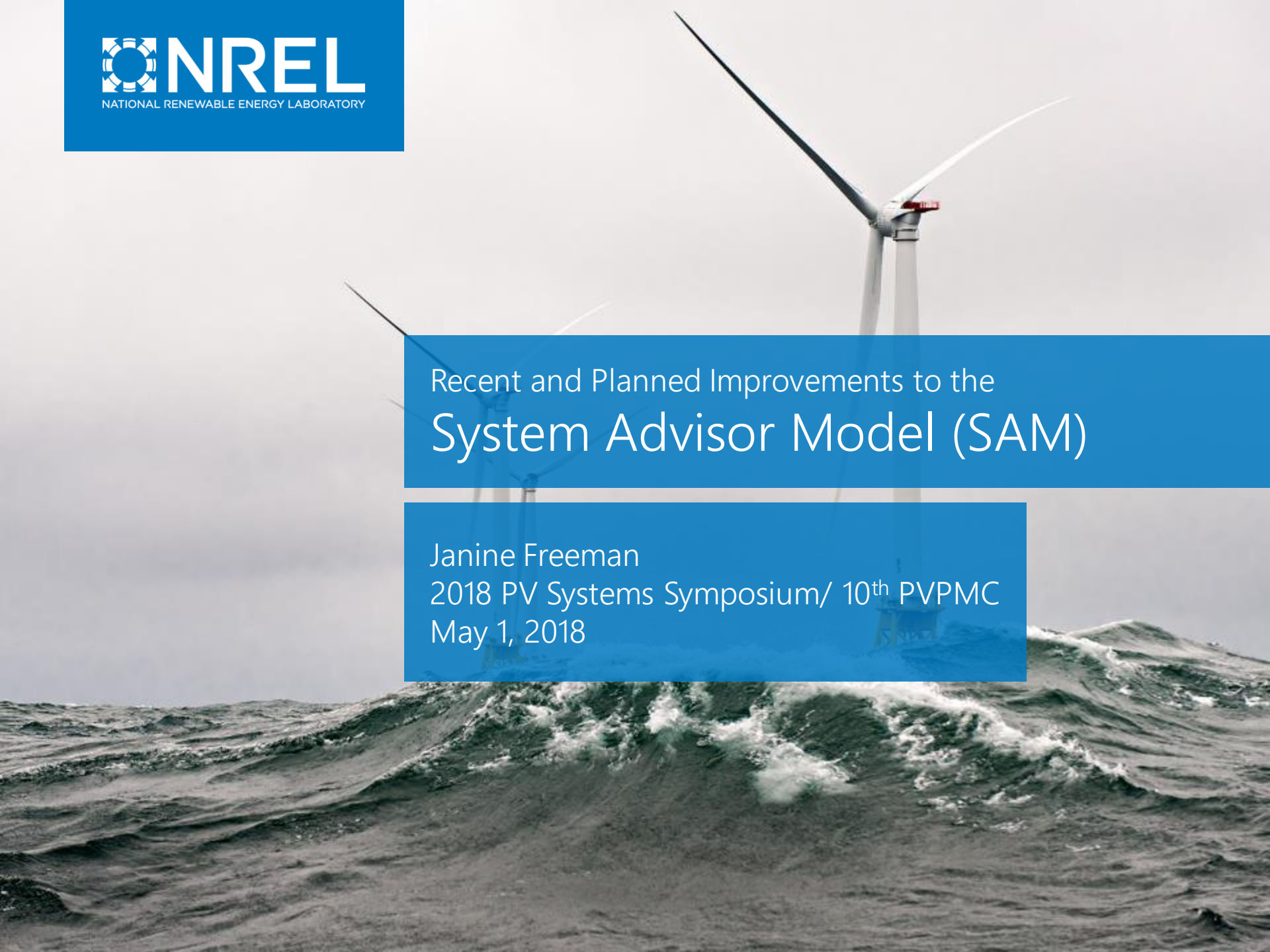


NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Recent and Planned Improvements to the

System Advisor Model (SAM)

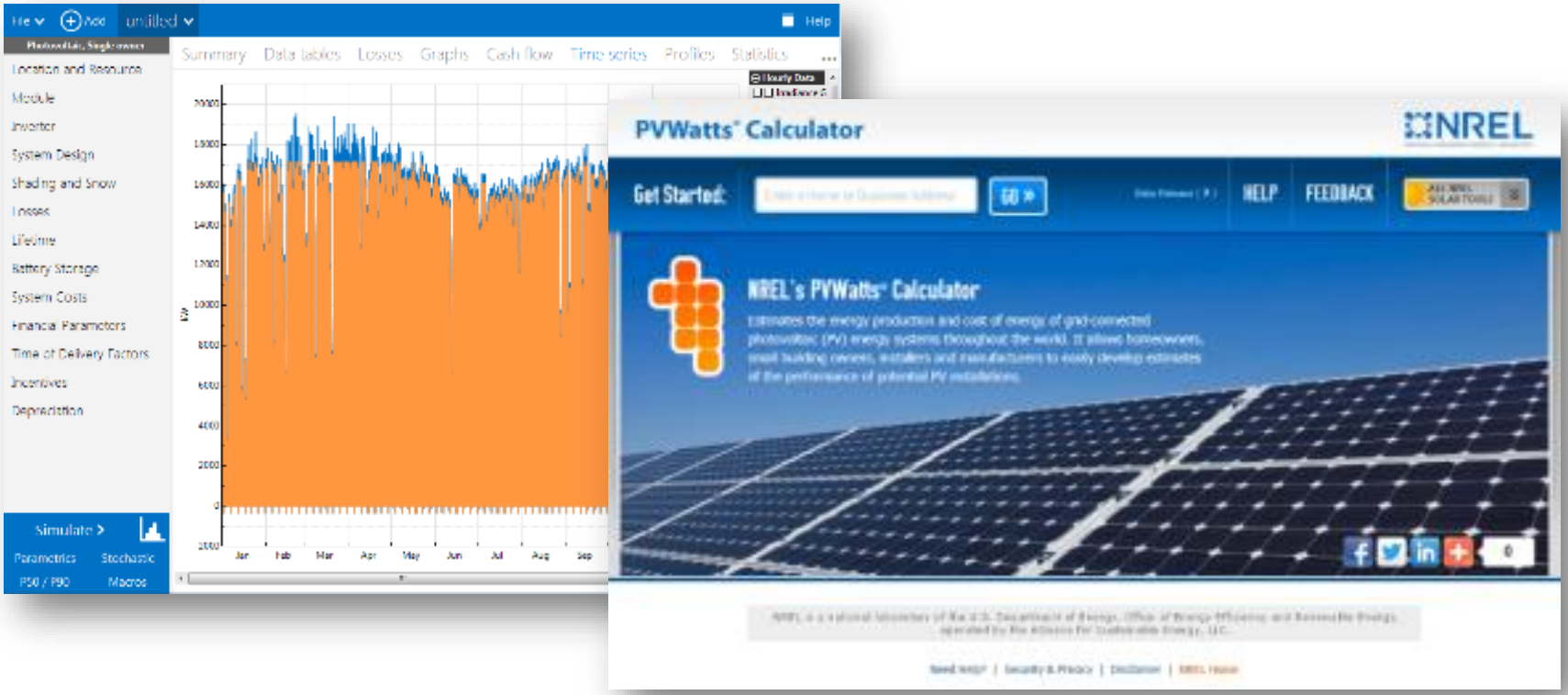
Janine Freeman

2018 PV Systems Symposium/ 10th PVPMC

May 1, 2018

System Advisor Model (SAM) & PVWatts

Free software that enables detailed performance and financial analysis for renewable energy systems

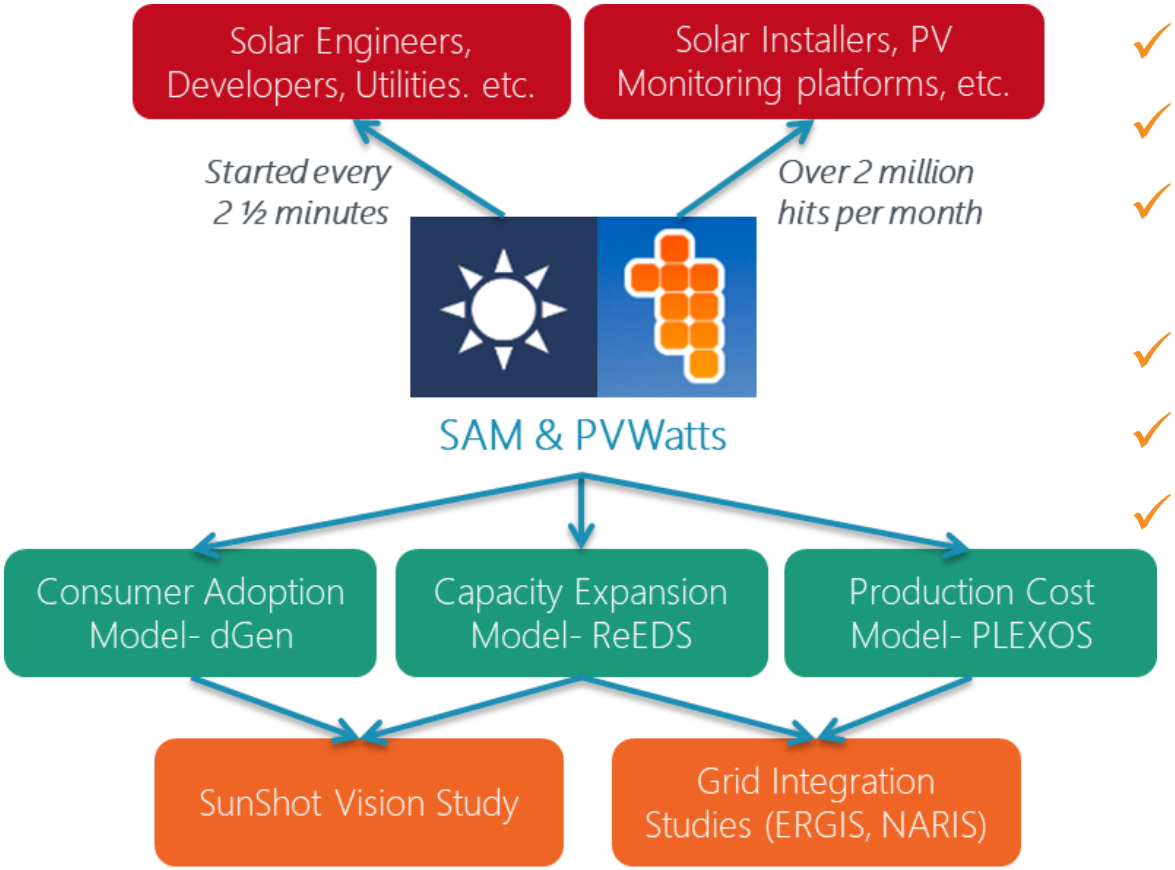


http://sam.nrel.gov/download

How can you access SAM models?

- Desktop Application
- Advanced Analysis Features
  - Parametric
  - Stochastic
  - P50/P90
- Built-in Scripting Language
- Macros
- Software Development Kit (SDK)
  - C/C++
  - Matlab
  - Python
  - PHP
  - C#
  - Java
  - VBA
  - *NEW: iOS / Android*
- Web Services API (PVWatts Only)
- *NEW: Open-source SAM code*

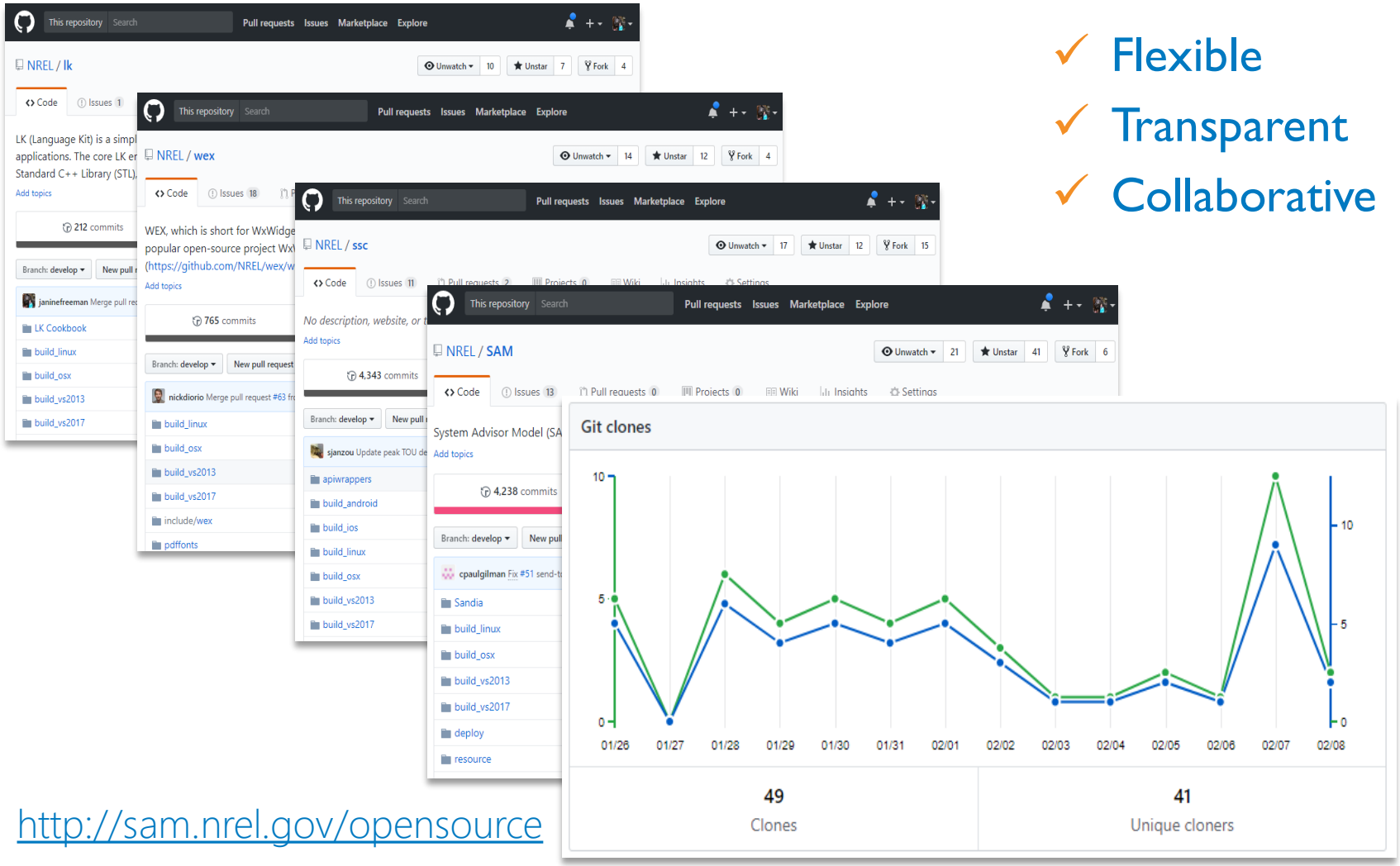
How does SAM fit in at NREL and externally?



- ✓ Grid integration studies
- ✓ Renewable energy futures
- ✓ LCOE of breakthrough technologies
- ✓ Policy and utility rate design
- ✓ Technical potential studies
- ✓ Commercial applications (e.g. Southern Company, AEP, Sunrun)

Recent Improvements

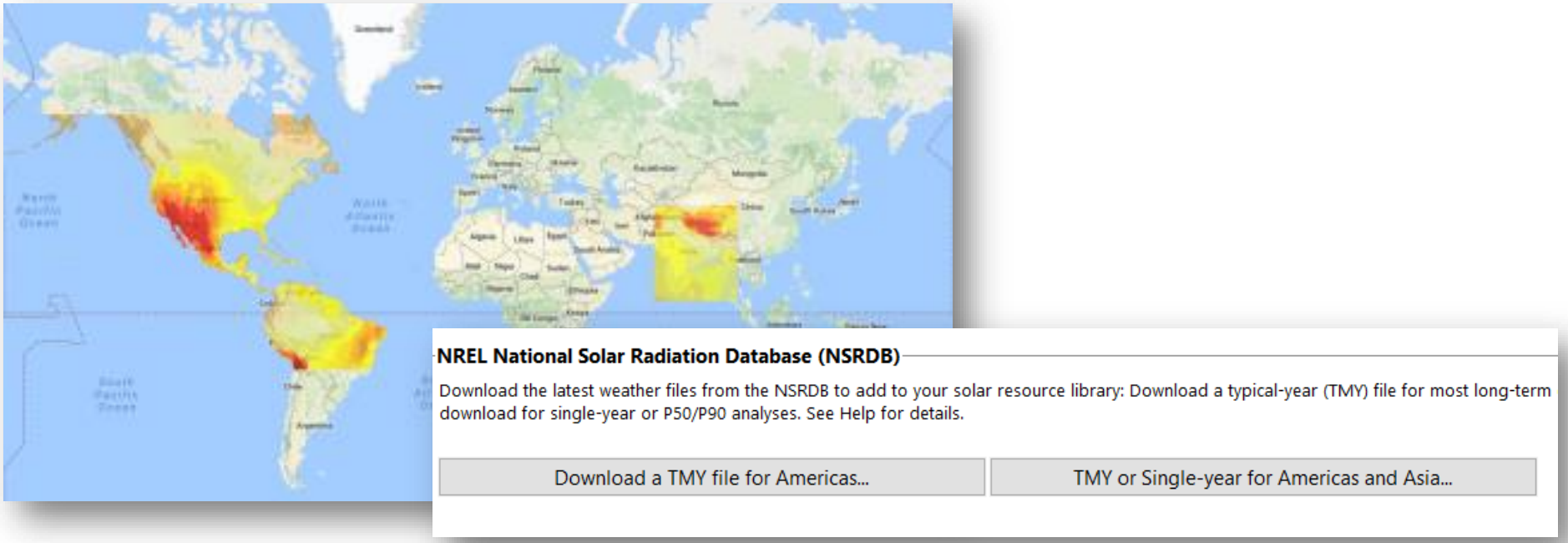
Open Source Code



- ✓ Flexible
- ✓ Transparent
- ✓ Collaborative

http://sam.nrel.gov/opensource

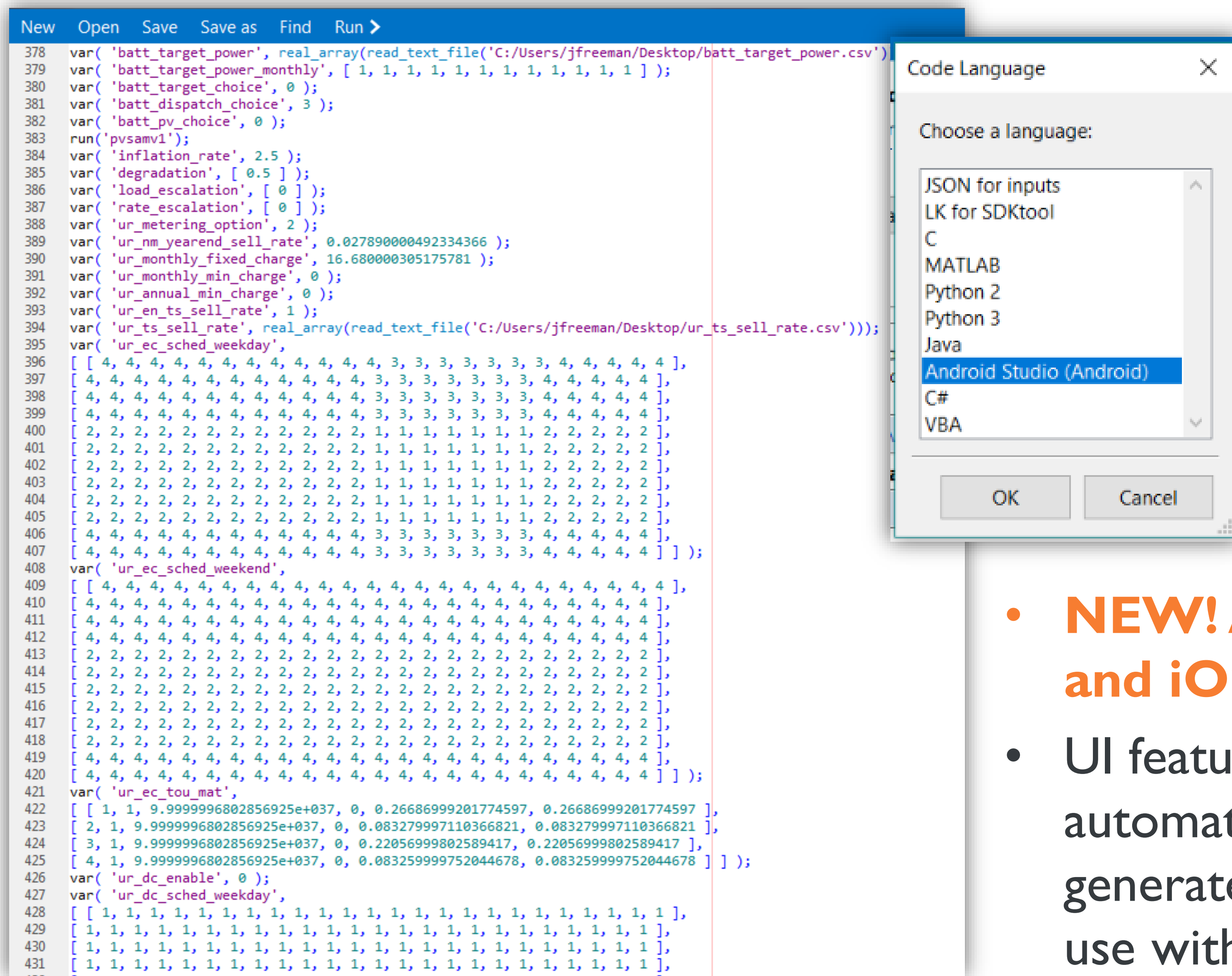
New Weather Data for SAM and PVWatts



- NREL NSRDB V2 and V3 include weather data for much larger geographical extent
  - We are also collaborating with PVGIS to incorporate their data
- From SAM UI: download TMY for your location, or download multiple files of specific year data or TMYs from multiple datasets (update to V3 coming soon)
- NEW: PVWatts V6 API that allows access to NREL NSRDB V3

Software Development Kit (SDK)

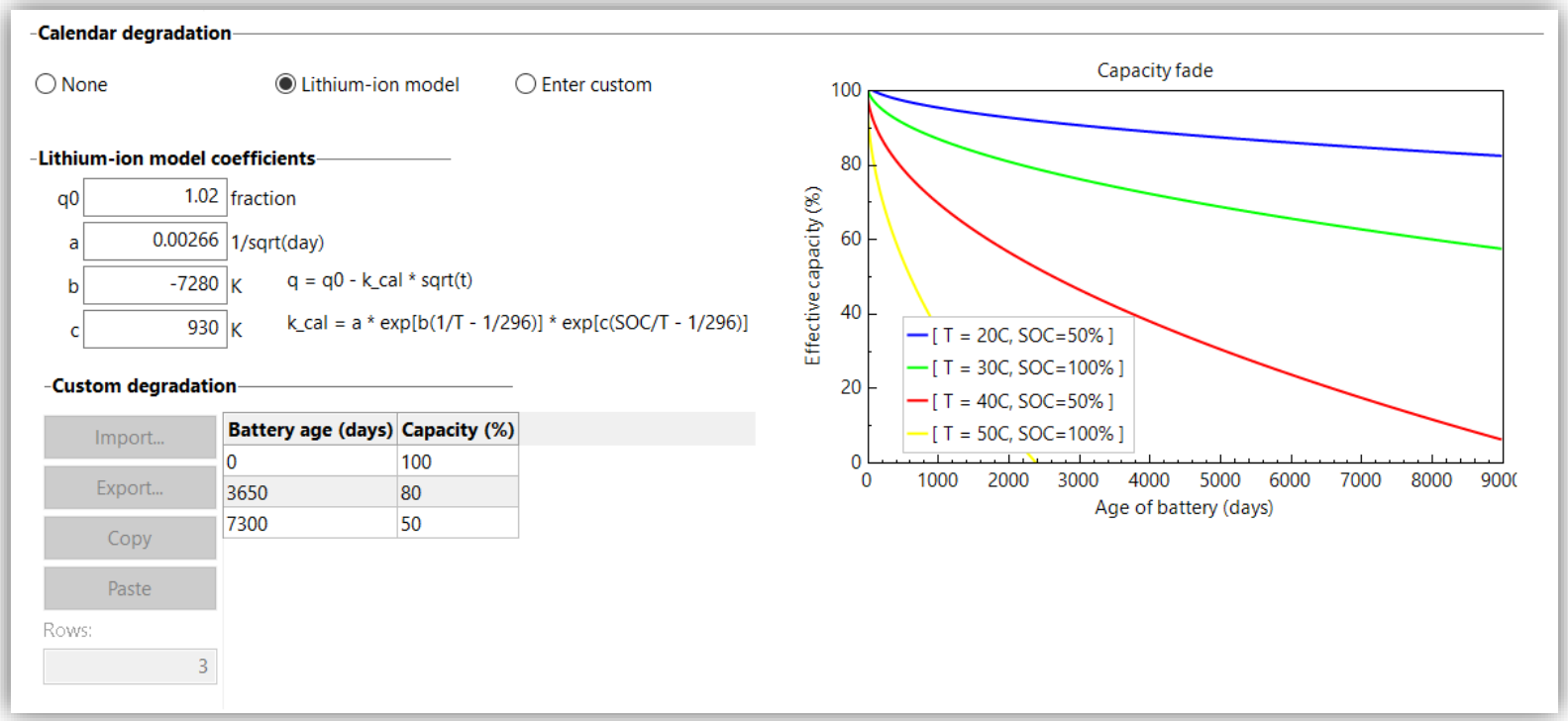
System Advisor Model



- **NEW! Android and iOS wrappers**
- UI feature to automatically generate code for use with SDK

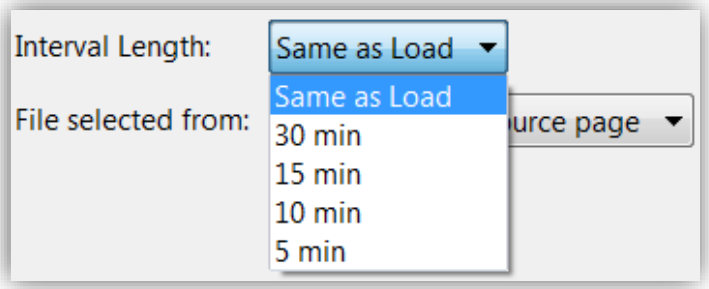
Battery Model Improvements

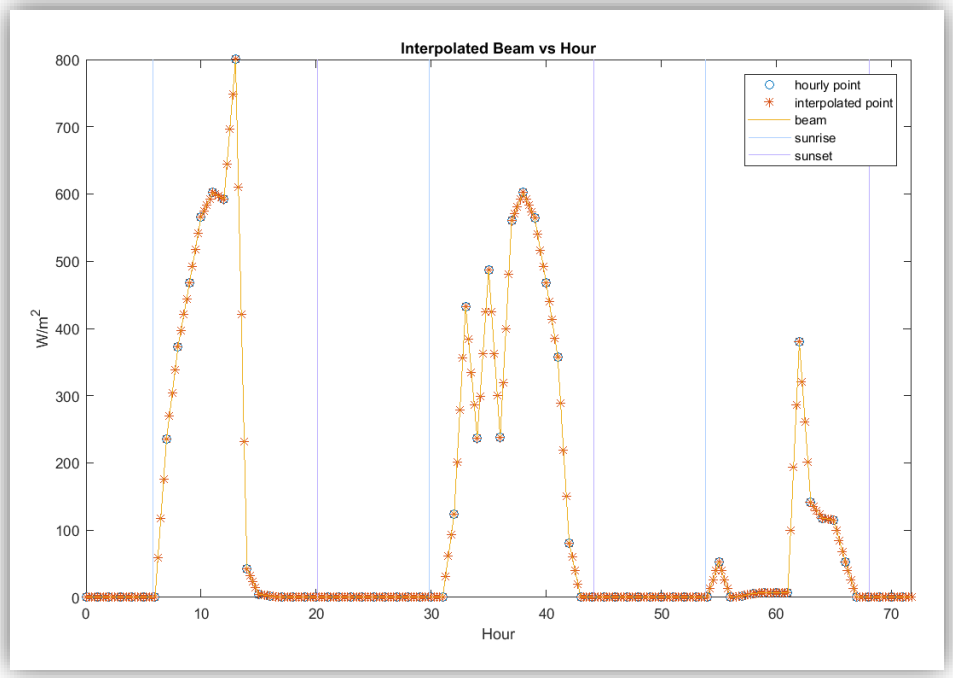
- **Calendar life degradation** model for lithium-ion batteries
- **All-iron flow batteries** and flow battery model improvements
- Improved **battery dispatch** control
- **DC-connected battery** model improvements
  - ➢ *See Will Hobbs' presentation on Thursday!*

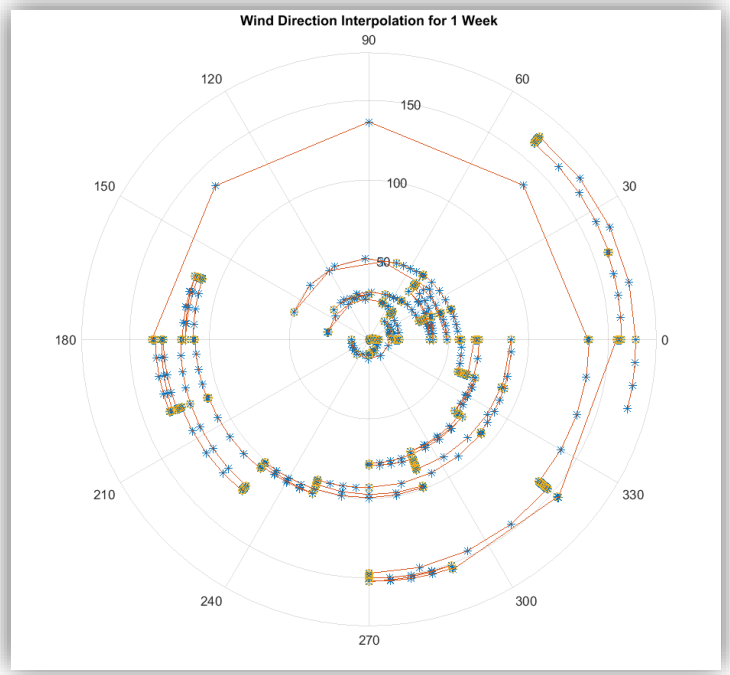


Solar Resource Interpolation Macro

Easily interpolate hourly weather files to sub-hourly to match load profiles



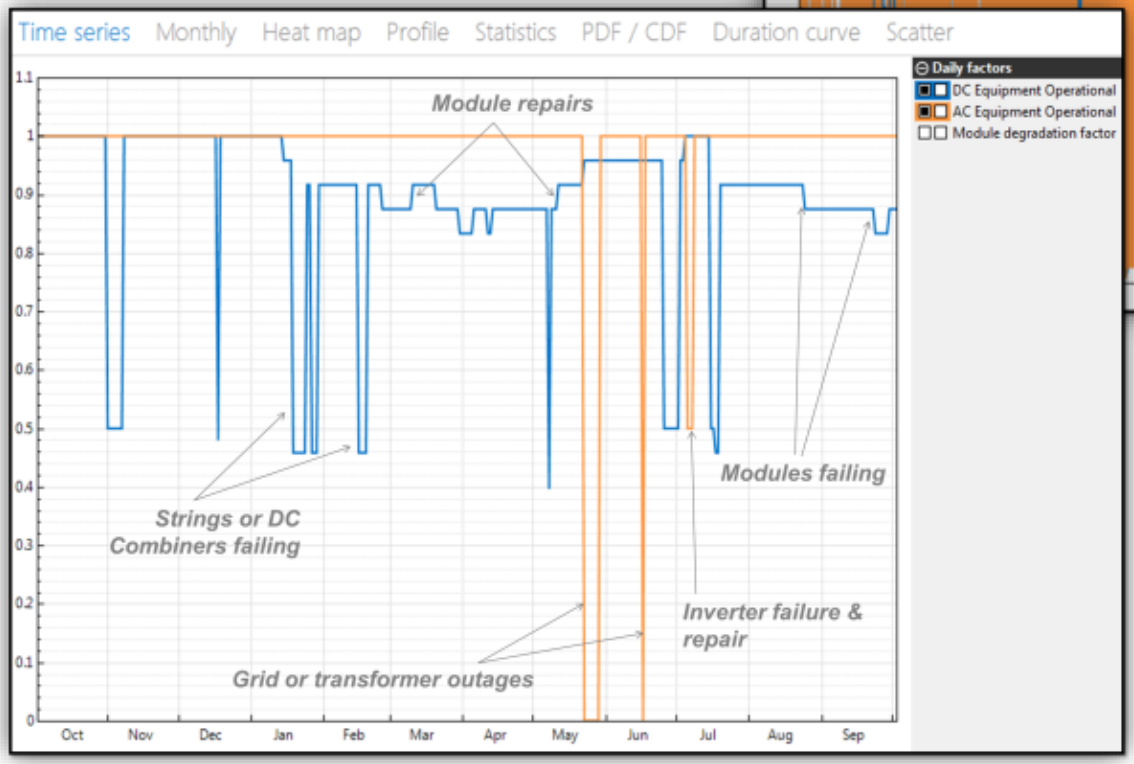




Stochastic Model for PV System Reliability & Performance

Released Beta version of the Photovoltaic Reliability Performance Model (PV-RPM) that has been implemented in SAM LK scripting language

http://sam.nrel.gov/pvrpm



Samples failure distributions for components in a PV system and predicts failure times, replacement costs, and performance/cost impacts for a more realistic representation of LCOE of PV systems

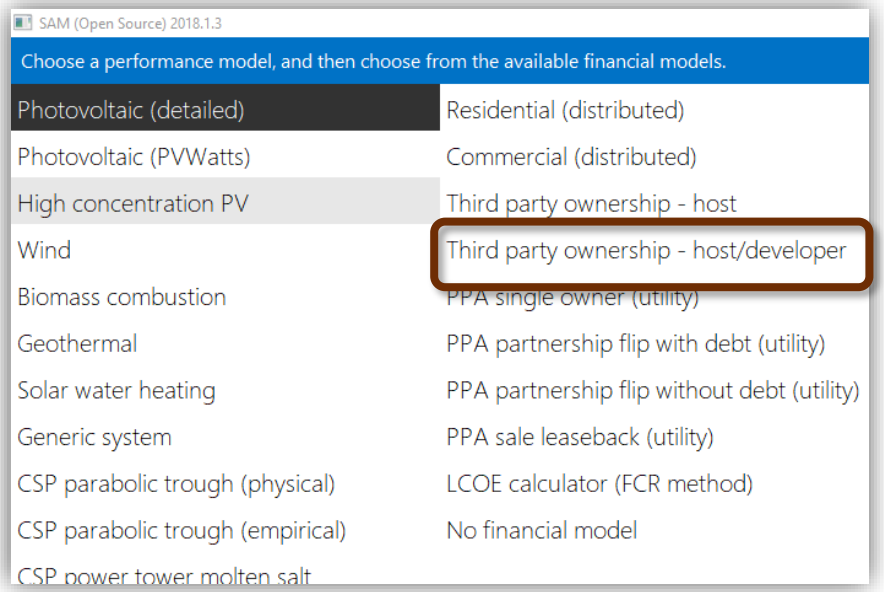
Coming Soon

Host + Developer Financial Model

Dual-perspective financial model combines:

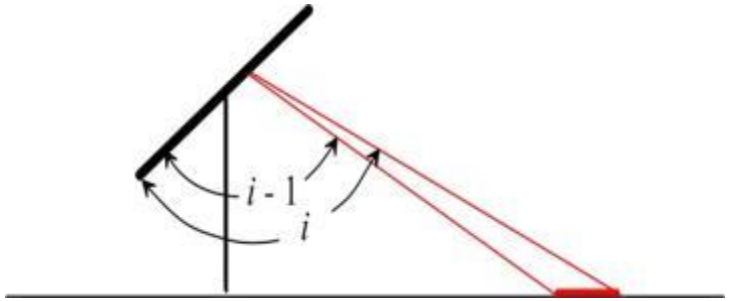
1. Single owner cashflow model: calculates PPA required for financial viability to developer
2. Third party ownership model: calculates value to host with PPA price as input

To evaluate PPA prices that make system financially viable to both parties (military bases, housing authorities, etc.)



Bifacial Module Model

Implementing bifacial model developed by Marion et al into main workflow of SAM



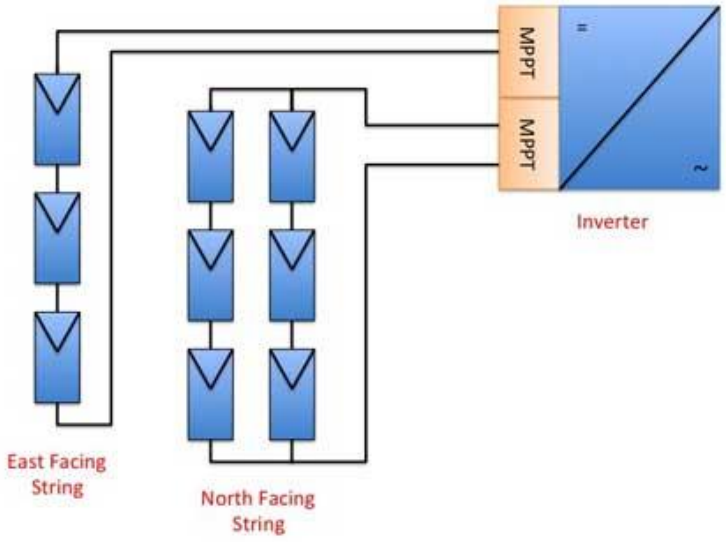
"A Practical Irradiance Model for Bifacial PV Modules", Marion et al, 44th IEEE PVSC, June 2017

PV-Connected Fuel Cell Model

In conjunction with Southern Company, implementing a PV+Battery+Fuel Cell model within SAM

Multiple MPPT Inverters

- Ability to model inverters with multiple MPPT inputs
  - Different subarray orientations
  - Varying string lengths
  - etc
- Requires re-architecting core PV model code
  - Simultaneously designing to simplify possible future projects



Proposed Work

DOE SETO Lab Call 1: Core SAM Development

- Open Source Model
  - Incorporating user contributions, open source community support
  - Better align PV model with pvlib
- Platform Improvements
  - Keep up to date in rapidly evolving battery, utility rate, and financial modeling worlds
  - Better connection with NREL building load modeling resources
- PV Model Improvements
  - Battery model: resiliency calculations, optimal sizing, optimized dispatch
  - Smart inverter and off-MPPT operation for realistic grid integration studies
  - Improved shorter timestep modeling
- Stakeholder engagement, foundational maintenance, technical support

Thank you for your 15 letters of support!!

DOE SETO Lab Call 2: PV Uncertainty

NREL NATIONAL RENEWABLE ENERGY LABORATORY

Sandia National Laboratories

Establish consensus methods for quantifying energy uncertainty in energy production estimates

- Propagate modeling uncertainty into annual energy estimates
  - Identify & quantify sources of uncertainty
  - Identify & implement methods to efficiently propagate uncertainty to desired energy estimate metrics
  - Publish methodologies (both in literature and in open source code)
- Quantify & publish reliability uncertainty using operational data
- Propagate reliability uncertainty into energy estimates using the PV-RPM model as a foundation
- Quantify and represent weather uncertainty, leveraging long-term historical datasets

We need your involvement!!

Unfunded Ideas

- Crowd-sourced component database
- Floating PV, BIPV, Transparent/shifted spectrum PV
- Using spectral data from the new spectral NSRDB
- Importing measured data and tools for automated comparison

Thank you! Questions?

Janine Freeman - project lead, photovoltaic and wind models
Nick DiOrio - code architecture, battery storage models
Nate Blair - emeritus lead, financials, costs, systems
Steve Janzou - programming, utility rate structures (subcontractor)
Paul Gilman - user support and documentation (subcontractor)
Ty Neises - concentrating solar power models
Mike Wagner - concentrating solar power models

www.nrel.gov
http://sam.nrel.gov

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