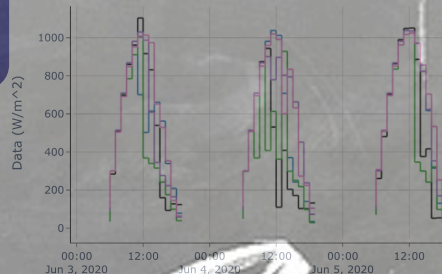
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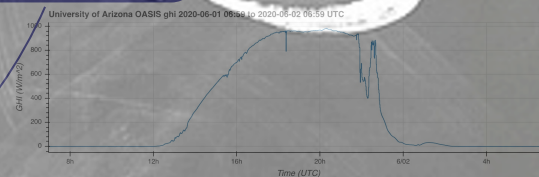
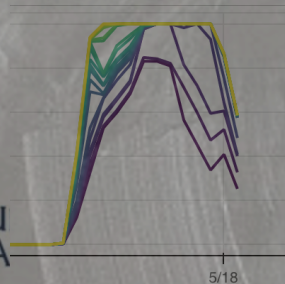
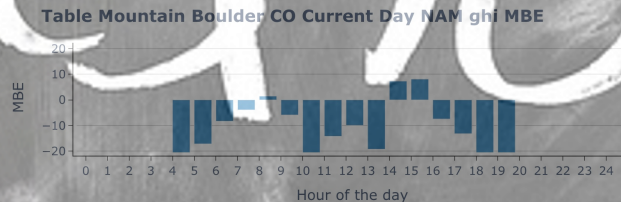


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Multi-vendor
trials
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Data quality
control
Reference data
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Office of
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