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# SAM Webinars 2017: Modeling Photovoltaic-Battery Systems in SAM 2017.1.17

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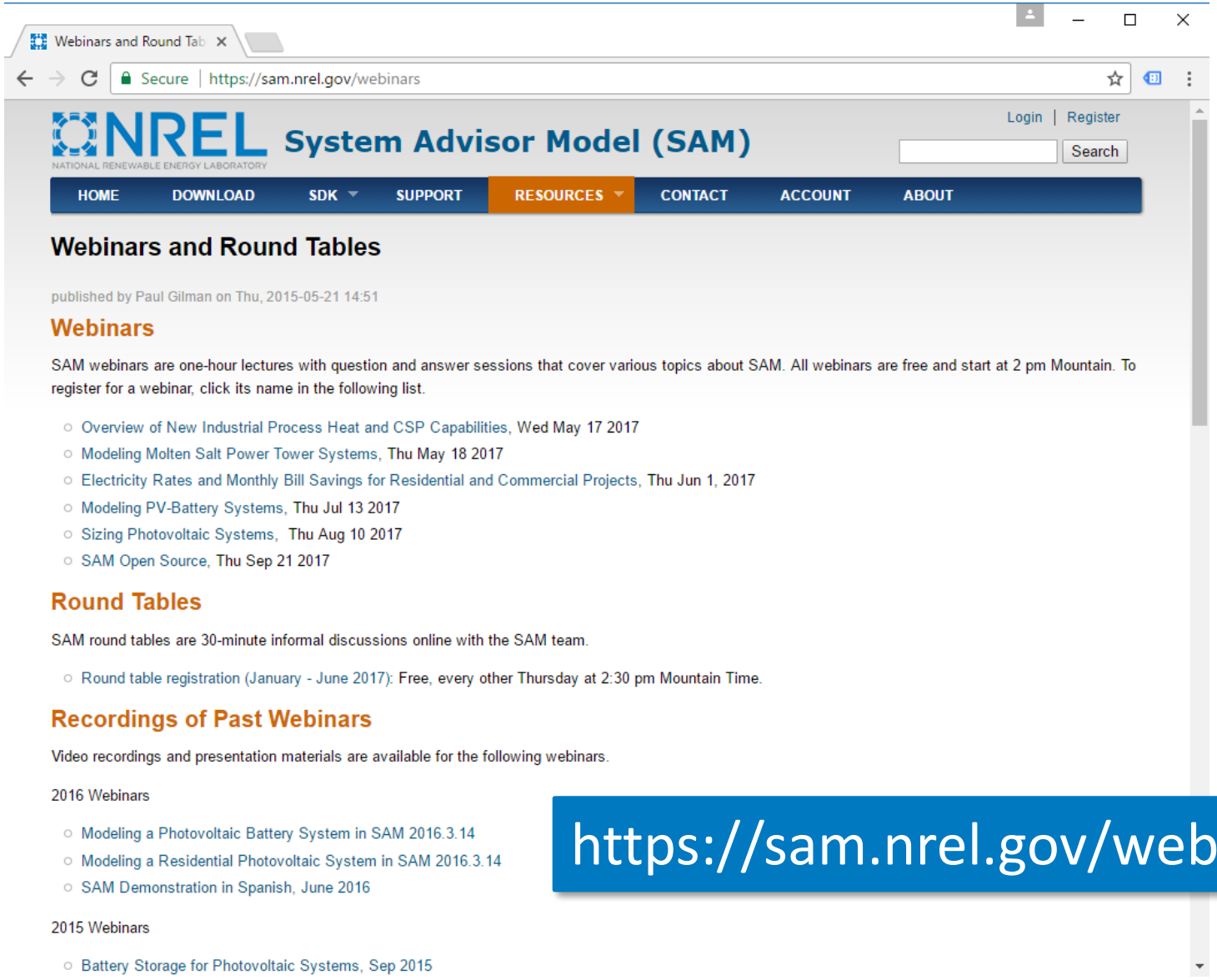
# SAM Webinars 2017

- Overview of New Industrial Process Heat and CSP Capabilities, May 17
- Modeling Molten Salt Power Tower Systems, May 18
- Electricity Rates and Monthly Bill Savings for Residential and Commercial Projects, June 1
- **Modeling PV-Battery Systems, July 13**
- Sizing Photovoltaic Systems, August 10
- SAM Open Source, September 21

# Registration Links and Webinar Recordings



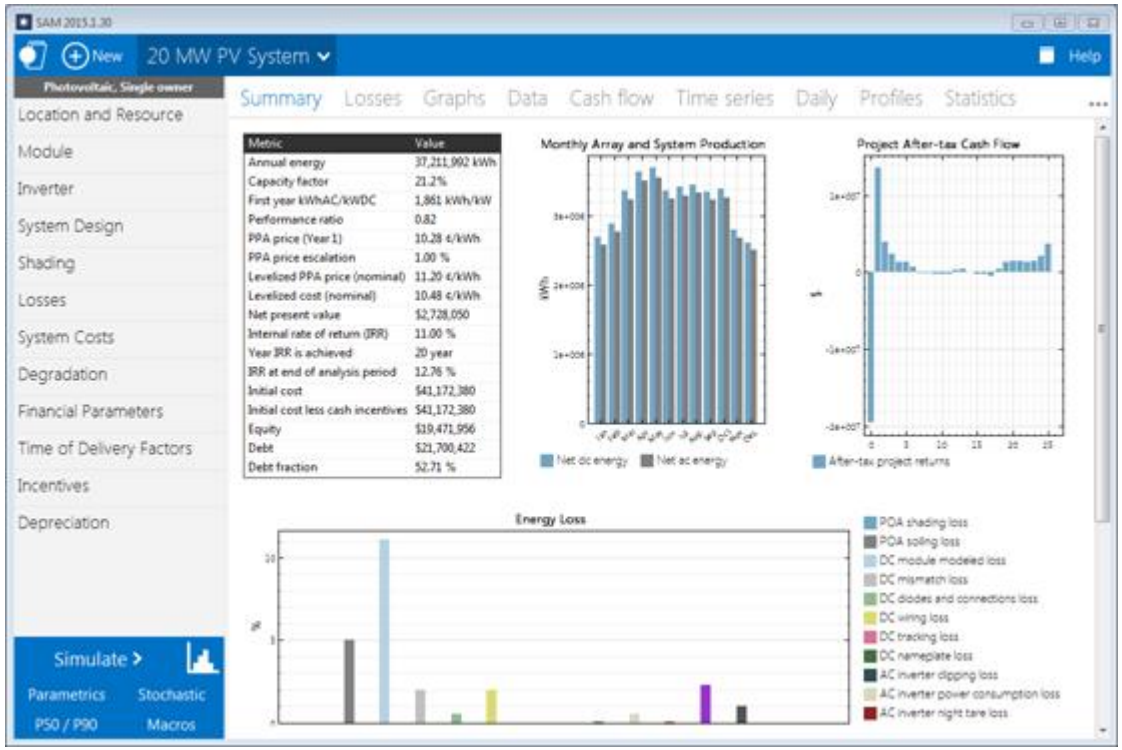

https://sam.nrel.gov/webinars

# Outline

- Overview of SAM's PV-Battery model
- New features
  - DC Connected batteries
  - Utility-scale PV-battery systems
  - Simple battery model for PVWatts
  - Automated dispatch improvements
- Demo
- Q&A

# System Advisor Model (SAM)

SAM is free software for modeling the performance and economics of renewable energy projects.

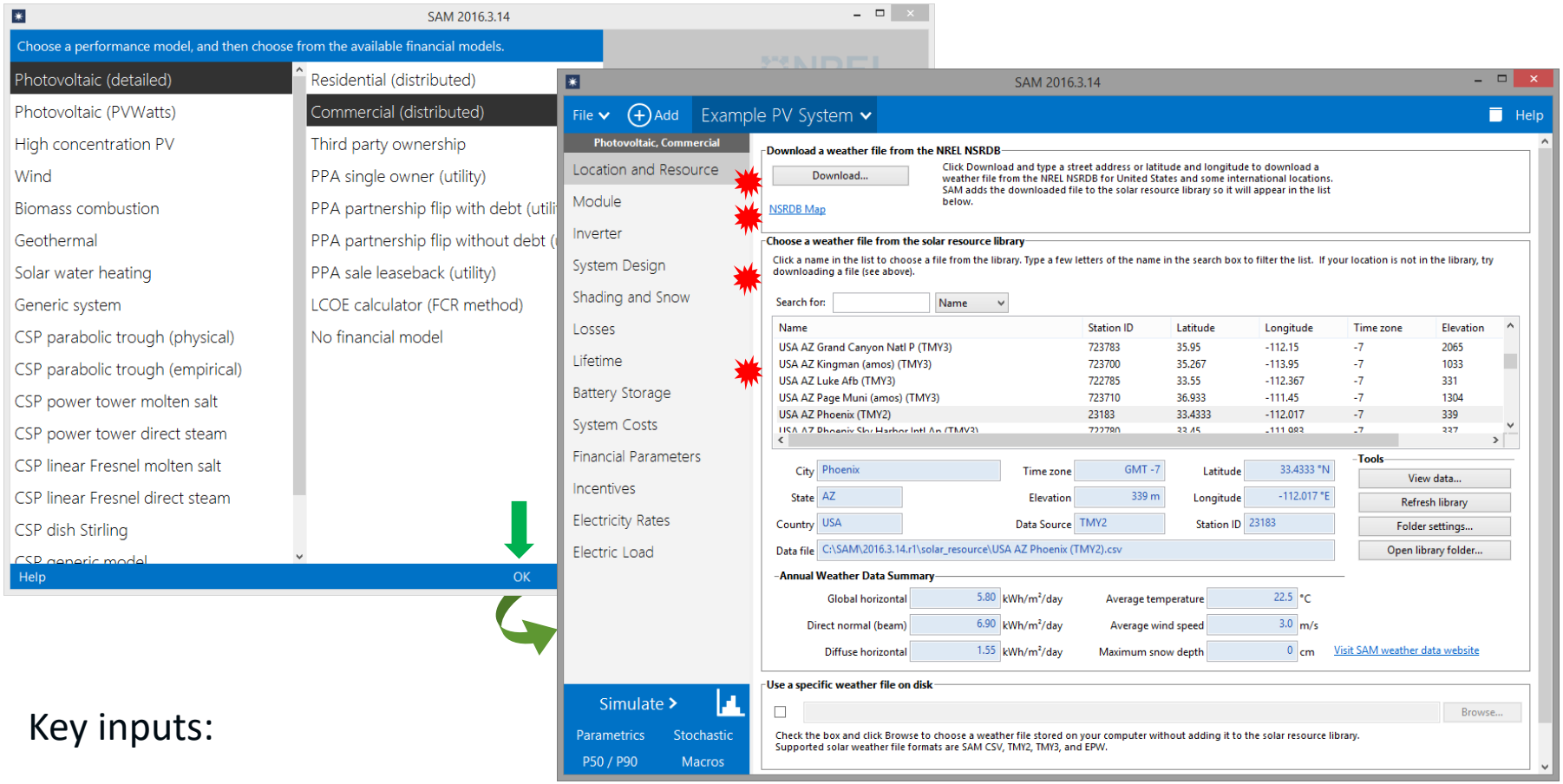



SAM is planned to be released as an open-source project in the next few weeks!

http://sam.nrel.gov

- Developed by NREL with funding from DOE
- Windows, OSX, and Linux
- One or two new versions per year
- Software Development Kit (SDK)
- Support
  - Help system
  - Documents on website
  - Online forum
  - Contact form on website

# PV System Modeling in SAM




Key inputs:

Solar resource data: NSRDB (via 'Download' button), TMY2, TMY3

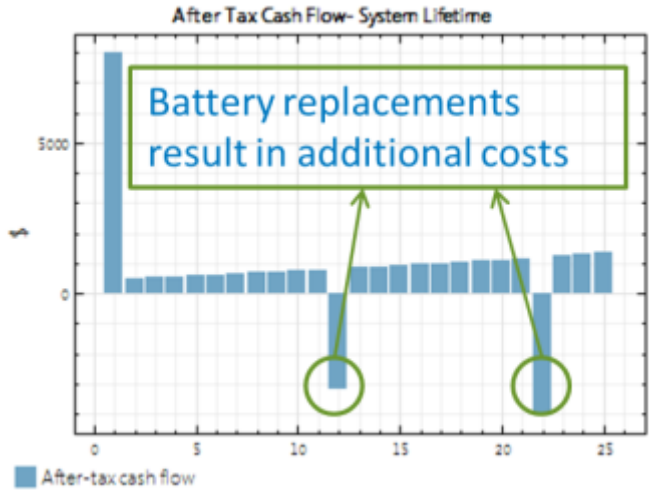
PV modules: Simple efficiency, Single-diode, or Sandia models

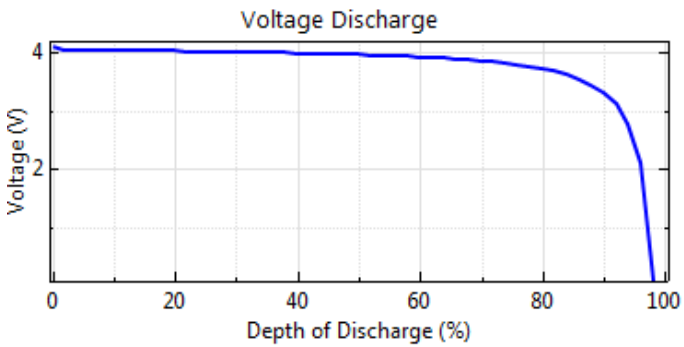
System design: Configure system size, type, and orientation

Single-year vs lifetime: Select lifetime mode to run full model in all years

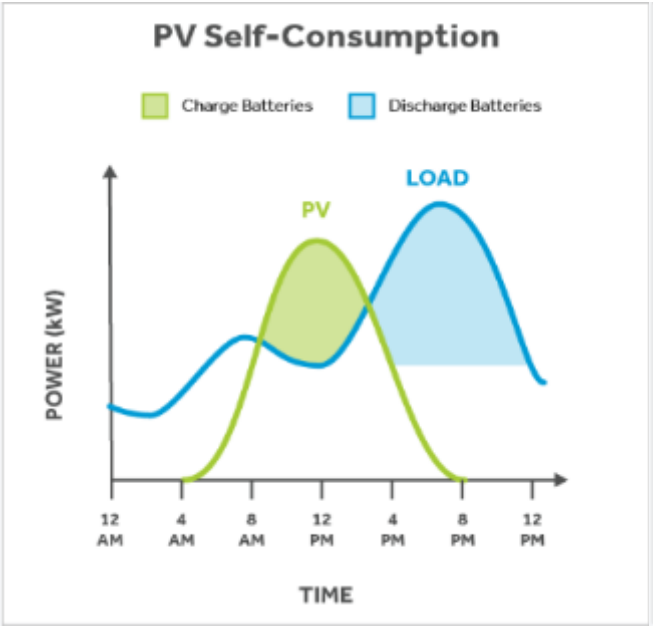
# Battery Model Overview

- Techno-economic model for behind-the-meter and front-of-meter scenarios.
  - Lead acid & lithium ion battery chemistries
  - System lifetime analysis including battery replacement costs
  - Models for terminal voltage, capacity, temperature
  - Multiple dispatch controllers available

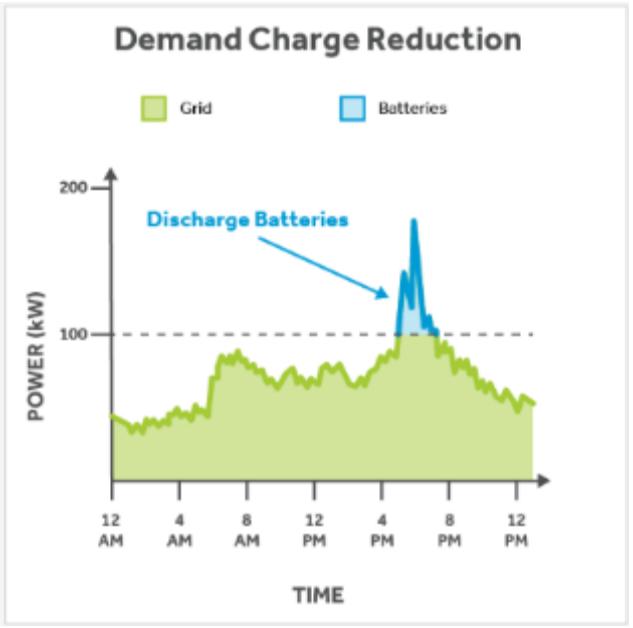


# Behind-the-meter storage








Images from: http://www.aquionenergy.com/

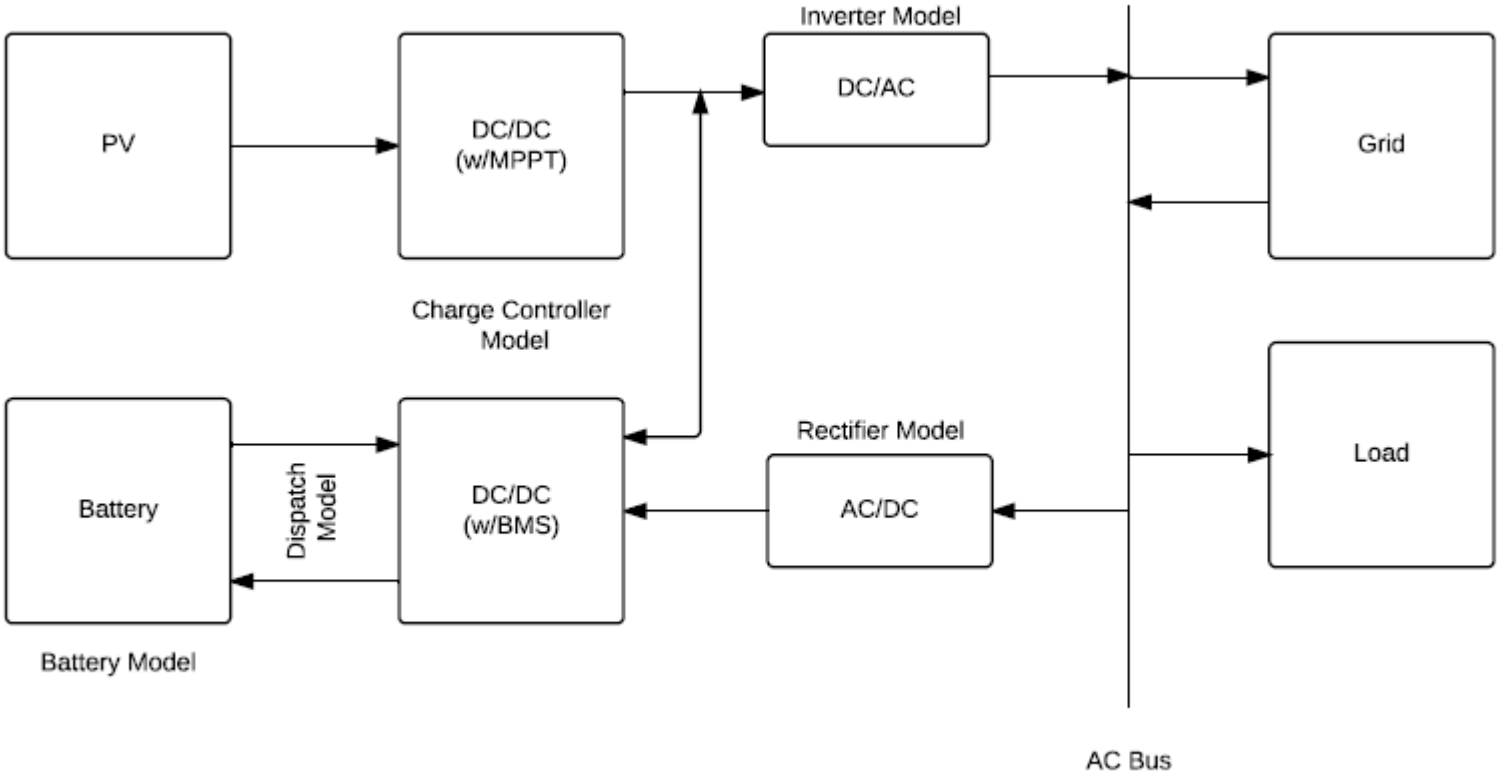
- Batteries charged primarily from PV eligible for Federal ITC subject to 75% cliff
- End of NEM in some states

- Residential and commercial utility rate structures with high TOU charges.
- Charge when rate is low, discharge when rate is high

- Commercial utility structures can have very high TOU demand charges.

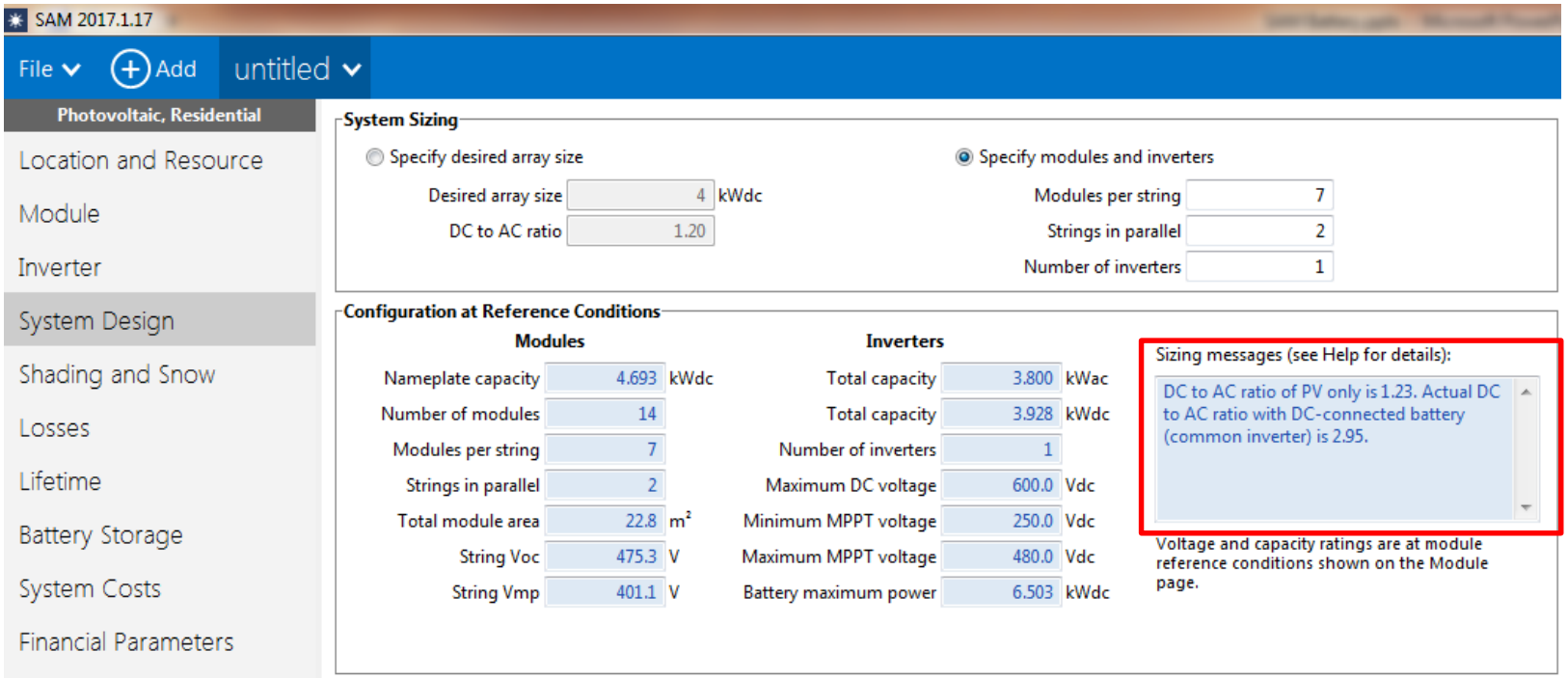
# DC Connected Battery

# Configuration Options: DC Connected battery




- Previously, only an AC-connected battery was possible in SAM
- The DC-connected option models single point conversion losses in:
  - The PV DC power optimizer (DC/DC w/MPPT)
  - The DC/DC BMS
- Combined battery and PV  DC power go through a common inverter

# DC Connected battery potential pitfalls

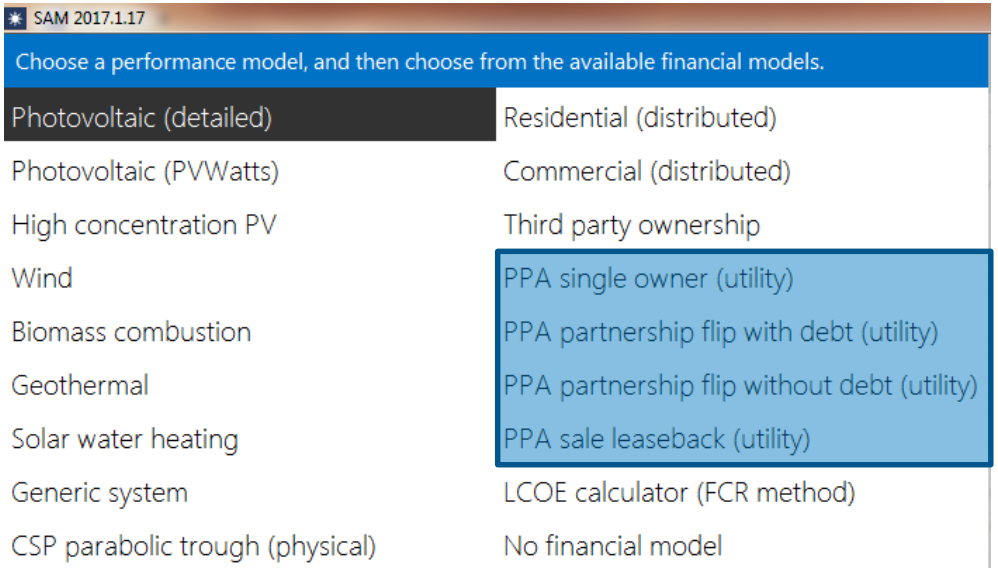



- The DC to AC ratio of the PV system does not account for the DC-connected battery.
- If you undersize the inverter, discharging the battery during peak PV production will result in inverter clipping.

# Utility-scale (PPA) battery systems

# Front-of-the-meter storage


Images from: http://www.aquionenergy.com/

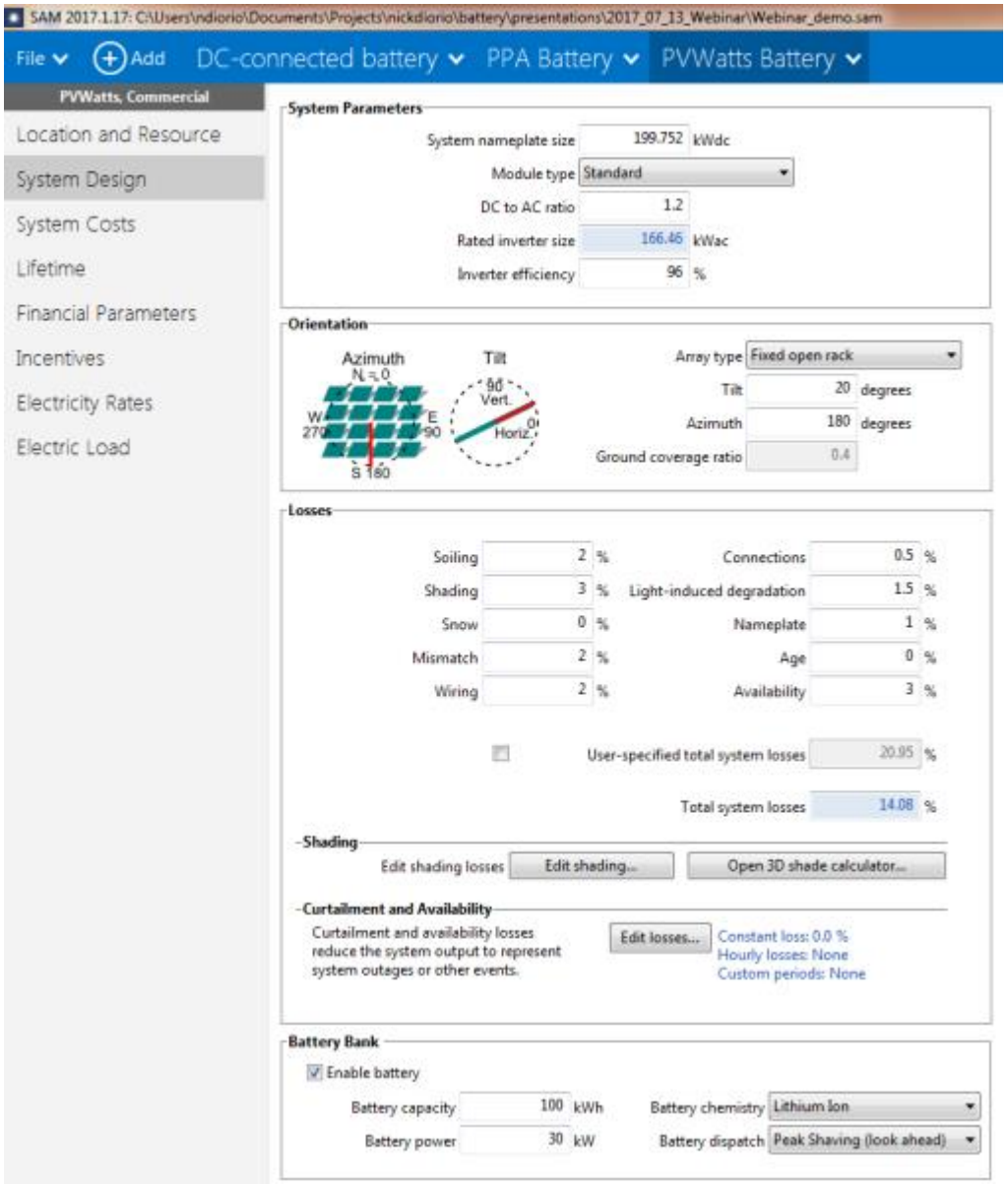



- PPA time-of-use optimization for changing PPA sell rates.
- Charge from PV when rate is low, discharge when rate is high

- In SAM, multiple PPA models available

# PVWatts Battery Model

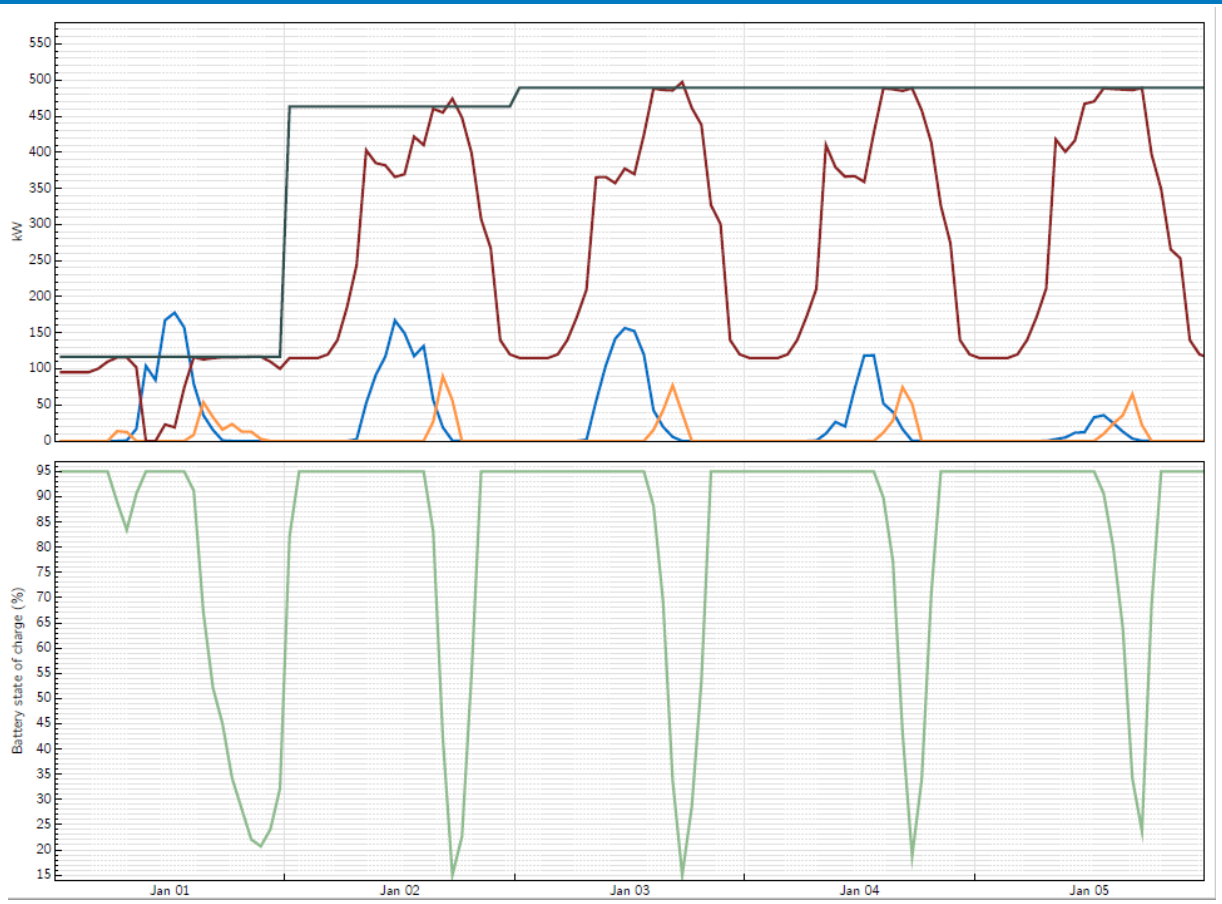
# PVWatts Battery




- Four inputs
  - Battery capacity and power
  - Battery chemistry
  - Battery dispatch (only offers automated controllers).
- Suitable only for high-level studies of demand charge reduction

# Automated dispatch improvements

# Enter custom demand target




- User can specify the allowed amount of grid power purchased at every time step.
- The battery control will then either charge or discharge the battery to seek to match that target.
- Offers detailed way for users to customize dispatch on time-step basis.

# Thank you!

www.nrel.gov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# Configuration options: AC Connected battery