ENERGY

SolarFarmer (*beta* version): Accurate Modelling of Real World PV Systems

PVPMC – 10

Albuquerque, NM

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Outline

- PV System Modelling Software
  - Current state
  - Needs

- Intro to SolarFarmer (*beta* version)
  - Unique approach
  - Functional user interface

- Validation
  - Comparison with other models

- TODO:

PV System Modelling Software

PV System Modelling Software: Current State

SOLAR BINGO

Calculation Focus	Rooftop Design	Cost Optimization	Detail Design	MFG Yield/ Design Tools	Open Source/ API
PVSYST	Folsom Labs Helioscope	PVCOMPLETE	PVCOMPLETE	SUNPOWER® PVSim	System Advisor Model (SAM) NREL NATIONAL RENEWABLE ENERGY LABORATORY
meteodyn meteorology & dynamics	PV*SOL	HST	HELIOS 3D SOLARPARKPLANUNG	First Solar. PLANT PREDICT	CASSYS
	aurora	RatedPower Updating Engineering			CanadianSolar MAKE THE DIFFERENCE
					PVPerformance MODELING COLLABORATIVE
					PVLIB-Python/MATLAB

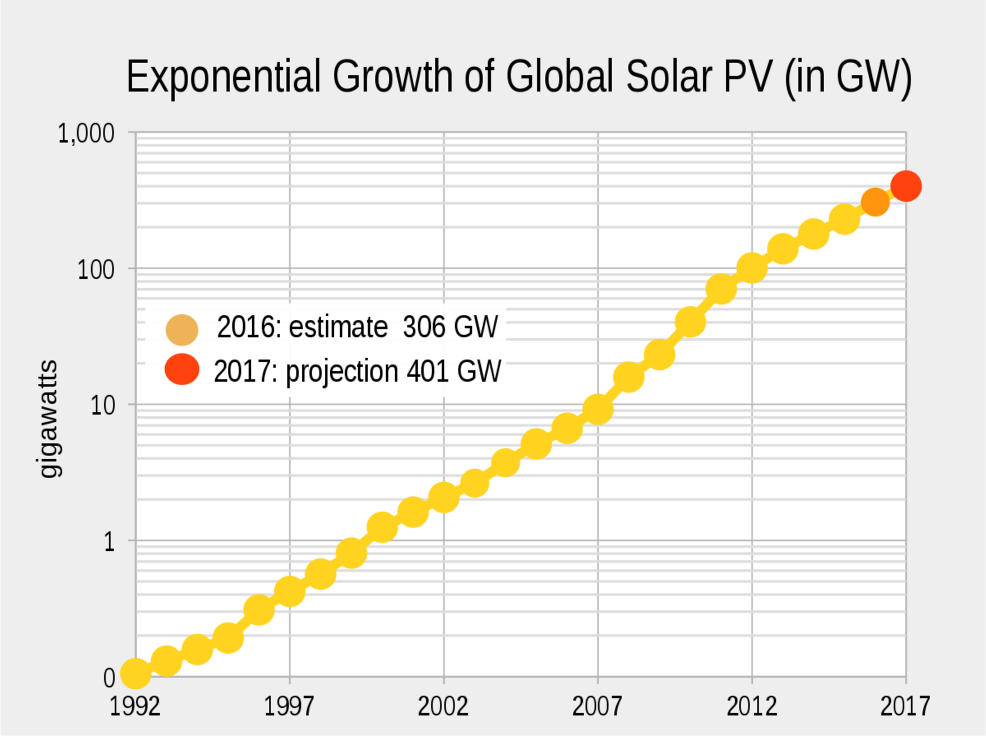
PV System Modelling Software: Needs

- There are a lot of excellent PV system modelling software covering many aspects of solar industry
  - Rooftops, cost and design optimization, utility scale, open-source, SDK/API, and manufacturer

- PV industry is growing and changing rapidly
  - Ungraded terrain, variable spacing, complex layouts

- → Industry needs faster project turnover
  - Ability to handle complex utility scale layouts
  - Accurate enough calculations
  - Fast enough to evaluate more projects

Cumulative Installed Capacity



Source: [Wikipedia "Growth of Photovoltaics"]

Intro to SolarFarmer (*beta* version)

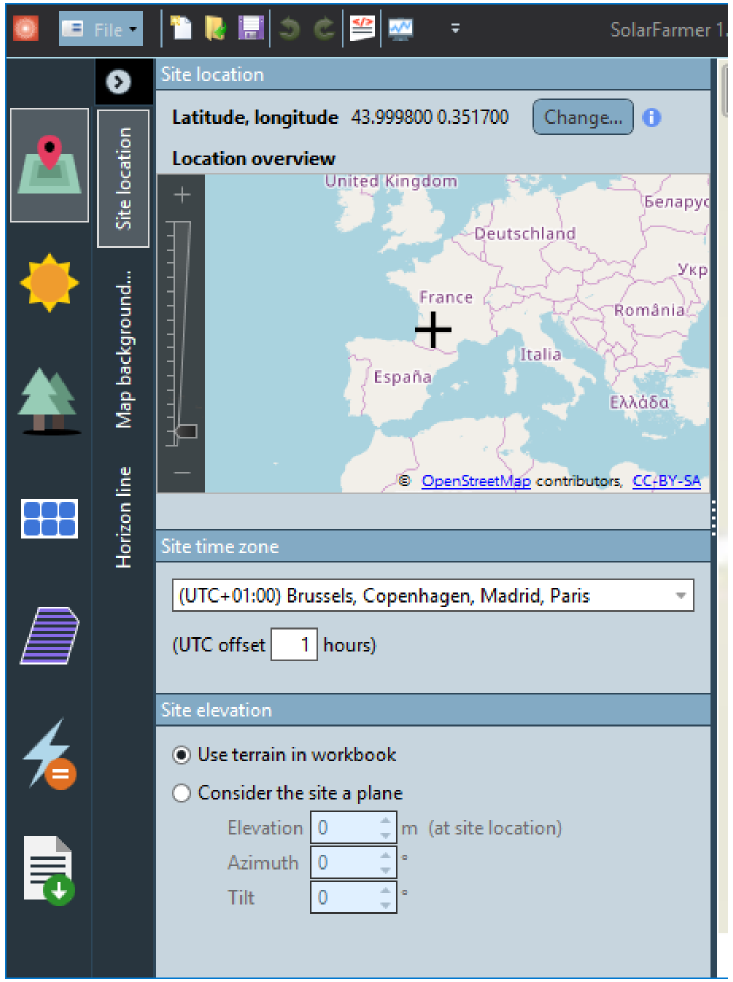
Intro to SolarFarmer (*beta* version): Unique Approach

- **PV system modelling software in *beta* testing**
  - 3-D shade hemicube model [Cohen & Greenberg, *SIGGRAPH*, 1985] rendered by GPU
    - Resolution of 5 hemicubes per submodule found optimal
  - Fast but accurate calculation using explicit approach [Bishop, *Sol. Cells*, 1988] at submodule/bypass diode level with interpolation
    - Entire IV curve calculated in one iteration
  - Based on established models: irradiance, solar-cell electrical and thermal, AC inverter, *etc.* models are public [pvpmc.sandia.gov]
    - PVSyst or SAM Desoto/5-parameter
    - Hay-Davies, Perez/DIRINT, or GTI-DIRINT (*tbd.*)
    - FirstSolar spectral mismatch, ASHRAE/Physical IAM
    - *Etc.*

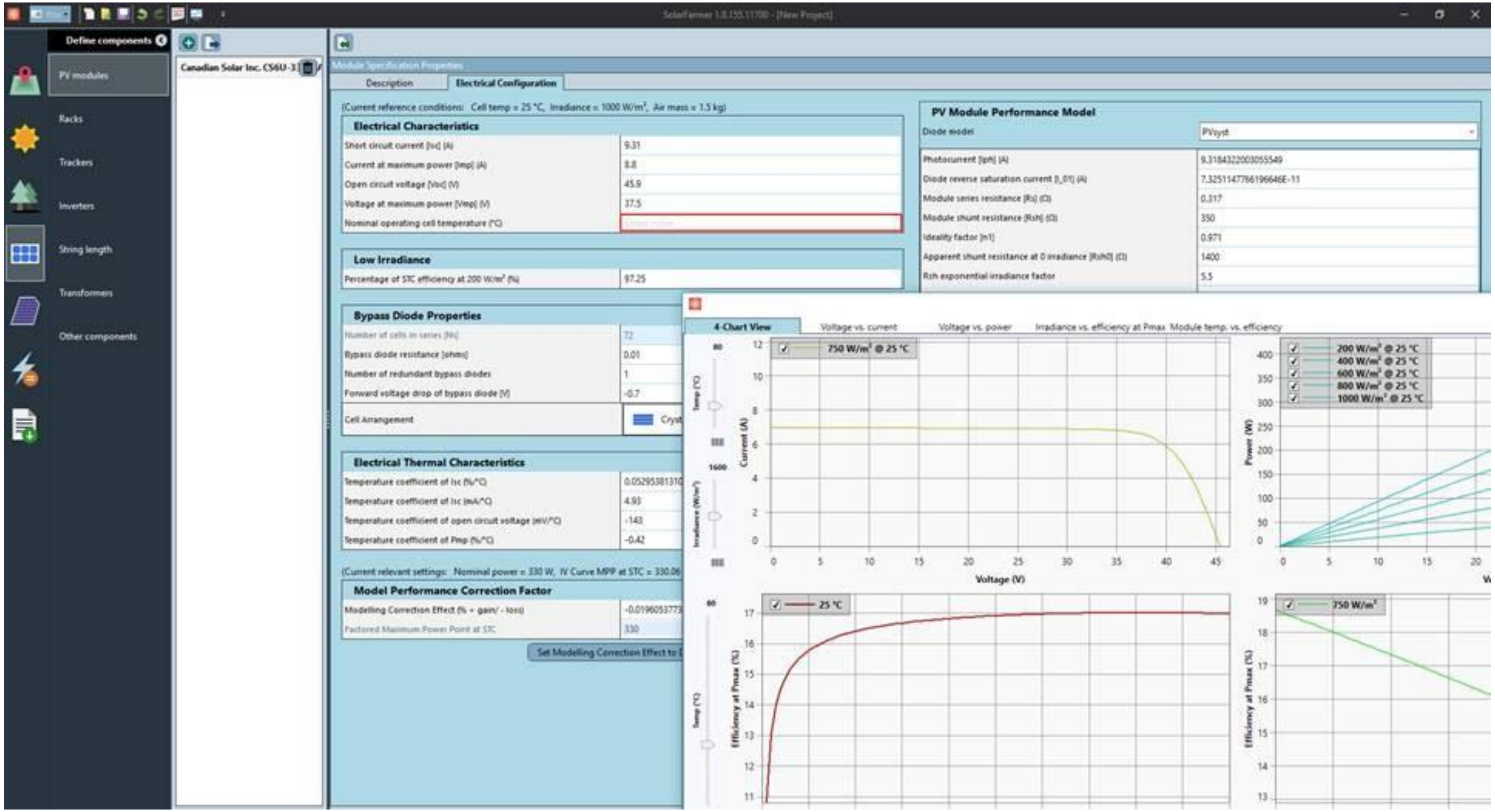
SOLARFARMER

Intro to SolarFarmer (*beta* version): Functional User Interface

- DNV-GL decade of experience developing industry leading renewable energy applications:
  - **WindFarmer** (wind energy), **Bladed** (turbine simulation), *etc*.
- SolarFarmer (*beta* version) workflow:
  - Site selection: search world map by name or coordinates
    - Upload or download terrain and map imagery data
    - Upload or generate horizon
  - Upload or download solar resource and weather at any resolution
  - Near shade: Import obstacles from SketchUp, *etc.*
  - Racking and trackers, modules, strings, inverters, transformers
  - Layout design, electrical connections, preview rendered shade
  - Settings, checks, simulate, loss-effects tree, generate reports
  - Save SolarFarmer (*beta* version) workbook as `*.sfw` file



Intro to SolarFarmer (*beta* version): Functional User Interface



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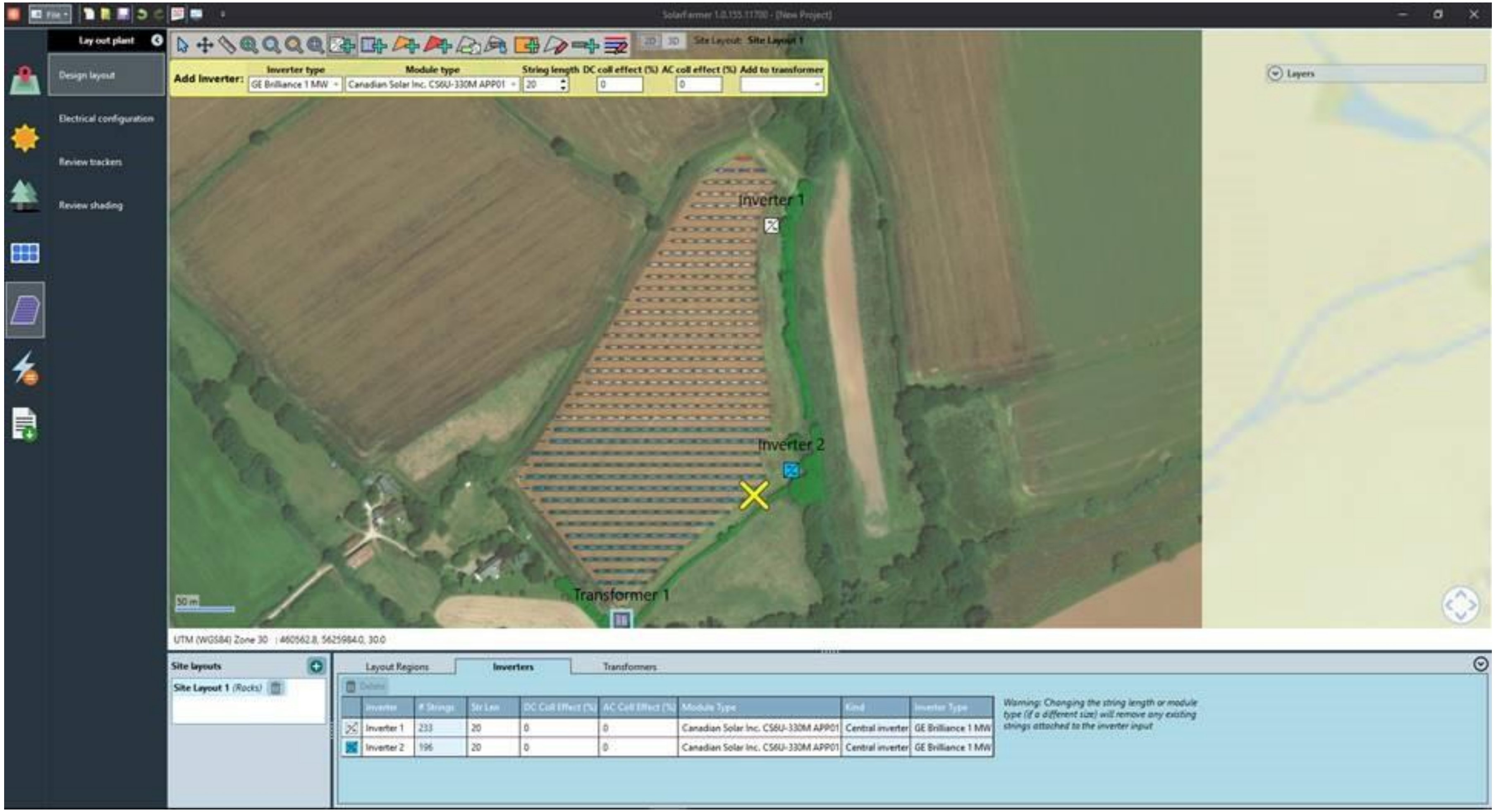
Intro to SolarFarmer (*beta* version): Functional User Interface



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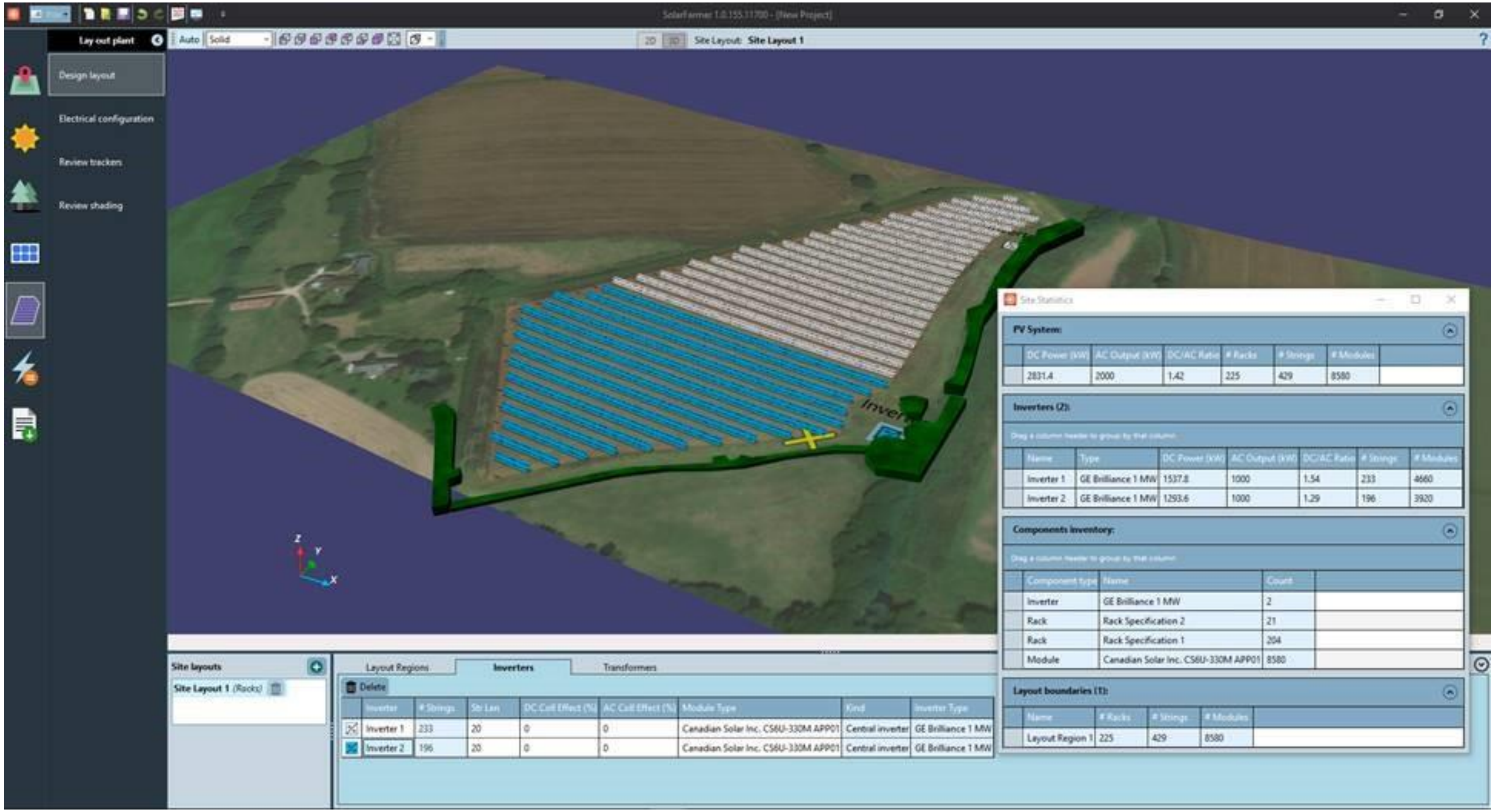
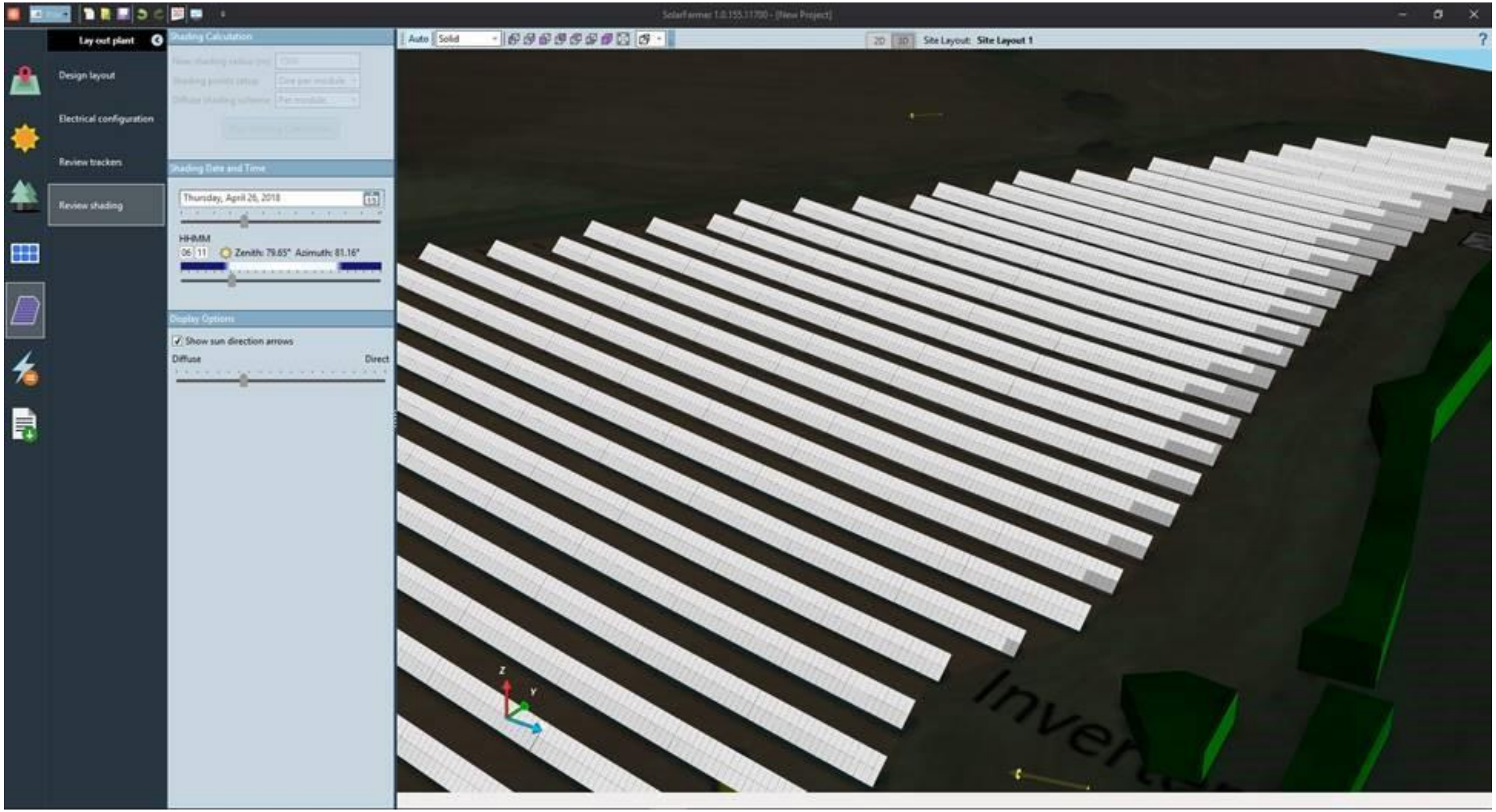
Intro to SolarFarmer (*beta* version): Functional User Interface



Intro to SolarFarmer (*beta* version): Functional User Interface

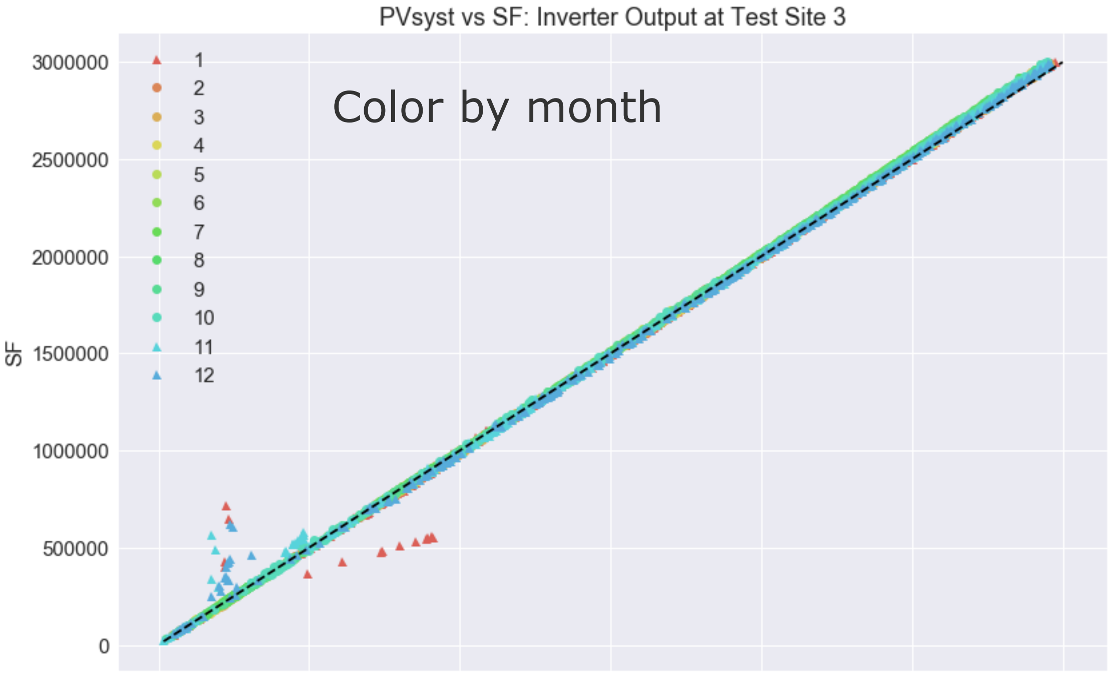


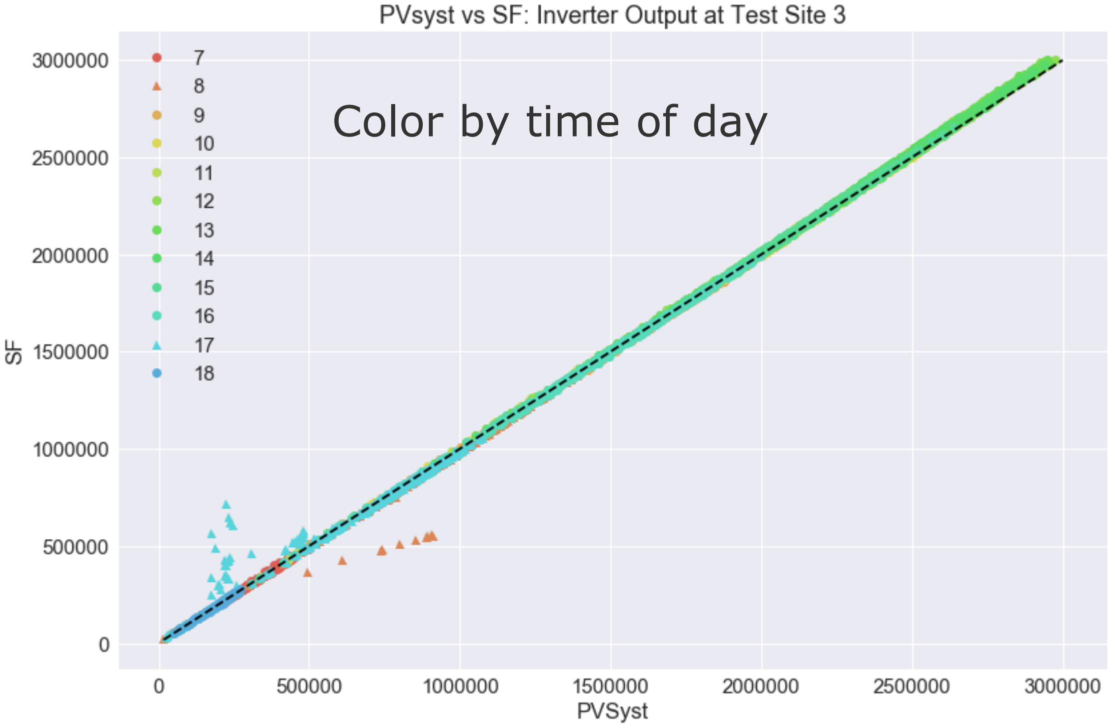
Validation

Validation: Comparison with other models

- Real sites modelled with both SolarFarmer (*beta* version) and PVSyst using identical parameters
  - Expect nearly 1:1 comparison where there is no shading or only row-to-row shading
  - Differences observed in winter and early morning, late evening
  - Test site 3 average annual positive bias
  - Test site 4 nearly zero average annual bias

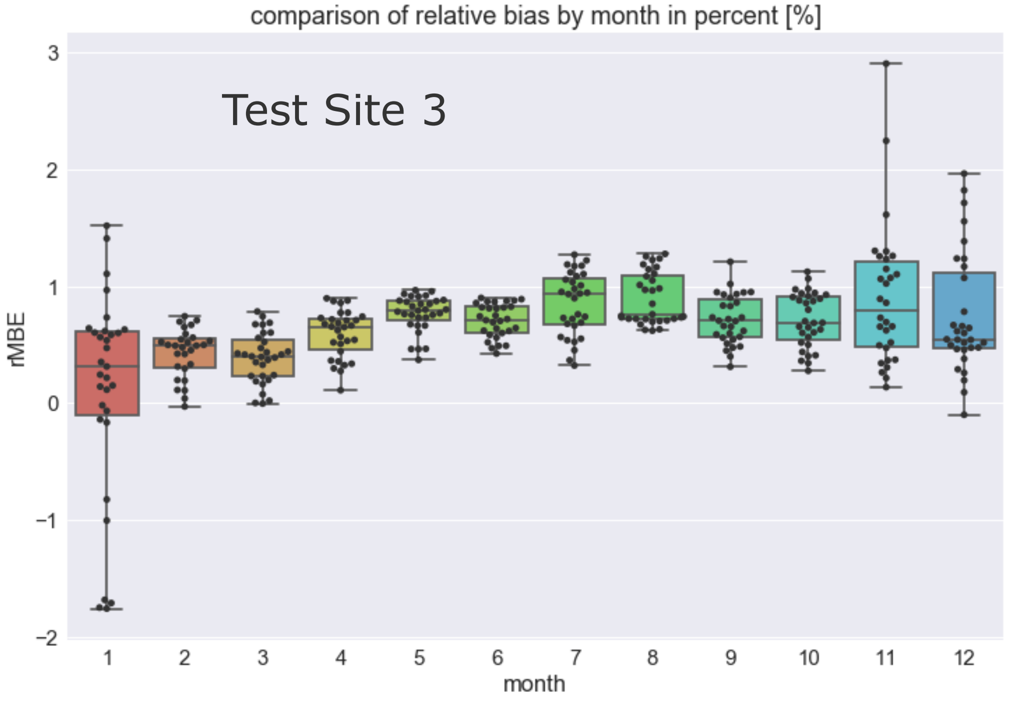
Annual Bias	rMBE	rRMSE
Test Site 3	0.67	1.8
Test Site 4	0.01	1.7

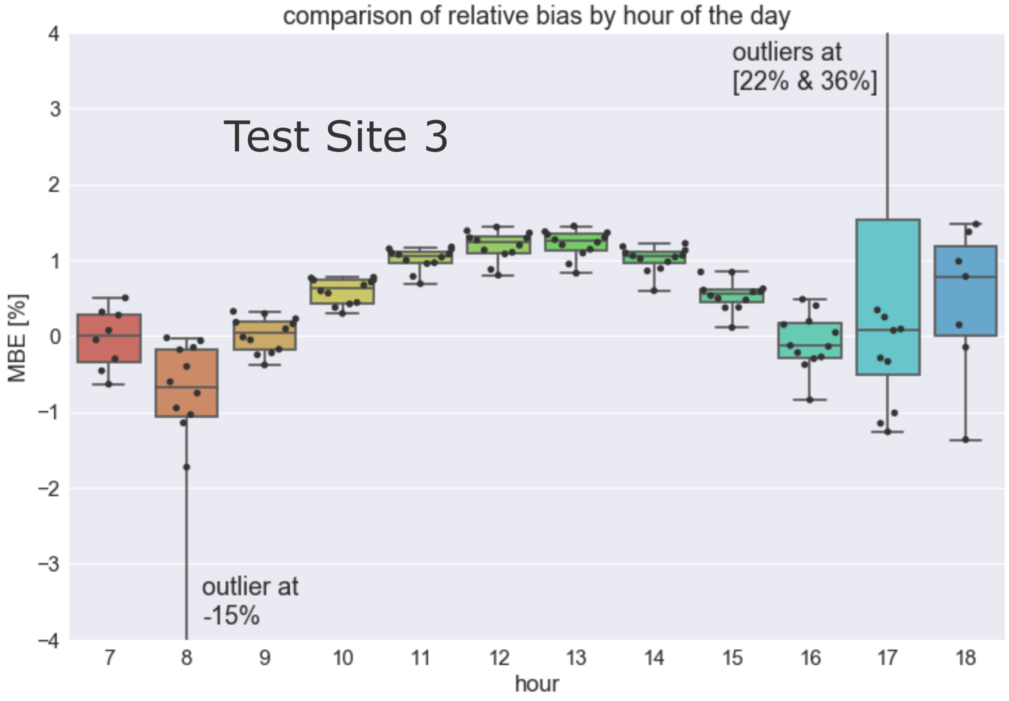




Validation: Comparison with other models

- Test site 3
  - No apparent seasonal bias other than +0.7% annual
  - Apparent strong diurnal bias more positive at noon, less positive, zero, or negative morning and evening





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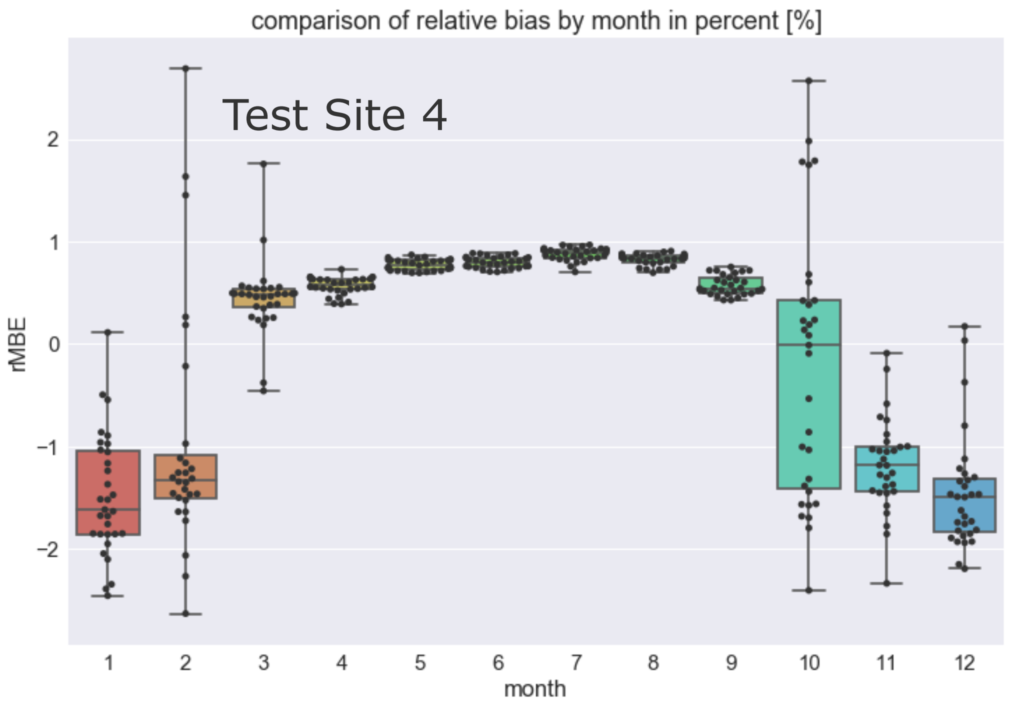
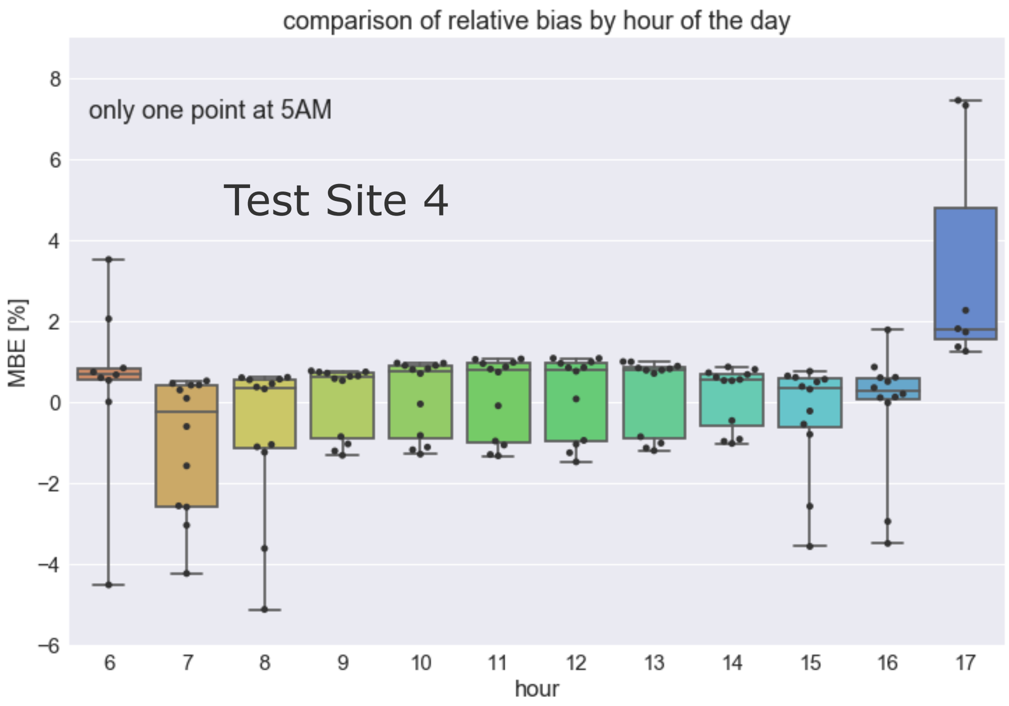
Validation: Comparison with other models

- Test site 4
  - Shows some seasonal bias, lower in winter versus summer
  - Nearly zero diurnal variation





TODO:

- Compare with measured site data
  - Public datasets
    - NIST Gaithersburg, MD test bed
    - Desert Knowledge Australia Solar Centre
  - Private datasets from industry partners
  - More test data – interested in collaborating? Please contact me!
- Examine individual points to determine if differences between models are expected or not
- Investigate positive bias in test site 3
- More *beta* testing – interested in collaborating? Please contact me!
- Release Version 1.0 in Q4
- *Etc.*

Thanks!

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SAFER, SMARTER, GREENER

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