

Open Source Evaluation Framework for Solar Forecasting

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U.S. DEPARTMENT OF
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& RENEWABLE ENERGY**

Outline

- Project overview
- Example use cases
- Data sources
- Benchmark forecasts
- Reports and metrics
- Post-DOE funding plans

Project Overview

Project goal

To develop an open-source framework that enables evaluations of irradiance, solar power, and net-load forecasts that are impartial, repeatable, and auditable.

Our solar forecast evaluation framework will:

- Improve forecasts based on objective, consistent metrics
- Develop user confidence in forecasts → system integration
- Reduce costs associated with forecasts (SETO goals, help providers)
- Easily extend to wind power and load forecasting

Three Key Tasks

Stakeholder Engagement

- Help define use cases
- Guide selection of benchmarks, metrics, data sets
- Provide data
- Aid long-term plan

We need your input!

Support Topic Areas 2 and 3

- Define test data
- Provide evaluation services

Construct the Framework Service

- Open source
- Thoroughly test, document, validate

Sketch of Forecast Trial Use Case

Forecast User

Forecast Provider A

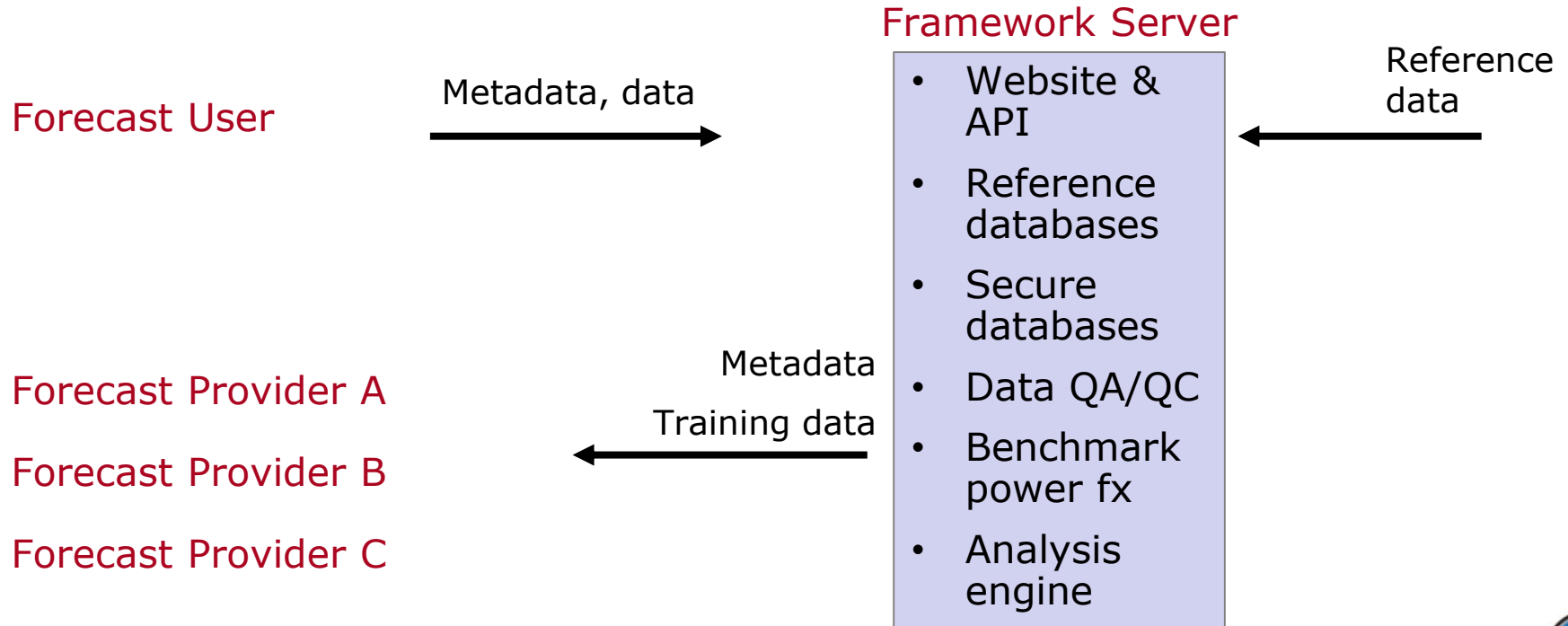
Forecast Provider B

Forecast Provider C

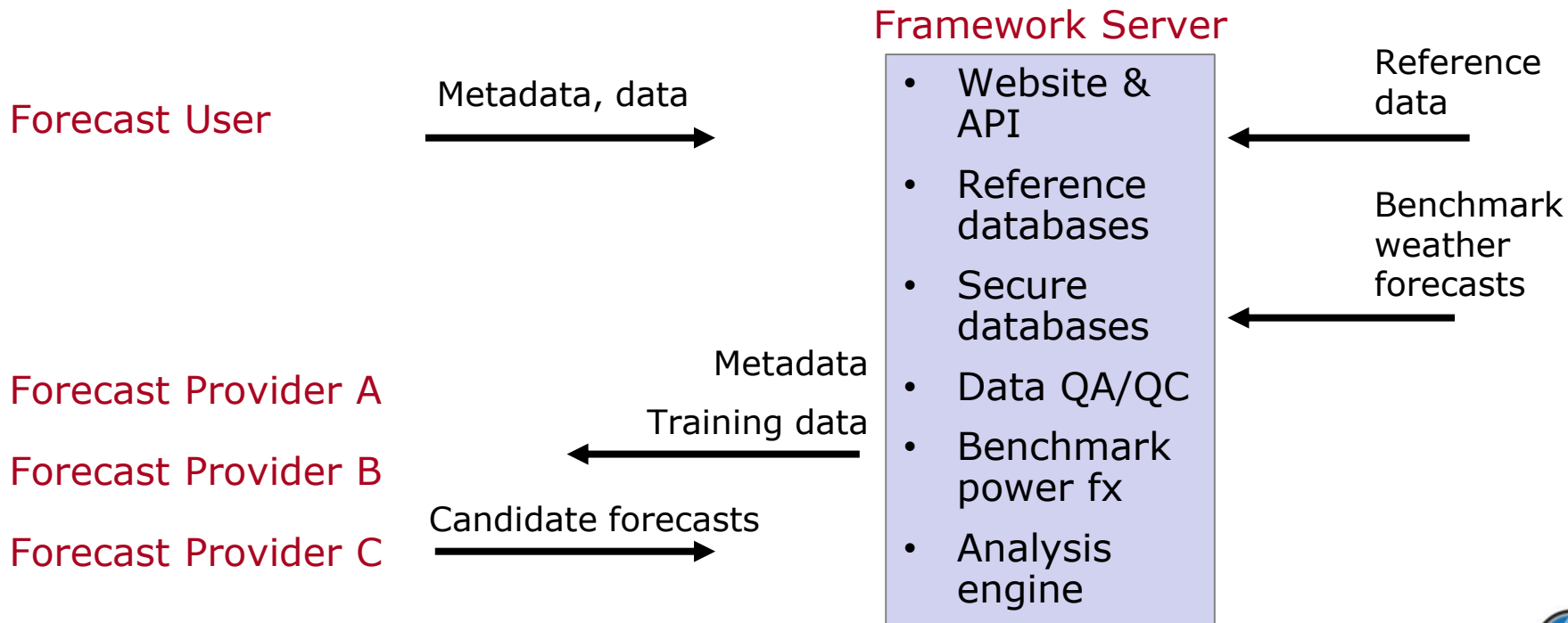
Framework Server

- Website & API
- Data QC
- Reference databases
- Secure databases
- Benchmark power fx
- Analysis engine

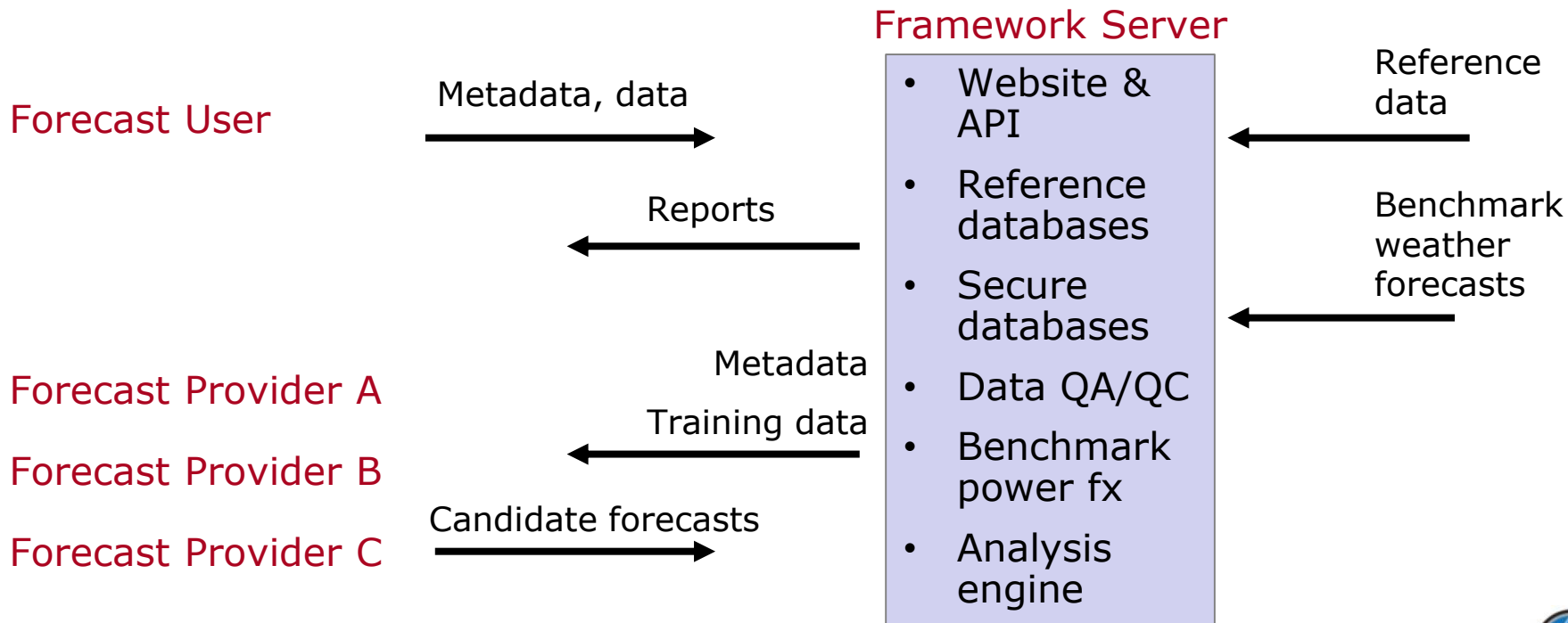
Sketch of Forecast Trial Use Case



Sketch of Forecast Trial Use Case



Sketch of Forecast Trial Use Case



Possible Use Cases

A. Hindcasting Reference Data

Forecast providers will want to forecast reference data to measure forecast accuracy or to quantify impacts of new methodologies.

B. Public Forecast Trial

Facilitates anonymous comparison of operational forecast capability for public data.

C. Private Forecast Trial

A forecast user may use our framework to compare among forecasts to determine which forecast to purchase.

~~What is your use case?~~

What are your use cases?

Validation and Reference Data Sources

Reference Data

- NOAA SURFRAD
- Sandia
- NREL
- EPRI
- DOE RTC
- Stakeholders

User Data

- Stakeholder supplied
- Owner controls access
- Commitments: TEP, Abengoa, Southern Co.
- Working with: GroundWork Renewables, First Solar, **your company?**

Benchmark Forecasts

Proposed Attributes

- Available throughout the US
- Freely accessible or easily implemented
- Provide quantities of interest to both forecast users and providers
- Stakeholder buy-in

What attributes would you specify?

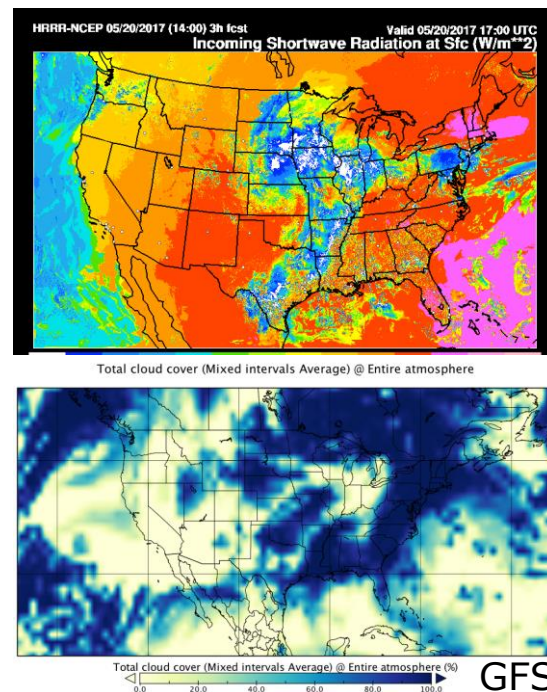
Different attributes and benchmarks for different use cases?

Can a benchmark be valuable in a private forecast trial?

Benchmark Forecasts

- For 1 hour – 7 day ahead and longer horizons:
 - NOAA operational models forecast irradiance, cloud cover, weather
 - Most operational NWP irradiance forecasts have known limitations
 - a) Derive irradiance or PV power from cloud cover
 - b) Bias correction
- For intrahour horizons:
 - Persistence, persistence of the clear sky index
 - An ARMA model fitted to site-specific data
- For net load:
 - Net load = True load – BTM PV
 - Use regression w/weather obs for true load? Use NWP for BTM PV?
- Probabilistic? Aggregates?

Give us feedback!



Reports and Metrics

Reports

- Design templates with stakeholder input
- Framework uses templates to automatically generate custom reports
- Time series plots, scatter plots, reliability diagrams
- Error metrics
- Enable direct comparisons between anonymized vendors and benchmarks
- Cryptographically signed to guarantee authenticity

Reports and Metrics

Metrics

- Choose default metrics with stakeholder input
- Depending on use case, users have final control over metrics selection
- Build on DOE Solar Forecasting I metrics results
- Standard metrics (MAE, MAPE, RMSE, MBE)
- Advanced metrics (KSI, Renyi entropy)
- Probabilistic metrics (Brier, RPS)
- Forecast skill metrics to directly compare test and benchmark forecasts



Available online at www.sciencedirect.com

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Baseline and target values for regional and point PV power forecasts: Toward improved solar forecasting

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Metrics for evaluation of solar energy forecasts

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Reports and Metrics

Cost metrics

1. User supplied fixed \$/MW
 2. User supplied time of day \$/MW
 3. User supplied time series of \$/MW
 4. User supplied time series of \$/MW for predefined error bins
- Report includes cost saved or incurred relative to benchmark forecasts
 - Seeking stakeholder feedback!

What happens after DOE funding ends?

EPRI User's Group Model

- Most North American utilities and all ISOs are EPRI members
- Self sustaining models for ongoing support research deliverables
- Updates/maintenance supported by member funds

Independently operated business

- Forecast vendors and utilities pay for live forecast trials and data brokering services
- Validation services may extend to include wind and load forecasting

All contributed data will be deleted at the end of the DOE funding period by default.

Project Timeline

Year 1 – Design, build, test and demonstrate the framework.

Year 2 – Refine the framework and host two operational forecast competitions.

Year 3 – Support evaluations for Solar Forecasting II Topic 2 and Topic 3 awardees. Transition framework to new operator.

Please send us your feedback/ideas

- Users: <https://www.surveymonkey.com/r/solarforecast-survey>
- holmgren@email.arizona.edu
- Please give us your feedback!
 - Will Holmgren
 - Justin Sharp
 - Aidan Tuohy
 - Cliff Hansen

Thursday stakeholder workshop:
a couple of spots available →
contact one of us