Upcoming Schedule

- Module 4 Office Hours
  - Wednesday, April 25th, 1-2 Eastern
  - Register here: https://attendee.gotowebinar.com/register/3018433584458928641
- U.S. EPA Webinar on its Local Government Solar Project Portal
  - Wed, Apr 25, 2018 1-2 Eastern
  - Register here: https://register.gotowebinar.com/register/5206149464354575105

EPA's Local Government Solar Project Portal

https://www.epa.gov/repowertoolbox/local-government-solar-project-portal

- EPA invites local governments across the country to meet their environmental, energy, economic and domestic job creation goals through greater utilization of solar energy from on and off site solar projects that serve municipal operations.
- Local governments will find project development resources and opportunities to learn from industry experts and their peers.
- Share Your Progress and learn more about available resources and technical support.

Local Government	State Cohort	Network Options	Pathway Progress	Project Development Pathway Steps							
				RE Public Commitment	RE Development Plan (Optional)	Collection of Utility Data & Site Assessment	Number of Projects Under Consideration	Issued Request for Proposals	Proposal Evaluations	Signed Contract	Capacity Installed
City of Alexandria	VA			Link (PDF) (82 pp, 33MB)	-	-	-	-	-	-	-
City of Ashland	OR			Link	-	-	-	-	-	-	-
City of Chicago	IL			Link (PDF) (40 pp, 12MB)	-	-	-	-	-	-	-
City of Durango	CO			Link (PDF) (42 pp, 1.1MB)	-	-	-	-	-	-	-
City of Eau Claire	WI			Link (PDF) (37 pp, 1.8MB)	-	-	-	-	-	-	-
Town of Fraser	CO			Link	-	-	-	-	-	-	-
City of Milwaukie	OR			Link (PDF) (15 pp, 5MB)	-	-	-	-	-	-	-
New York City	NY			Link	-	-	-	-	-	-	-
City of Philadelphia	PA			Link (PDF) (28 pp, 2.8MB)	-	-	-	-	-	-	-
City of Roanoke	VA			Link (PDF) (77 pp, 1GB)	-	-	-	-	-	-	-
City of Sarasota	FL			Link	-	-	-	-	-	-	-
City of Urbana	IL			Link (PDF) (28 pp, 1.9MB)	-	-	-	-	-	-	-

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1977 – 2017





System Advisor Model (SAM) Introduction Slides and Demo

Nate Blair and Janine Freeman

Tools That You Can Use

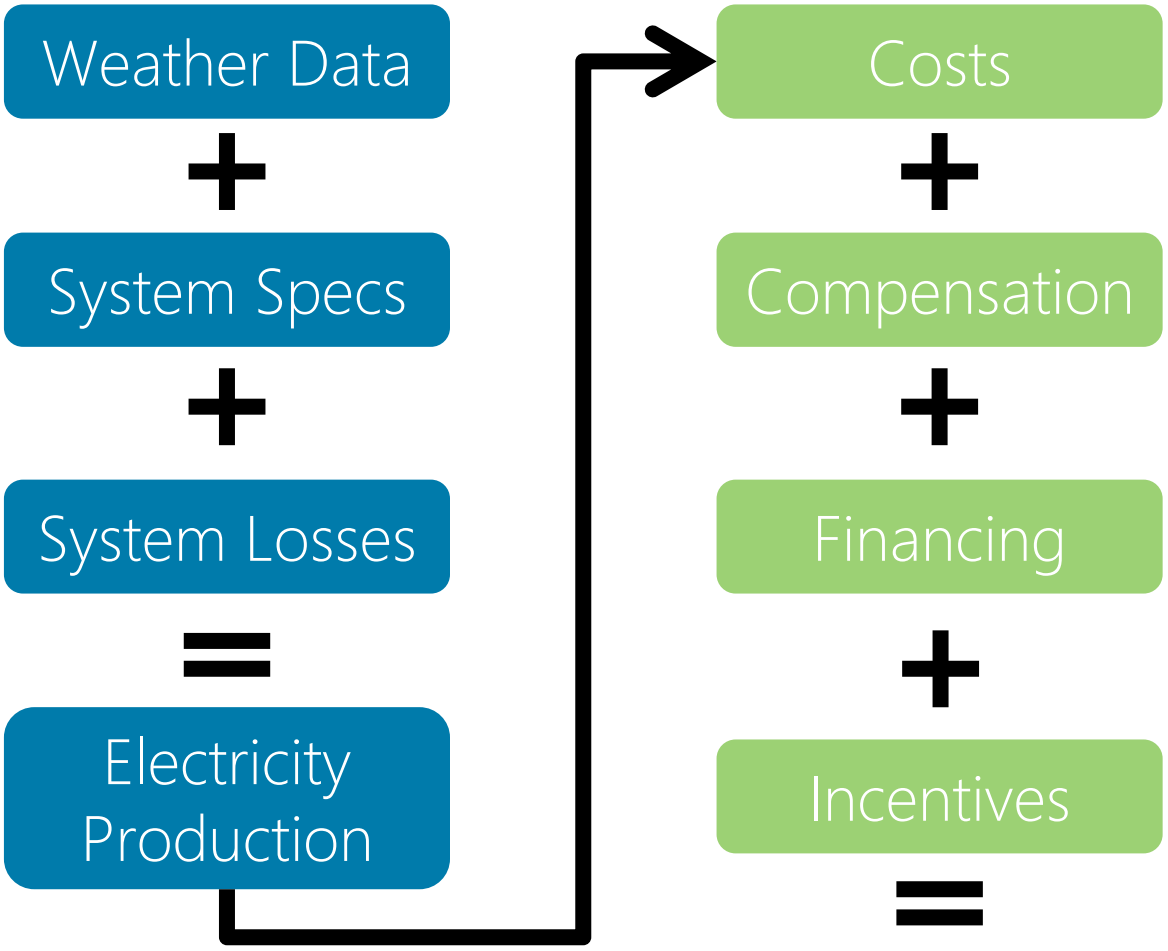
- PV modeling tools take into account the factors that impact project potential
- Publicly available tools can be used to gauge initial potential, optimize system sizing & refine project economics

	Expertise and Effort needed	Required Inputs	Key Outputs
FEMP DG Screening Tool	Low	• Location	• Map interface with geospatial layers • High-level economics
PVWatts Calculator	Low	• Location • System configuration	• PV energy generation (no economics)
REopt Lite Web Tool	Medium	• Location • Energy Consumption • Rate tariff	• Optimized system size and dispatch • High-level economics
System Advisor Model (SAM)	High	• Energy Consumption • Rate tariff • Detailed system configuration • Financing inputs	• Detailed technology performance • Detailed economic modeling

Poll Questions

- Have you previously used REOpt?
- Have you previously used SAM?

Steps to Modeling Renewable Energy

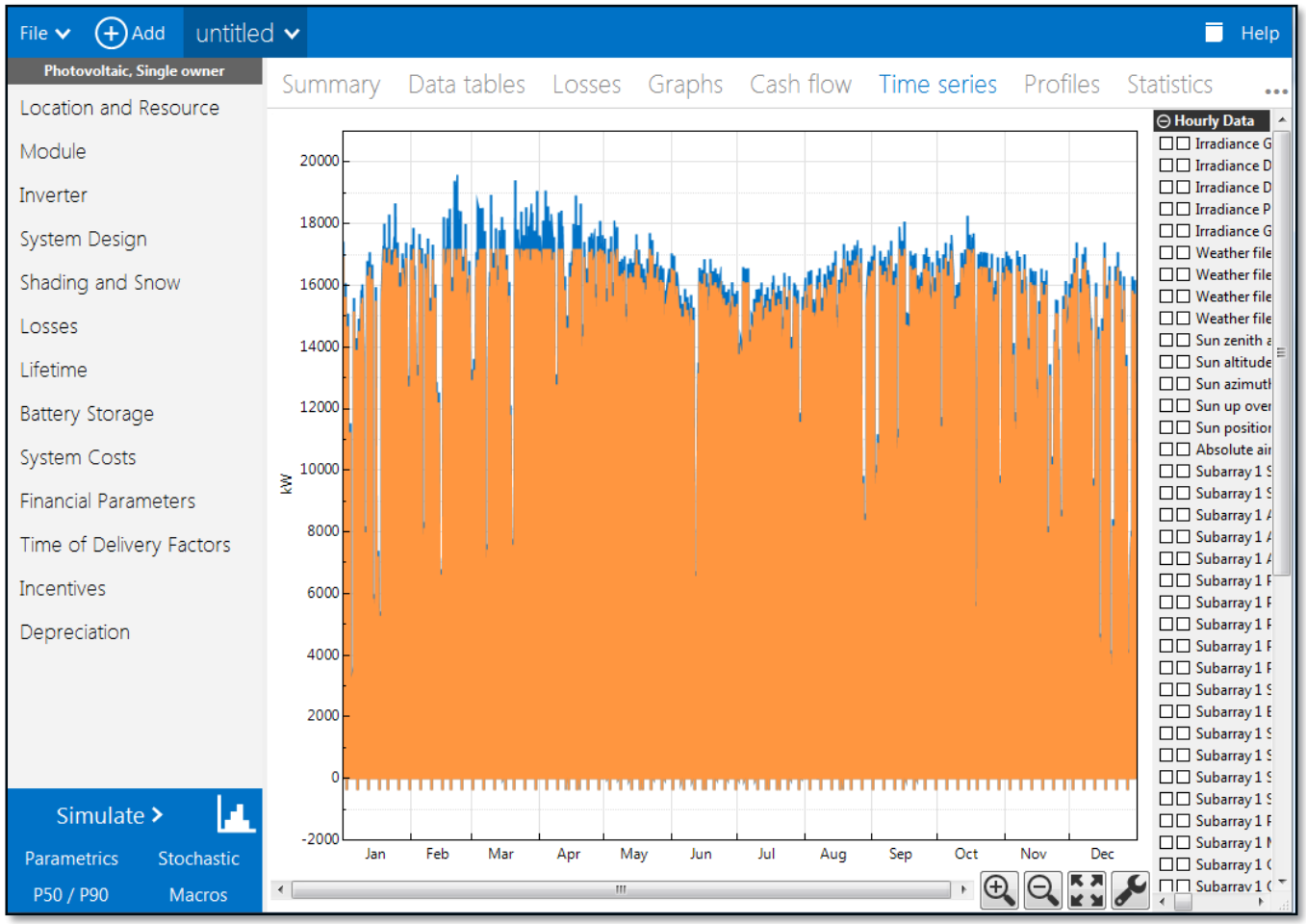


Results

Annual, Monthly, and Hourly Output, Capacity Factor, LCOE, NPV, Payback, Revenue

System Advisor Model (SAM)

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



http://sam.nrel.gov/download

Technologies

- Photovoltaics
  - Detailed & PVWatts
  - Battery Storage
- Wind
- Concentrating solar power
- Geothermal
- Biomass
- Solar water heating

Financial Models

- Behind-the-meter
  - residential
  - commercial
  - third-party ownership
- Power purchase agreements
  - single owner
  - equity flips
  - sale-leaseback
- Simple LCOE calculator

What can you do with SAM?

- Model a variety of technologies in a consistent platform
- Access high-quality performance and economic models developed by NREL, Sandia, and other partners
- Calculate financial metrics such as LCOE, NPV, payback for projects in different markets
- Perform parametric and uncertainty analyses
- View and export modeling results in a variety of ways
- Access extensive help documentation, view tutorials and webinars

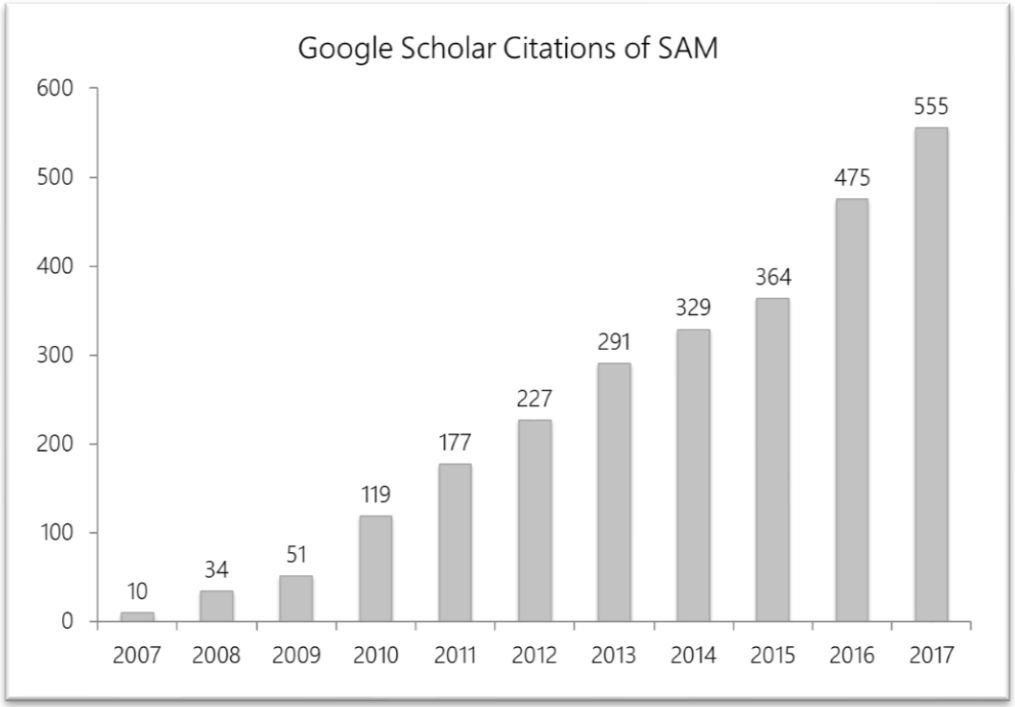
SAM Users

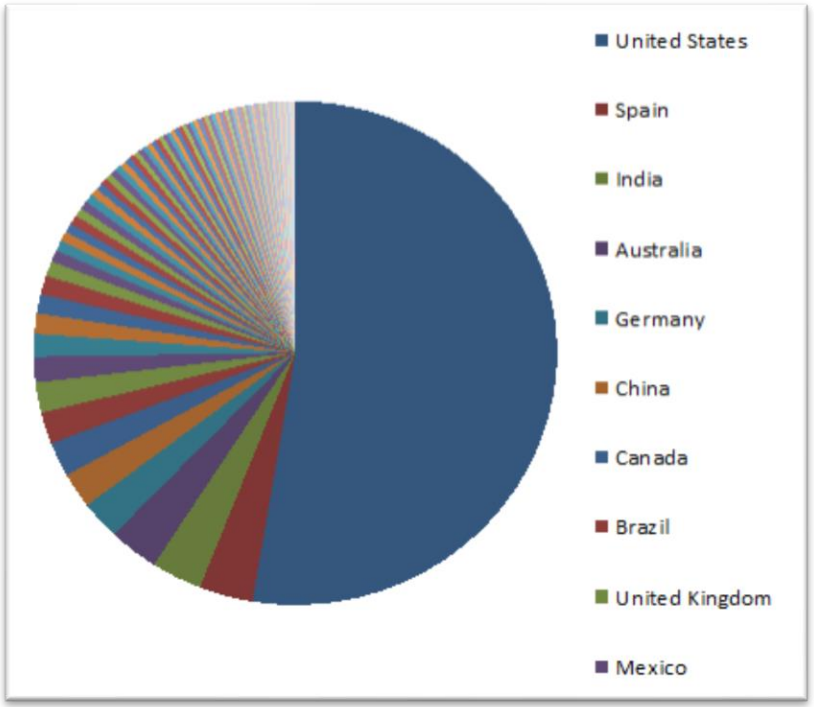
SAM is started **once every 2 ½ minutes**

Over **65,000** active users in 130+ countries

90+ webinars with **113,346 views**

Users include Sunrun, Enphase, AEP, Southern Company, EPRI, & more





Poll Questions

- Do you anticipate buying PV directly or through third-party owners at this point?

Third Party Ownership

- From perspective of building owner (discount rate, etc.)
- Enter the offered PPA/lease offer
- Enter load data and rate data
- Model evaluates if the third-party owned project is profitable (= positive net present value)

Sub-system Components Working Together

Example: Battery Model

- Designed primarily for behind-the-meter analysis (residential and commercial scale systems)
- Lithium ion and lead acid chemistries including submodels for cell voltage, capacity, thermal, degradation, and replacements
- Highly configurable manual dispatch controller
- Validated with laboratory measured test data for two systems.

Detailed photovoltaic model

Module

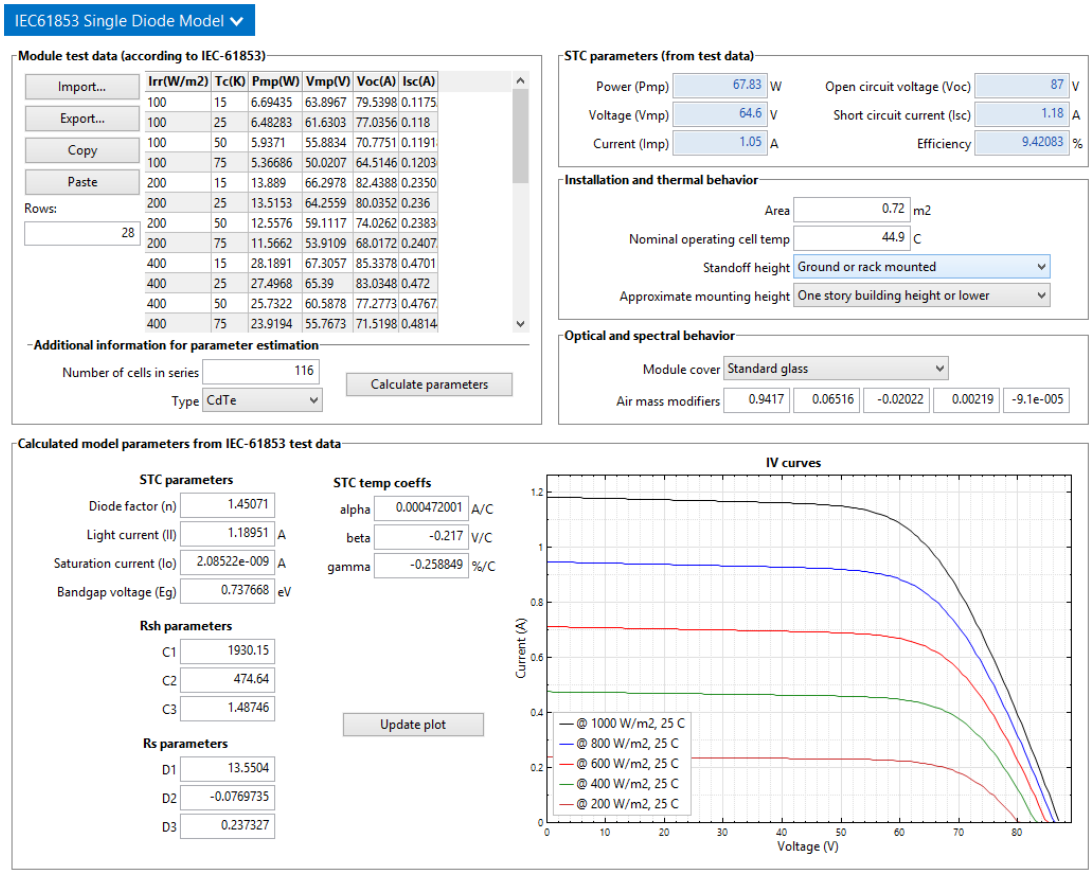
- Simple efficiency model
- Single diode model
  - CEC database or datasheet
- IEC-61853 data based model
- Sandia PV Array Perf. Model

Inverter

- Sandia/CEC grid-tied inverter model
- Datasheet part-load efficiency curve

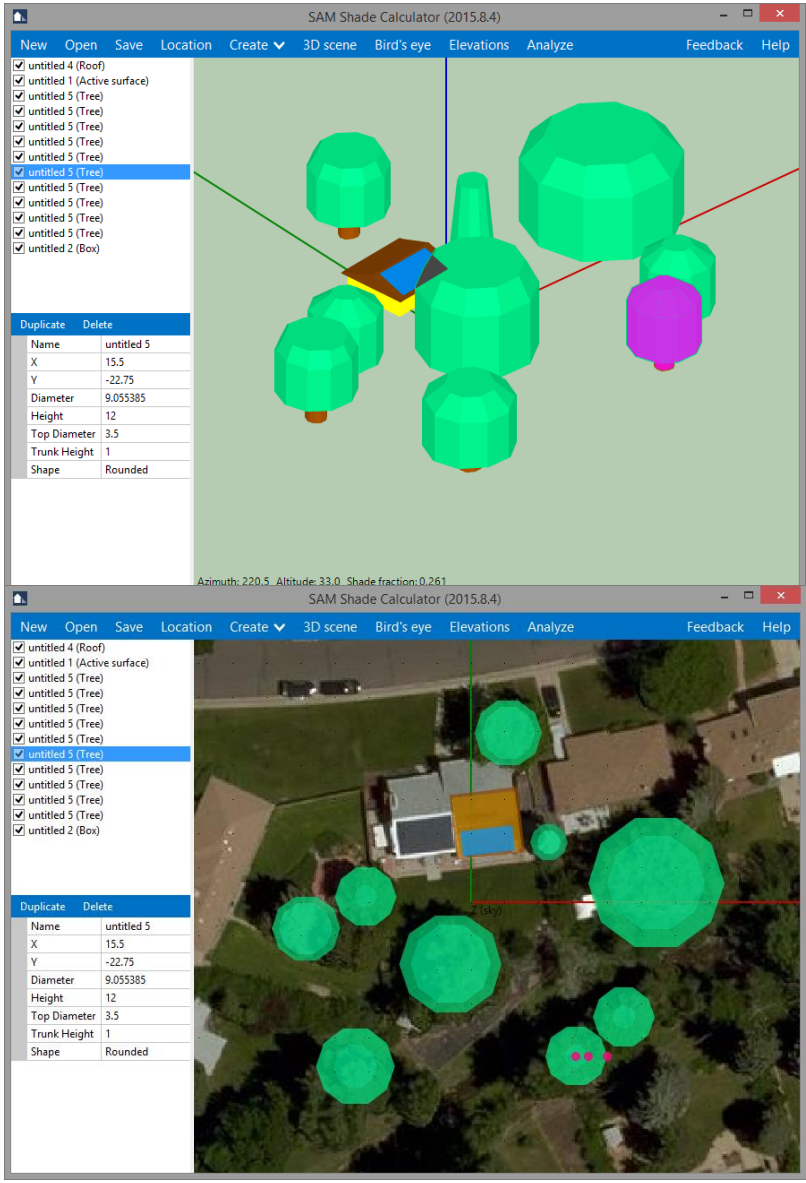
Degradation

- Extrapolated single year
- Lifetime simulation of all years



Complex System Feature: 3D shading calculator

- Fully integrated into SAM
- Calculates linear beam shading losses and sky diffuse view factor loss
- Imports 2D mapping underlays from Bing maps
- Diurnal or hourly/subhourly time series shade simulation
- Estimation of nonlinear losses for shaded parallel strings
- Scripting to automate panel layout and import/export geometry data

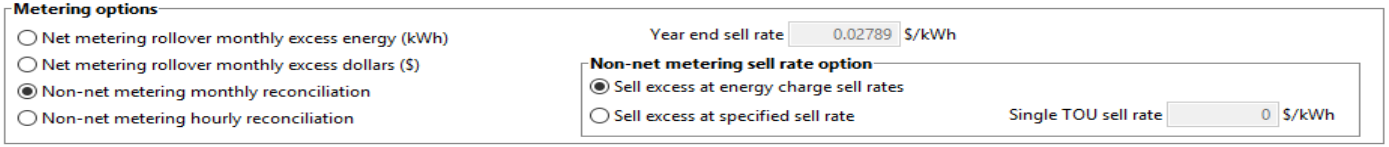


Complex utility rate model options

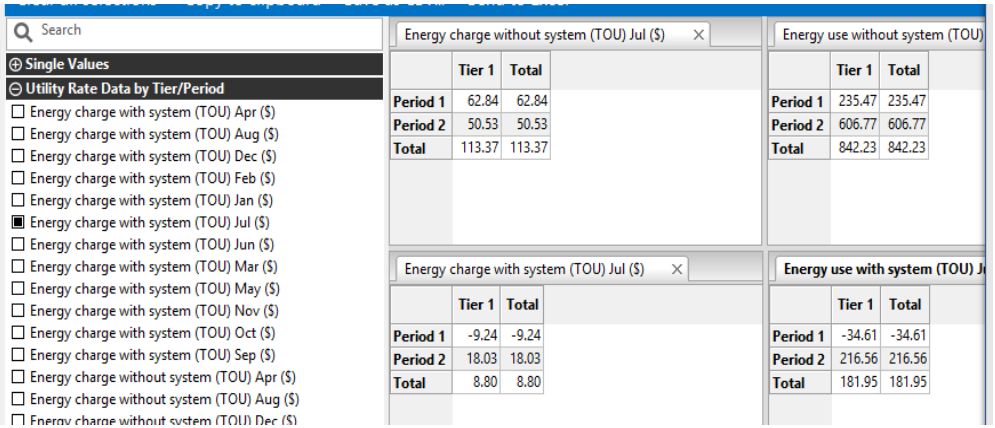
SAM models complex utility rates in conjunction with the NREL Utility Rate Database

Recent additions:

Additional net metering options have been added and implemented to help users understand the impact of different scenarios currently implemented in several states.



New data browser categorizes and consolidates results.



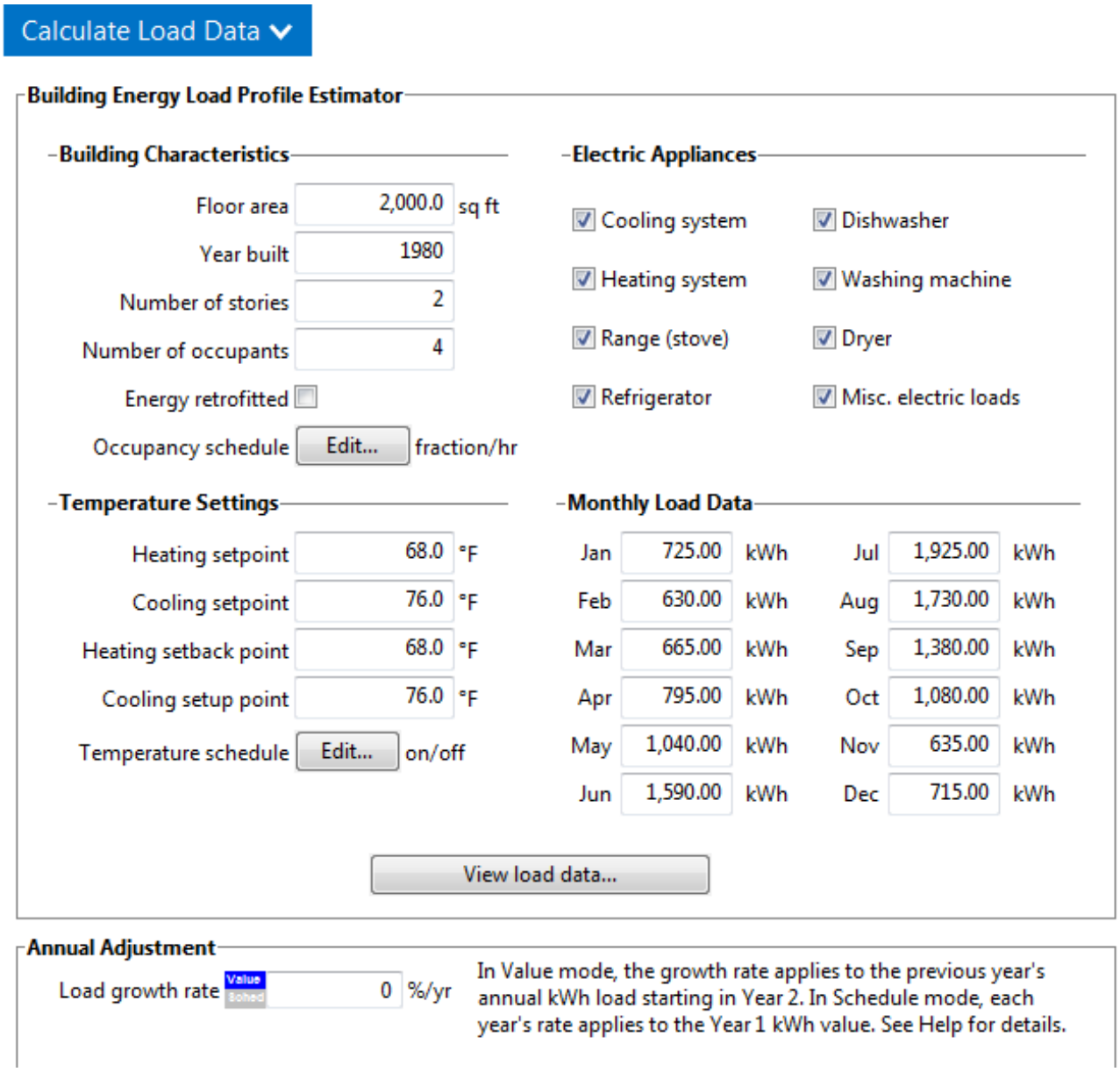
Linkage with OpenEI rate database improved and expanded for some international rates.

OpenEI
Open Energy Information

http://www.openei.org

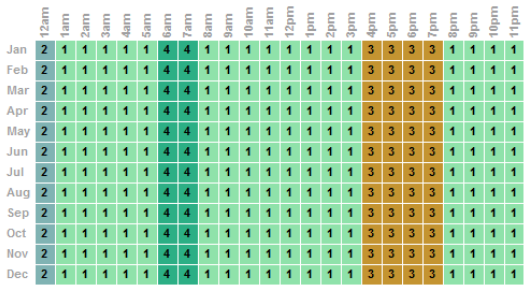
Utility Rate DATABASE

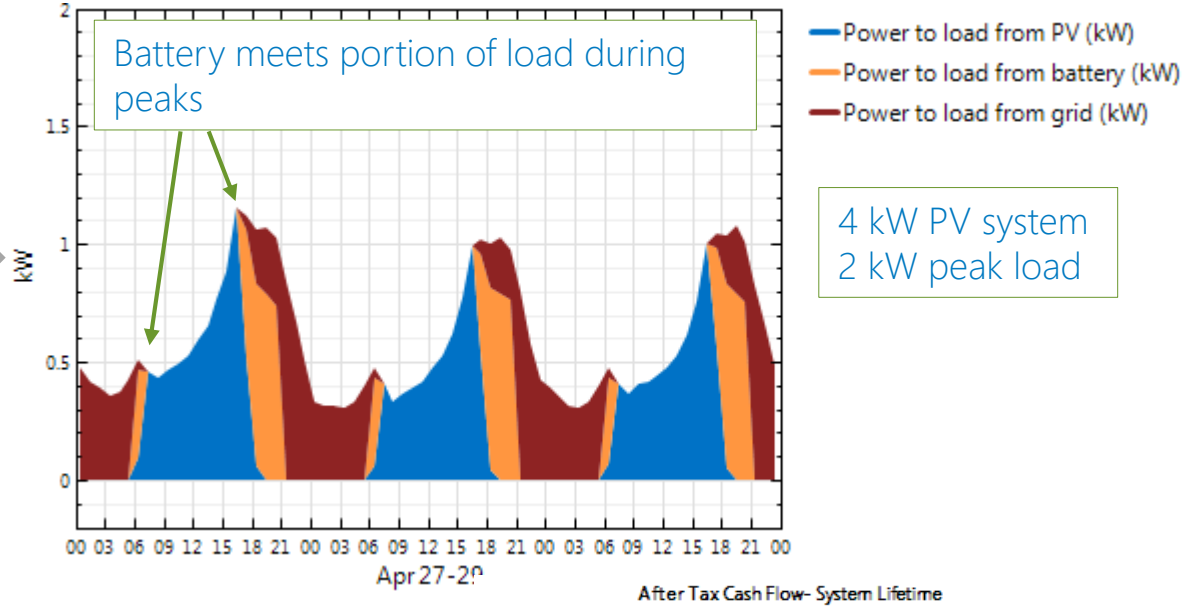
Several ways to enter building load data



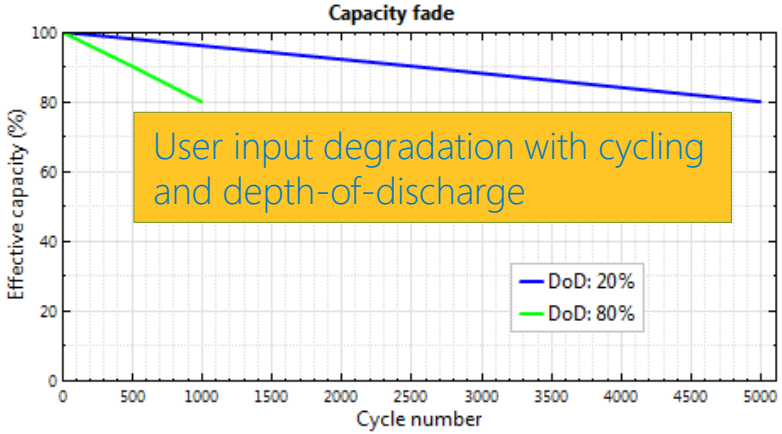
- Load profile in a file that can be scaled for monthly values.
- Residential loads: Use data about the building to create load data with consistent weather data
- Macro to download load data from OpenEI

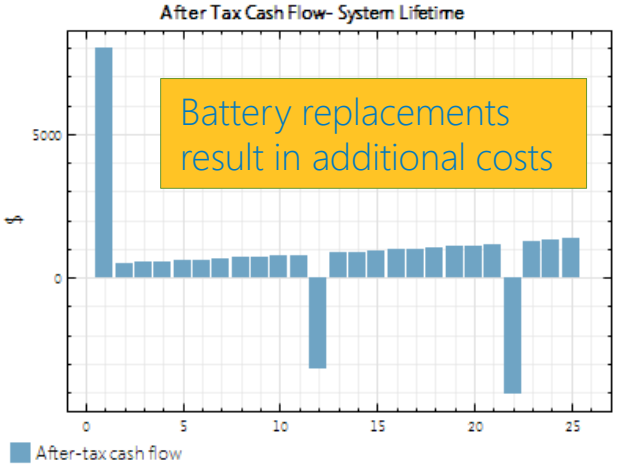
Putting it all together: Dispatch and degradation





4 kW PV system
2 kW peak load





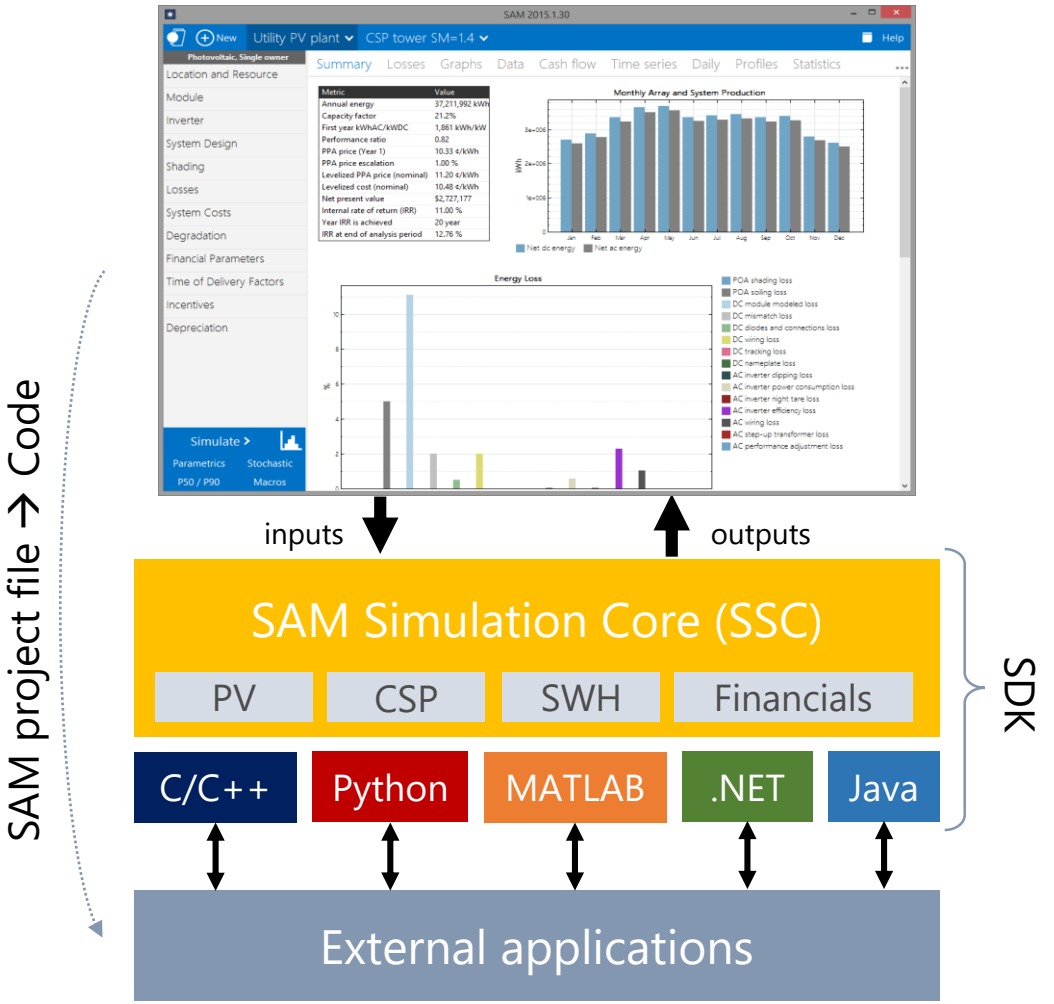
Extending SAM

Desktop Application

- Advanced Analysis Features
  - Parametric
  - Stochastic (and for O&M)
  - P50/P90
- Built-in Scripting Language
- Macros
  - Written with SAM scripting language

Requires programming skills

- Software Development Kit (SDK)
  - C/C++, Python, C#, Java
  - Matlab, VBA
  - PHP
  - iOS And Android (NEW!!!)
- Web Services API (PVWatts Only)
- Open-sourced SAM code (NEW!!!)

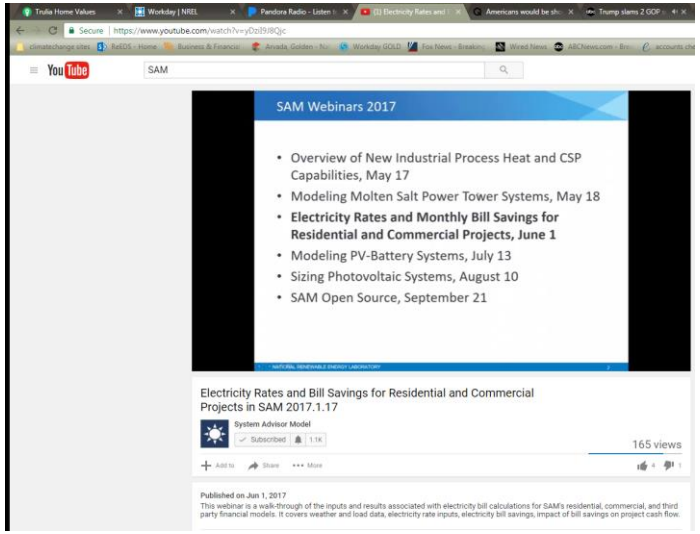


Poll Questions

- Do you anticipate using SAM in a way other than via the desktop tool?

How to Interact with the SAM team and get help?

- Website – http://sam.nrel.gov
  - Support Forum – Ask your question!
  - General info/ online help file / contact info
- YouTube Channel
  - https://www.youtube.com/user/SAMDemoVideos
  - All prior webinars and seminars
- Bi-Monthly Round Table sessions
  - SAM team asks questions live and interactively
- Email Support
  - SAM support can provide email support if question/bug is involved



Other Resources Online

The following information resources about SAM are available.

- News
- Webinars (mostly on the SAM YouTube channel)
- Weather Data (Description of various weather data sources)
- Sample Files (particularly scripting language examples)
- Financial Model Documentation
- Performance Model Documentation (detailed descriptions)
- System Cost Data (sources and latest cost data discussion)
- Case Studies and Validation (all data/files from our validations)
- Libraries and Databases (i.e. module and inverter specs)
- Source Code (linkages to Open Source code on GitHub)

Live Demo

1. Before you've issued a request for proposals:

- PVWatts + Financing Options
  - Buying the system yourself (Commercial model)
  - Third party ownership

2. After you've received bids:

- Detailed PV + Third Party Ownership
  - Parametric analysis with multiple PPA price offers

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

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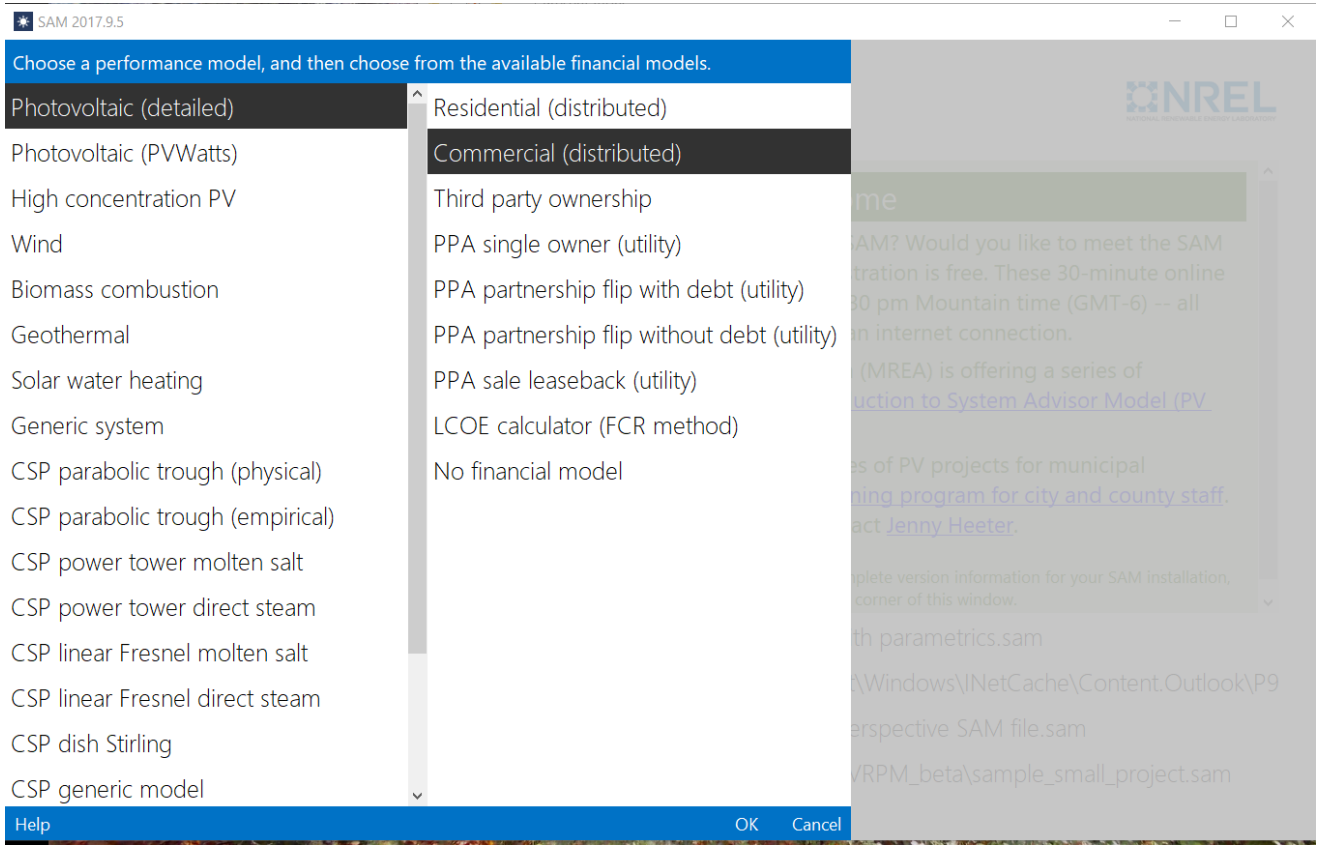
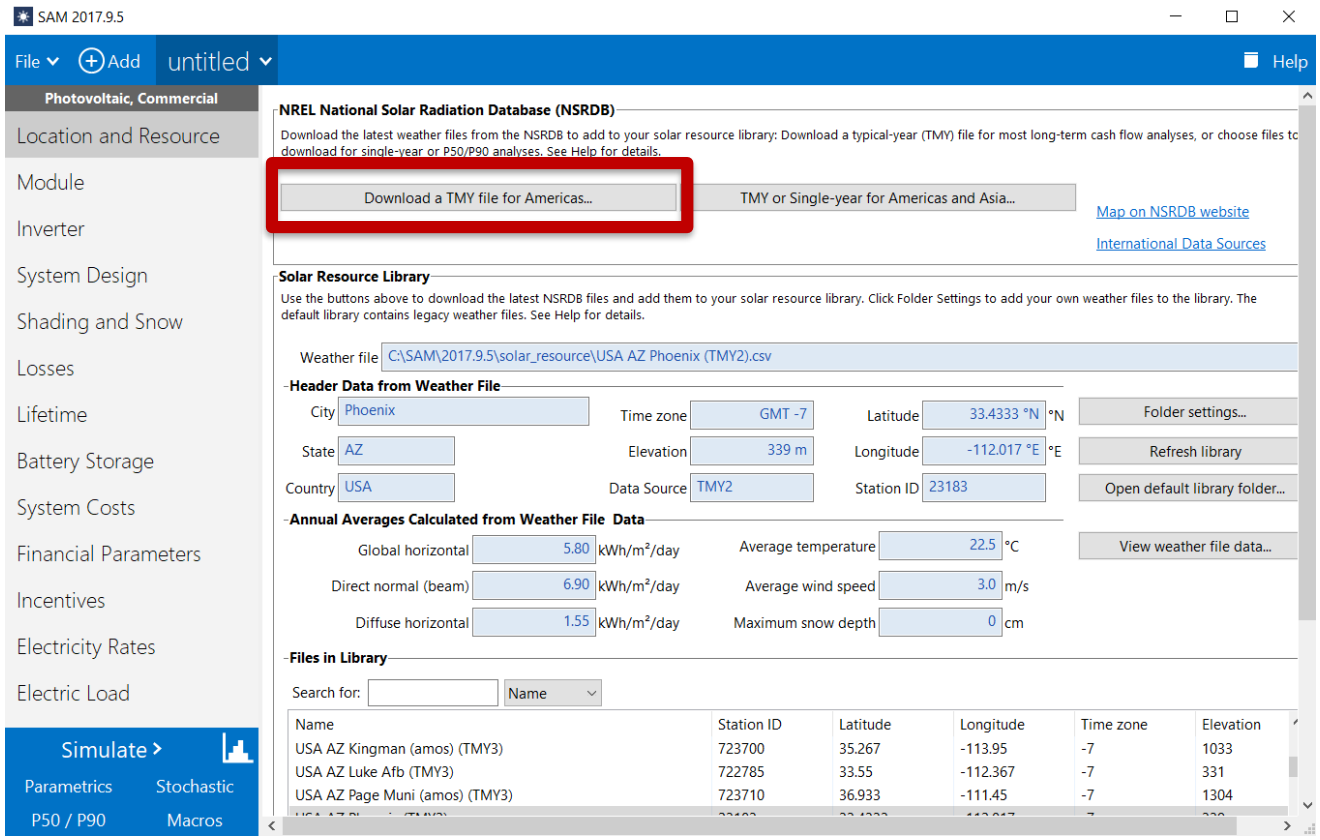
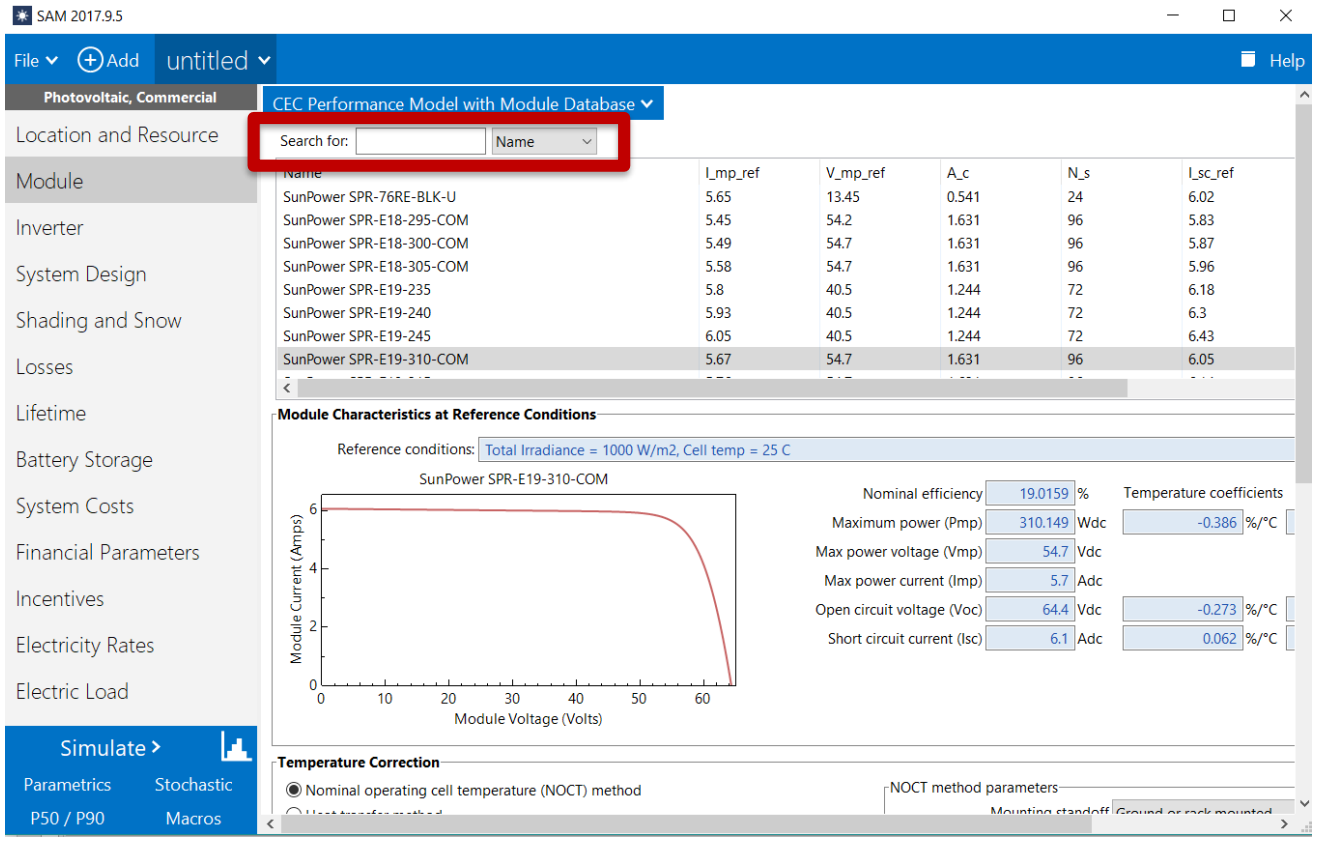
Selecting a Technology and Financial Model



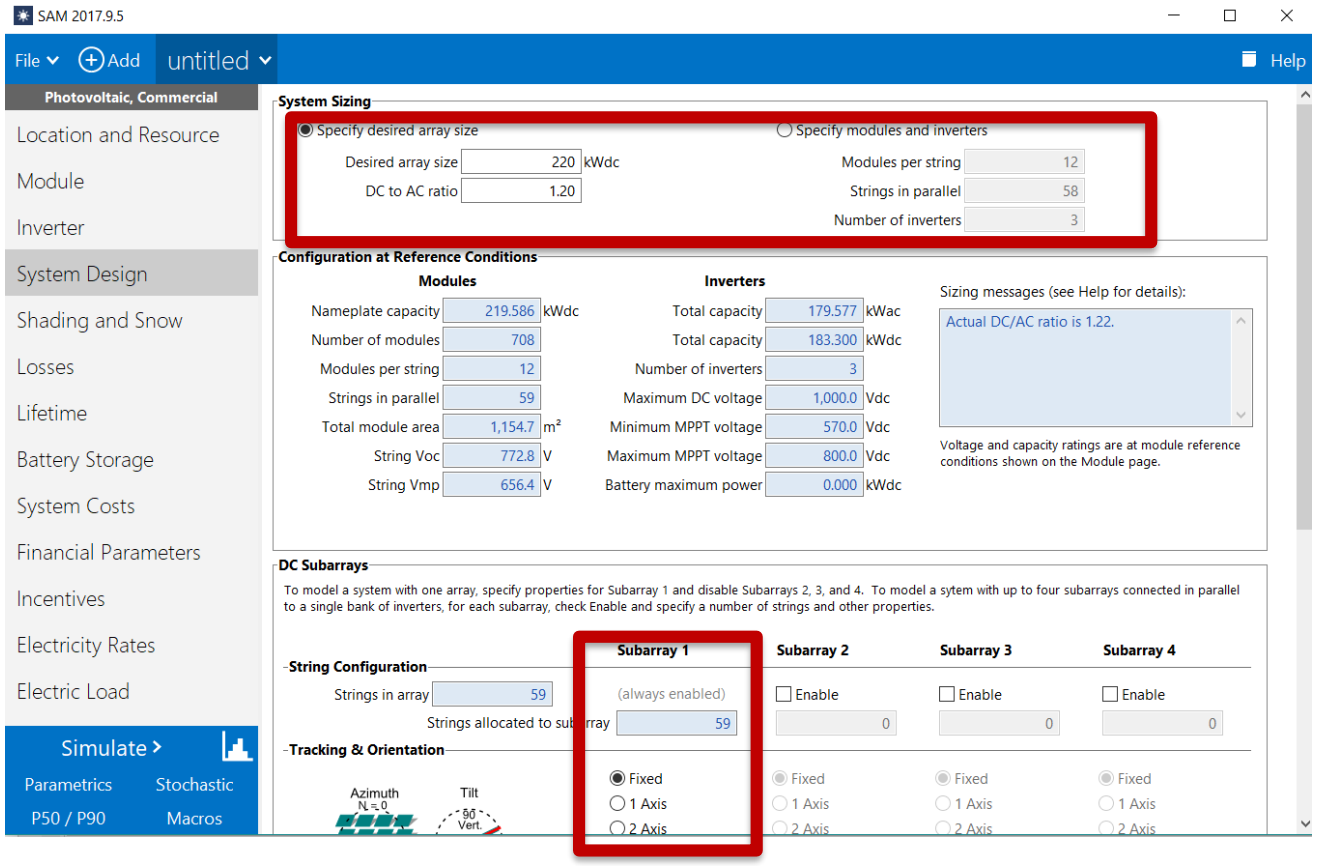
Select a Weather File



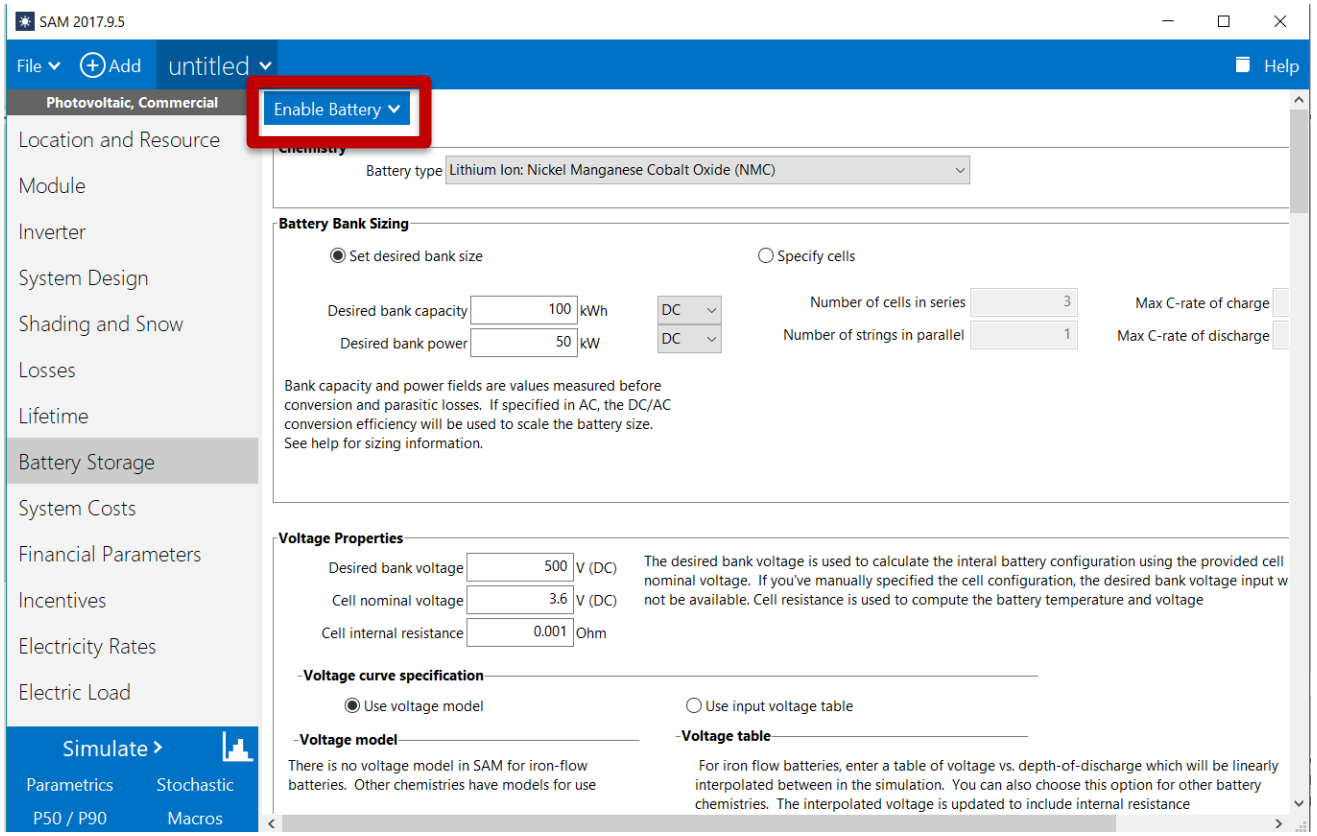
Choose a Module and an Inverter



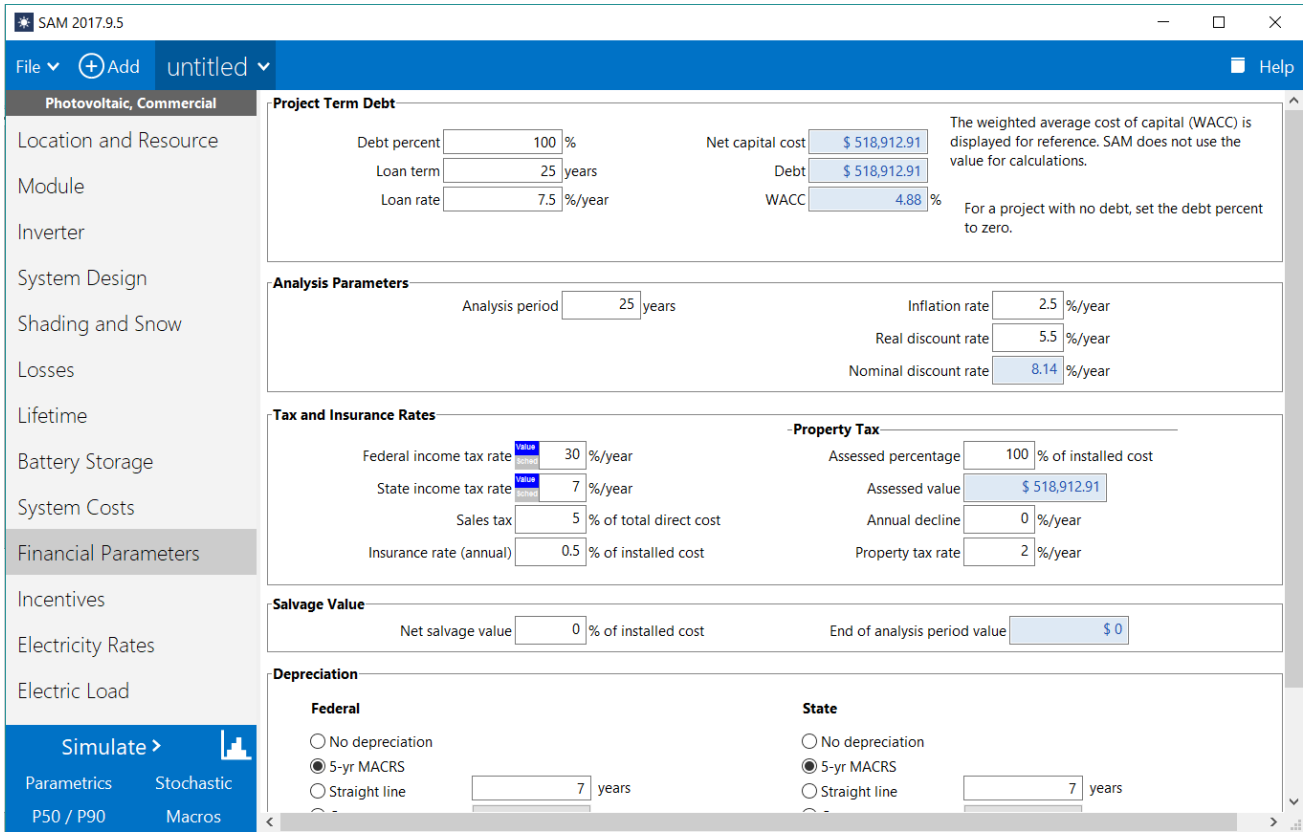
Set Up Your System



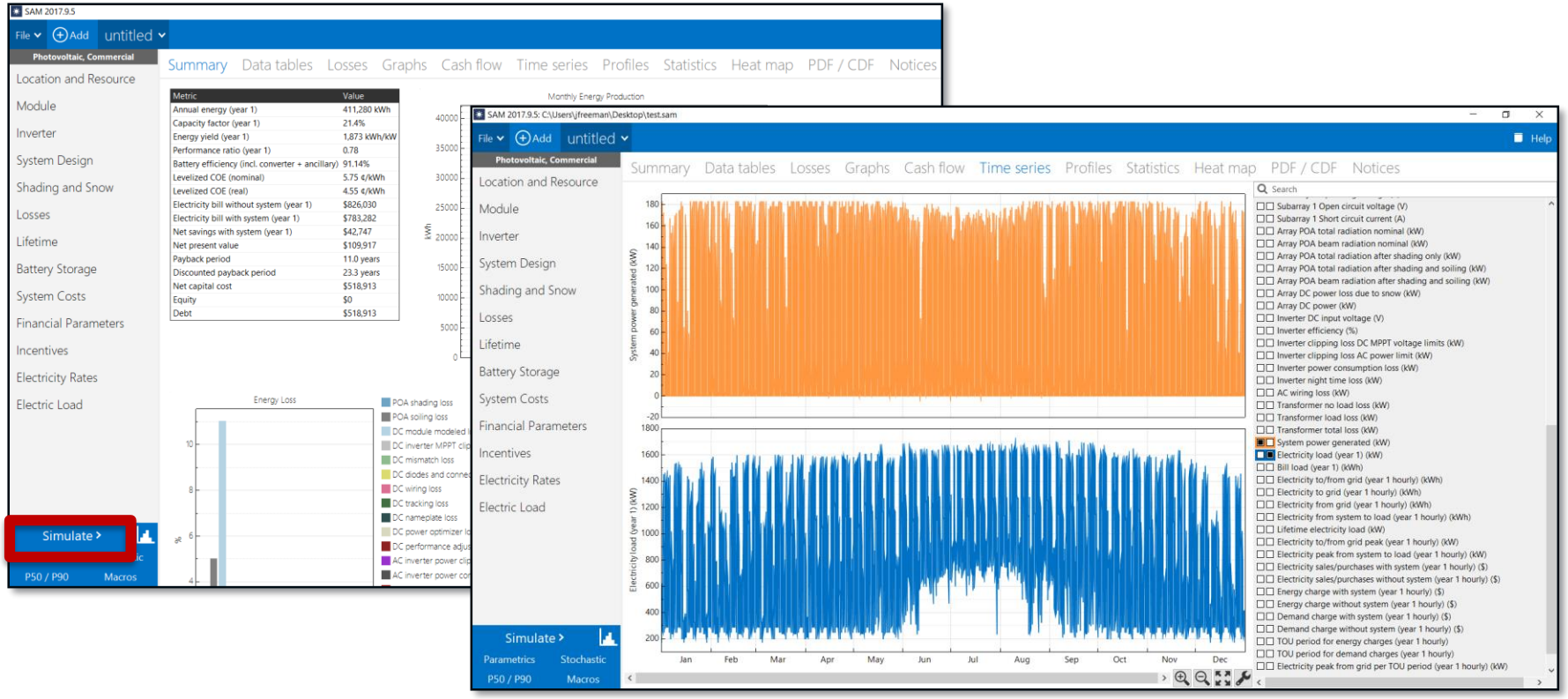
Optionally, Enable a Battery



Define Costs, Financial Parameters



Examine Outputs in a Variety of Ways



How to Learn More and Get Help

- Website – http://sam.nrel.gov
  - Support Forum – Ask your question!
  - Documentation / case studies / general info
- Webinars/YouTube Channel
  - https://sam.nrel.gov/webinars
- Bi-Monthly Round Table sessions
  - Ask the SAM team questions live
- Email Support for complex questions