NREL
Transforming ENERGY

Introduction to the

System Advisor Model (SAM)

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July 22, 2020

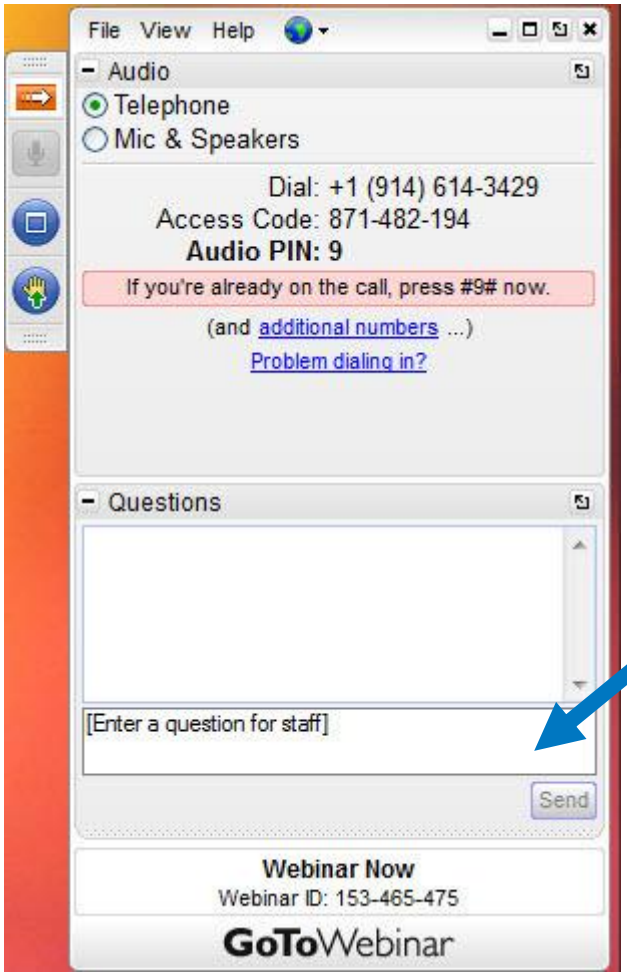
SAM 2020 Webinar Series

- Introduction to SAM Workshop — July 22
- PV Systems in SAM 2020.2.29 — Aug 5
- Batteries in SAM 2020.2.29:
  - Focus on Battery Technology — Aug 19
  - Behind-the-Meter Systems — Sep 2
  - Front-of-Meter Systems — Sep 16

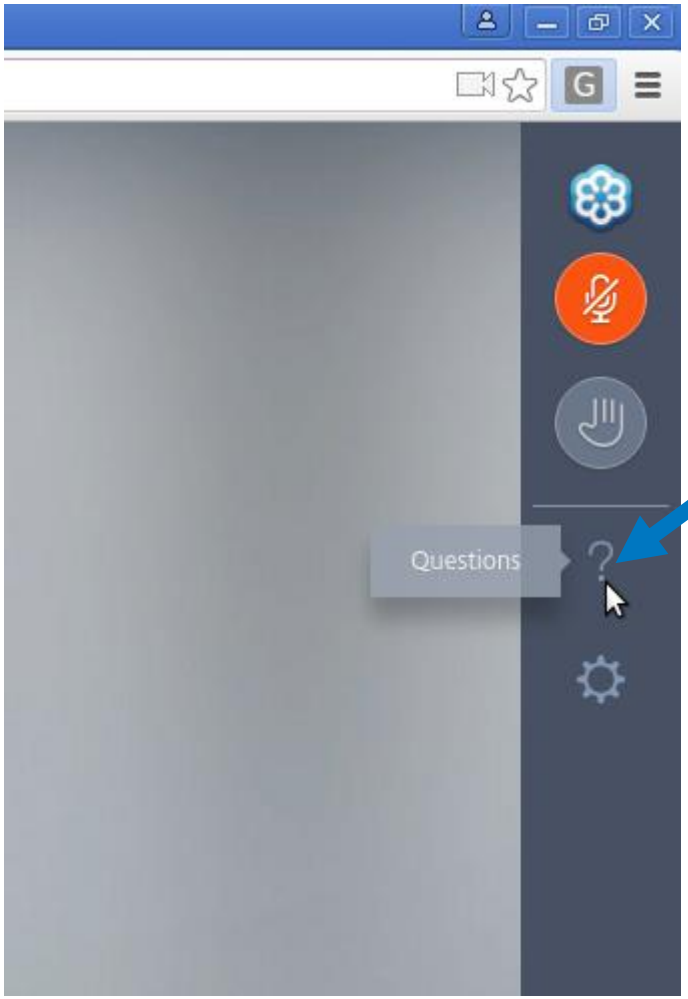
Register for free at: https://sam.nrel.gov/events.html

This webinar will be recorded and posted on the SAM website at https://sam.nrel.gov/

Use the GoToWebinar control panel to ask questions



Desktop application



Instant Join Viewer

We will either type an answer to your question or answer it at the end of the presentation.

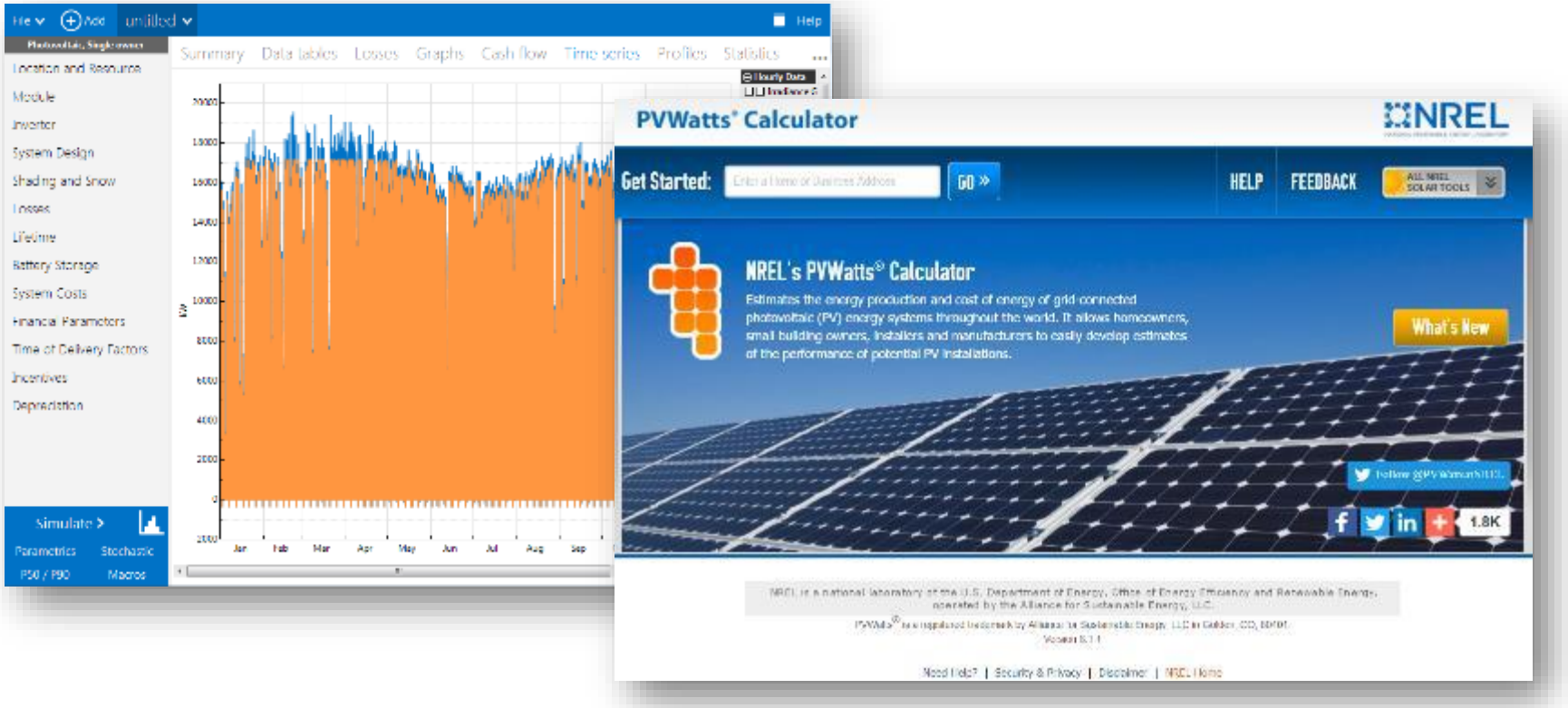
Webinar Outline

1. Introducing SAM
2. SAM User Interface Overview
3. New features in SAM 2020.2.29

Introducing SAM

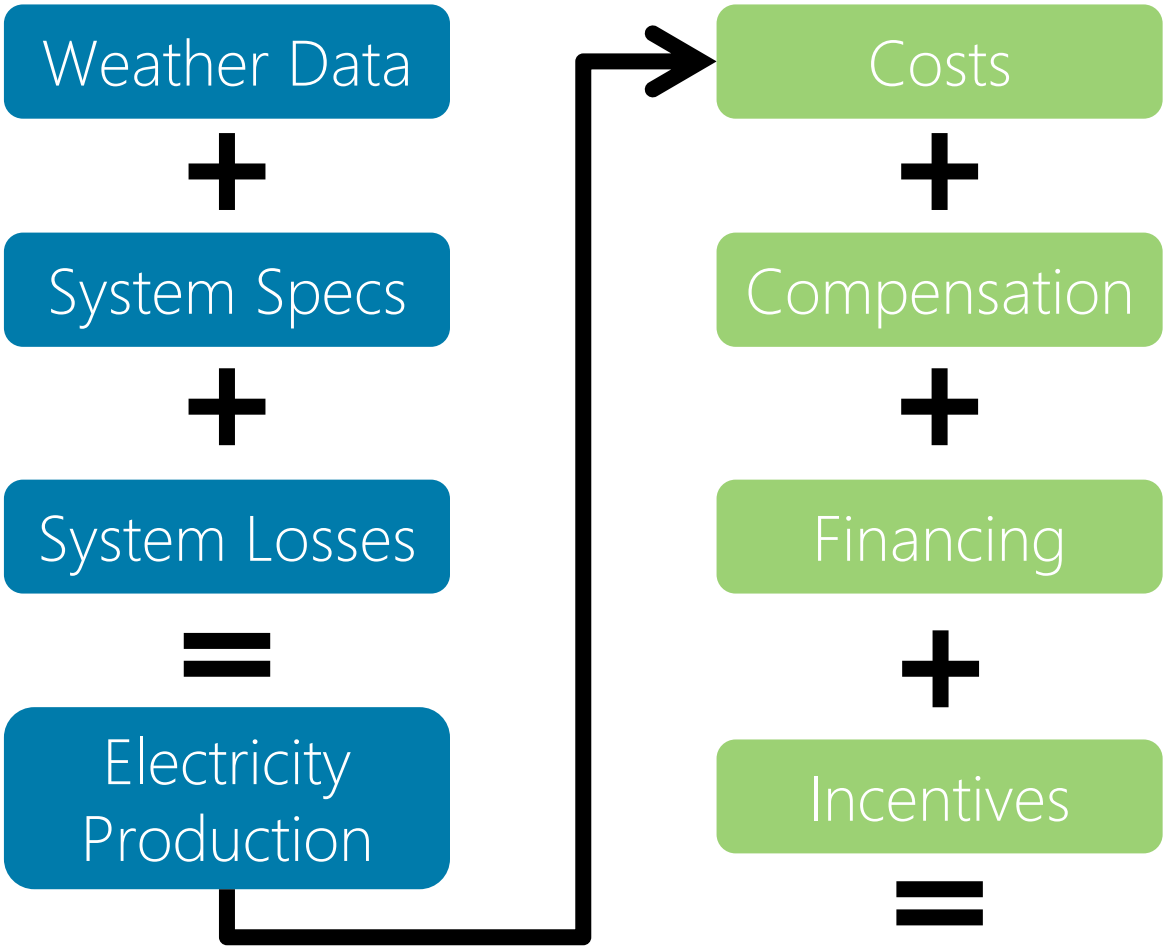
System Advisor Model (SAM) & PVWatts

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



http://sam.nrel.gov/download
https://pvwatts.nrel.gov

Steps to Modeling Renewable Energy



Results

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

Technologies

- Photovoltaics
  - Detailed & PVWatts
- Battery Storage
- Concentrating solar power
- Fuel cell-PV-battery
- Wind
- Marine Energy
- Geothermal
- Solar water heating
- Biomass

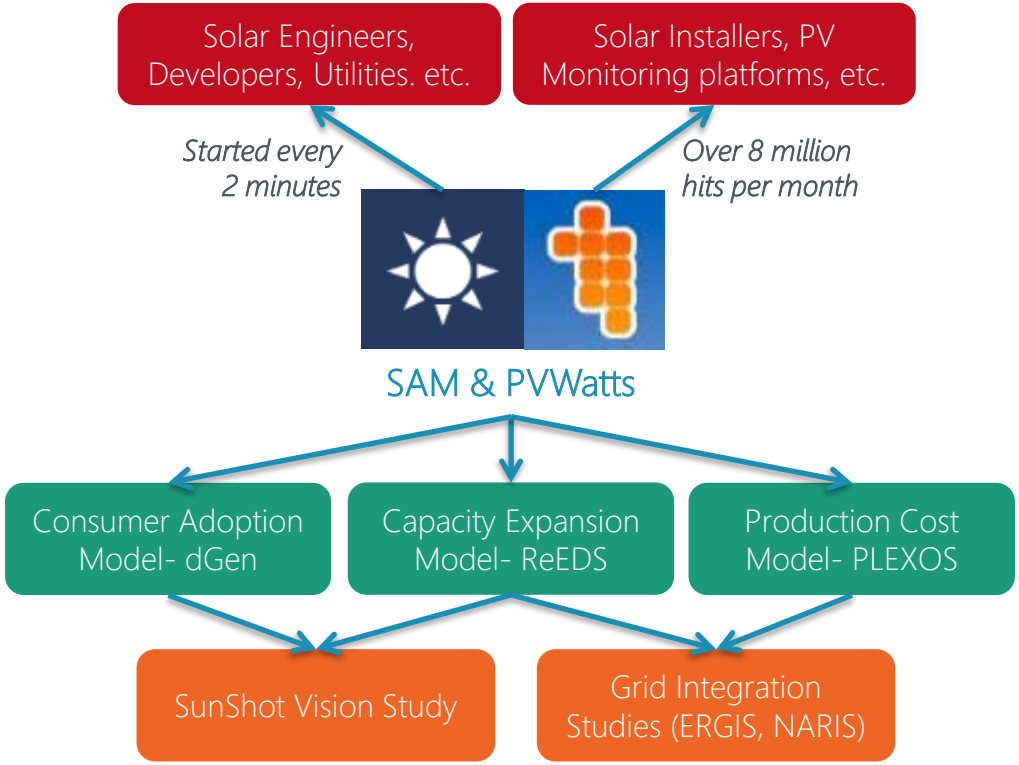
Financial

- Behind-the-meter
  - residential
  - commercial
  - third-party owned
- Power purchase agreements
  - single owner
  - equity flips
  - sale-leaseback
- Host/developer
- Merchant plant
- Simple LCOE calculator

Who uses SAM? Why?

- **Lawmakers and Utilities**
  … to study how a policy would affect the economics of a typical system
  … to analyze different types of utility rate structures for renewables
- **Developers and Engineers**
  … to compare technologies, sites, or configurations
  … to estimate the Levelized Cost of Energy for a system
- **Researchers**
  … to examine how an innovative concept might be able to lower the Levelized Cost of Energy
  … to estimate the technical potential of a technology in a region
- **Students**
  … to learn about renewable energy
  … to explore financing structures for renewable energy

SAM & PVWatts are used at NREL, too



- ✓ 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)

SAM Users

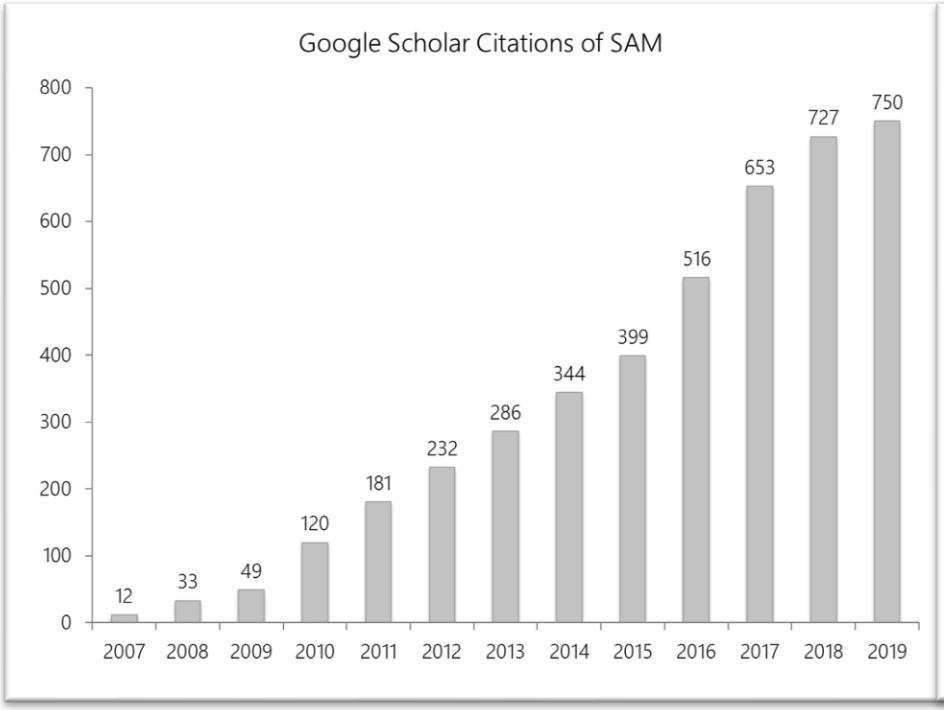
SAM is started **once every 2 minutes**

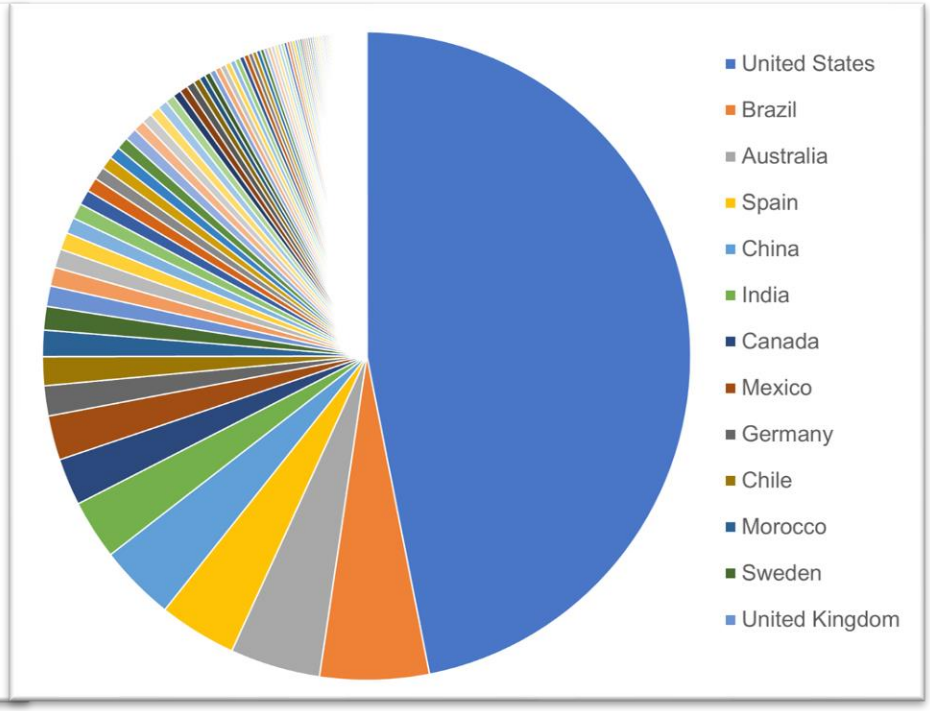
PVWatts receives over **8 million hits per month**

Over **130,000** users in 190+ countries

90+ webinars with **over 100,000 views**

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

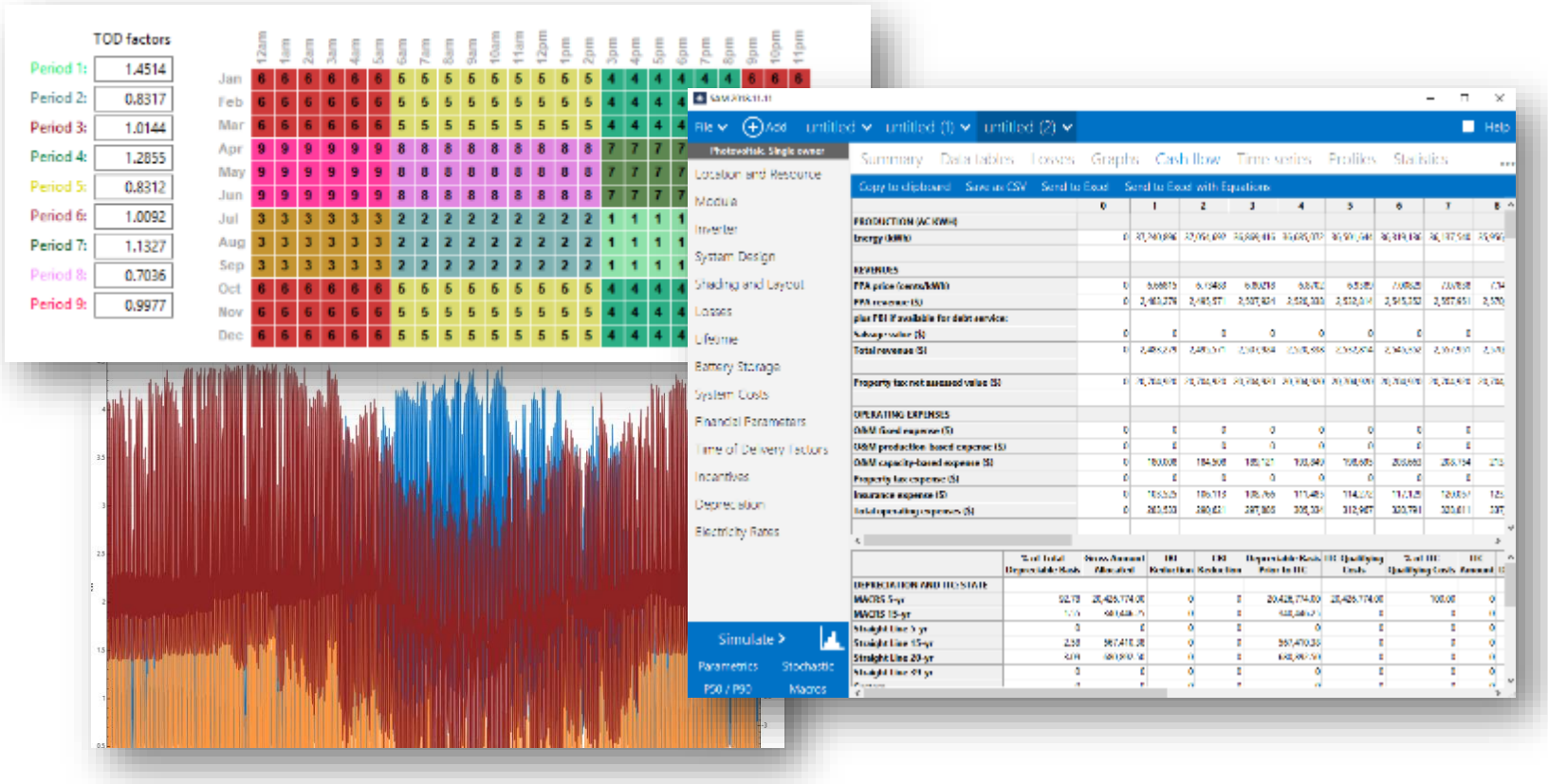




What's unique about this platform?

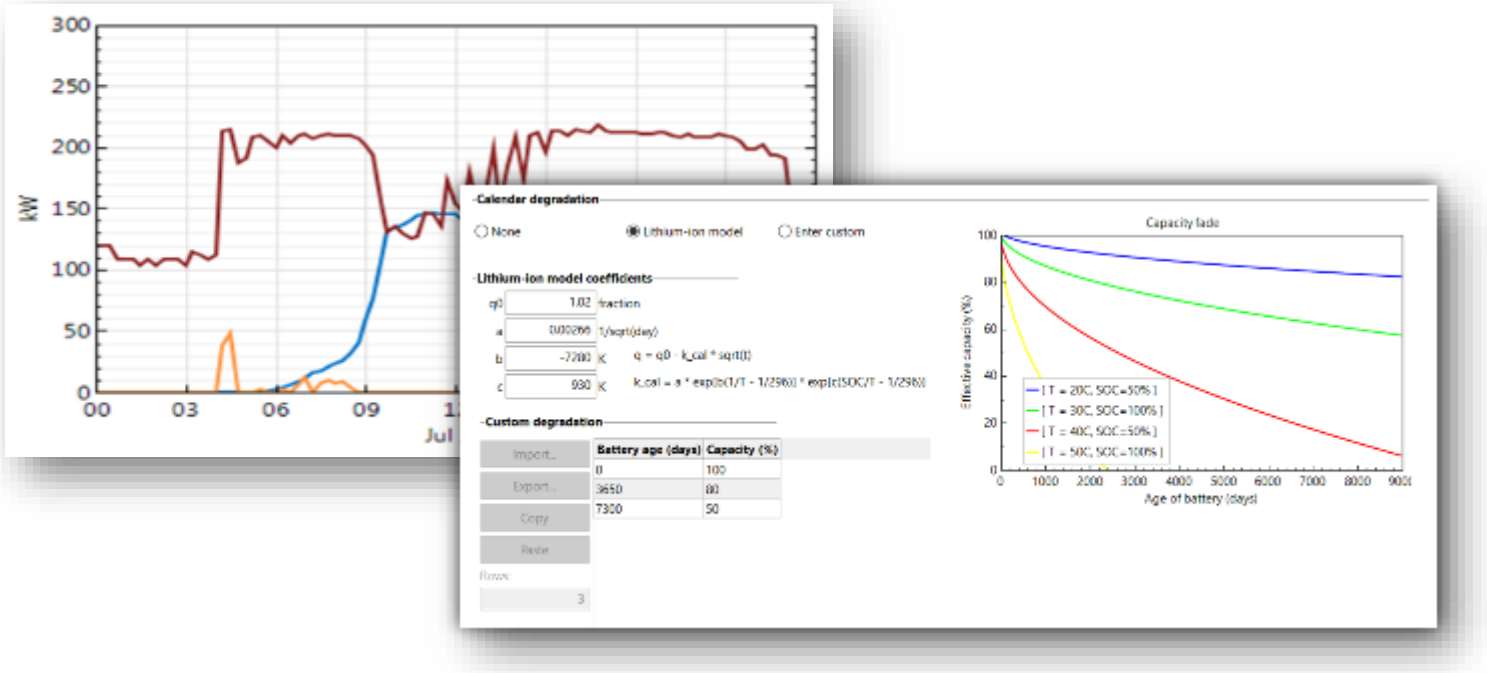
Detailed Cash Flow Financial Models

No other tool provides detailed, ***time-based*** financial modeling across multiple market sectors, including complex utility rates, combined with detailed performance modeling



Detailed Battery Model

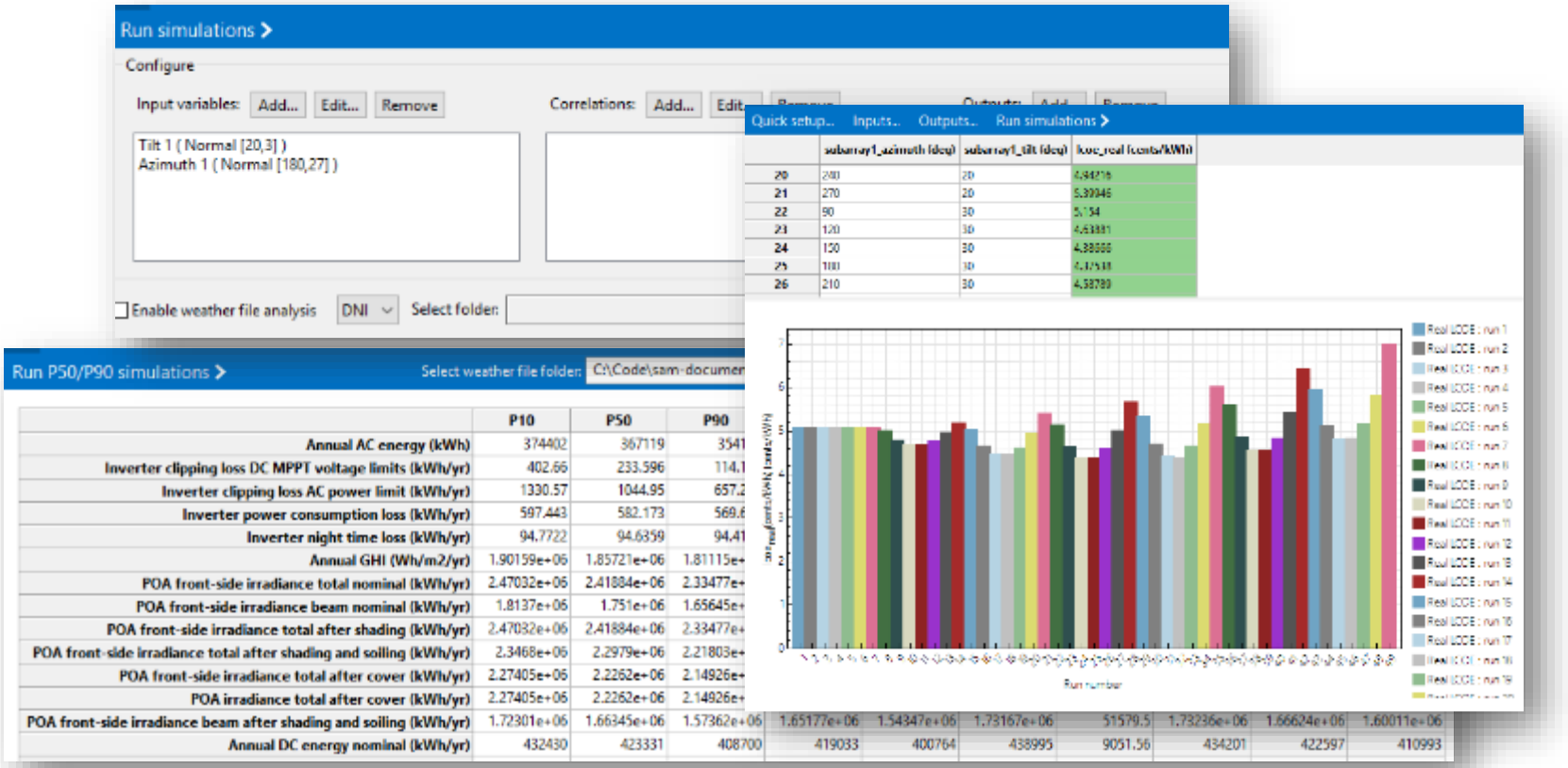
Only publicly available tool with detailed battery model that accounts for voltage characteristics, calendar and cycle degradation, etc



- ✓ Currently integrated with PV and “Generic System” model
- ✓ Available on DC or AC side of PV system
- ✓ Multiple automated dispatch strategies for different markets
- ✓ Behind-the-meter or front-of-the-meter operation

Advanced Analysis Features

Built-in parametric, stochastic, probability of exceedance (P50/P90), and scripting features enable complex questions to be answered quickly and easily

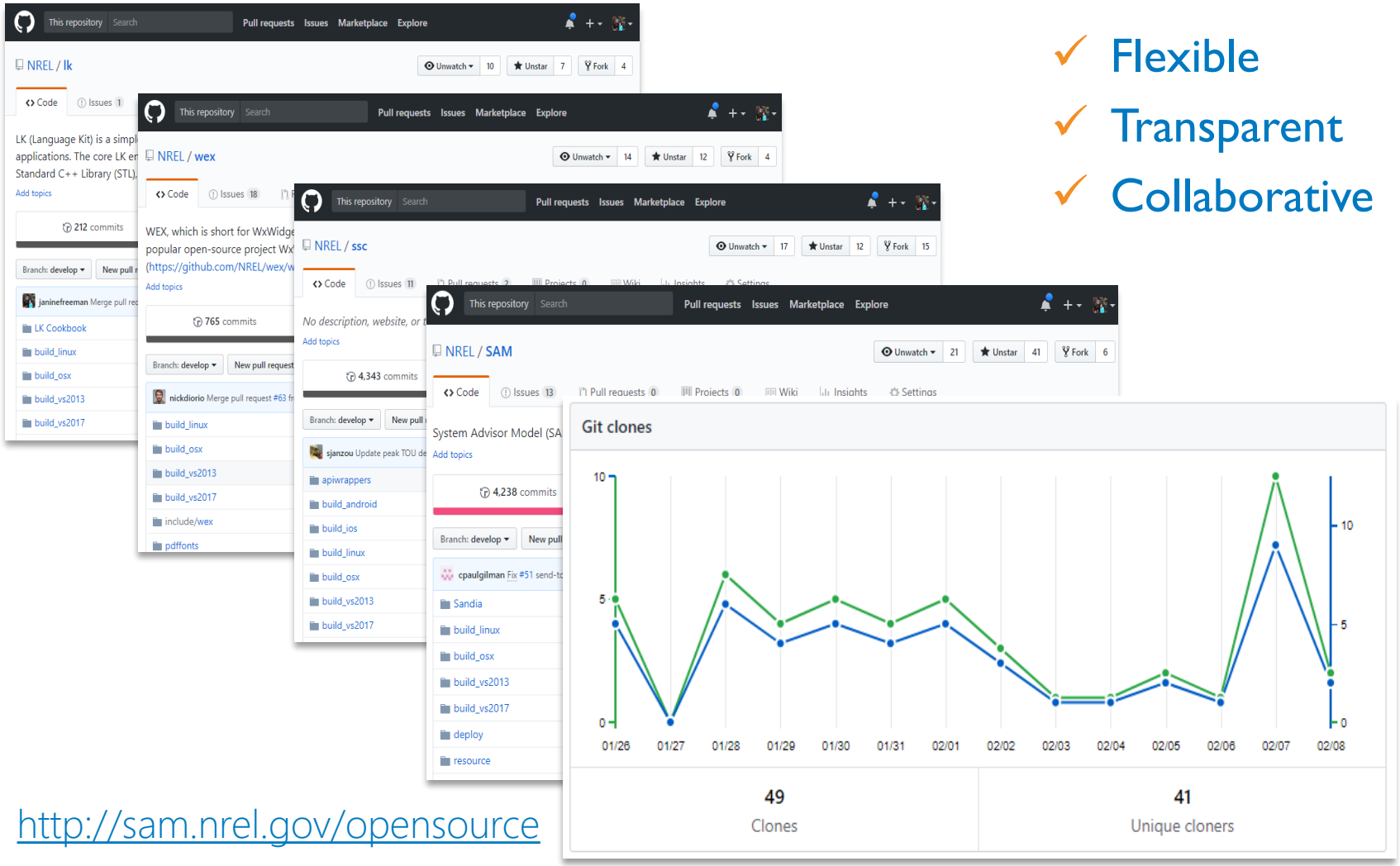


	P10	P50	P90							
Annual AC energy (kWh)	374402	367119	3541							
Inverter clipping loss DC MPPT voltage limits (kWh/yr)	402.66	233.596	114.1							
Inverter clipping loss AC power limit (kWh/yr)	1330.57	1044.95	657.2							
Inverter power consumption loss (kWh/yr)	597.443	582.173	569.6							
Inverter night time loss (kWh/yr)	94.7722	94.6359	94.41							
Annual GHI (Wh/m2/yr)	1.90159e+06	1.85721e+06	1.81115e+							
POA front-side irradiance total nominal (kWh/yr)	2.47032e+06	2.41884e+06	2.33477e+							
POA front-side irradiance beam nominal (kWh/yr)	1.8137e+06	1.751e+06	1.65645e+							
POA front-side irradiance total after shading (kWh/yr)	2.47032e+06	2.41884e+06	2.33477e+							
POA front-side irradiance total after shading and soiling (kWh/yr)	2.3468e+06	2.2979e+06	2.21803e+							
POA front-side irradiance total after cover (kWh/yr)	2.27405e+06	2.2262e+06	2.14926e+							
POA irradiance total after cover (kWh/yr)	2.27405e+06	2.2262e+06	2.14926e+							
POA front-side irradiance beam after shading and soiling (kWh/yr)	1.72301e+06	1.66345e+06	1.57362e+05	1.65177e+06	1.54347e+06	1.73167e+06	51579.5	1.73236e+06	1.66624e+06	1.60011e+06
Annual DC energy nominal (kWh/yr)	432430	423331	408700	419033	400764	438995	9051.56	434201	422597	410993

How can you access SAM models?

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

Open Source Code

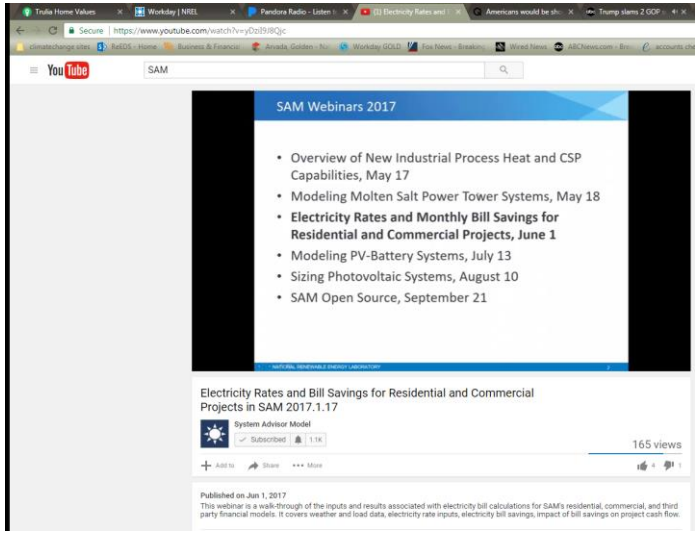


- ✓ Flexible
- ✓ Transparent
- ✓ Collaborative

http://sam.nrel.gov/opensource

Extensive Help Documentation

- 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



Live User Interface Overview

New Features in SAM 2020.2.29

Thank you! Questions?

Janine Freeman – project lead, photovoltaic and wind models
Nate Blair – emeritus lead, financials, costs, systems
Darice Guittet – software development, battery models
Brian Mirletz – software development, battery models
Matt Prilliman – photovoltaic and marine energy models
Steve Janzou – programming, utility rate structures (subcontractor)
Paul Gilman – user support and documentation (subcontractor)
Ty Neises – concentrating solar power models
Matt Boyd – concentrating solar power models

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