Batteries in SAM 2020: Front-of-Meter Systems

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2020 SAM Webinars

September 16, 2020

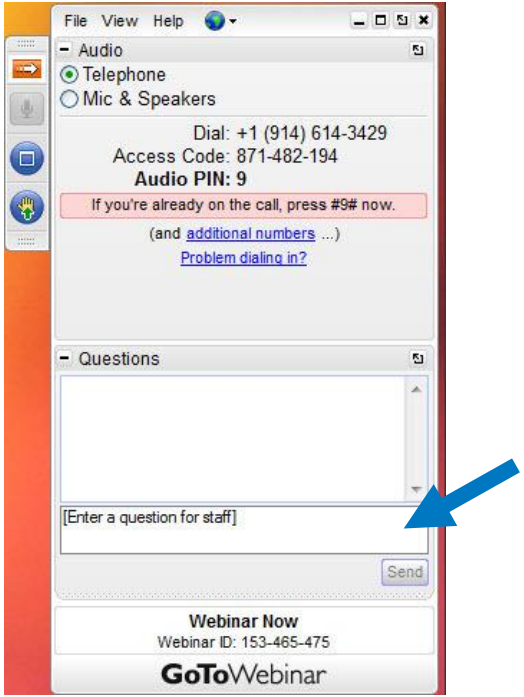
SAM Webinars for 2020

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**
PySAM Workshop	Oct 14

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

Find webinar recordings at https://sam.nrel.gov/

Questions and Answers



Desktop application

Instant Join Viewer

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

Outline

1. Quick SAM overview
2. Front-of-meter storage considerations
3. Example 1: Manual dispatch
4. Example 2: Automated dispatch options
5. Example 3: DC-connected vs AC-connected
6. Example 4: Generic System – Battery tricks, Merchant Plant
7. Questions and answers

What is SAM?

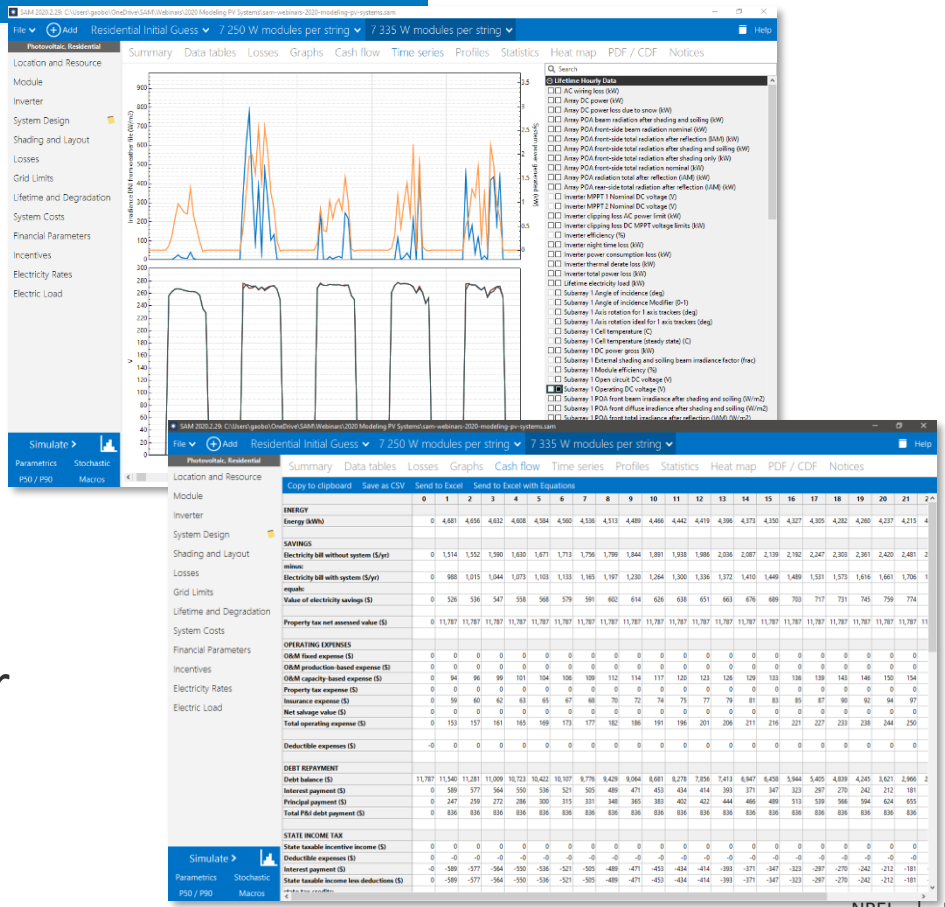
The System Advisor Model

Free computer software developed and distributed by the U.S. Department of Energy's National Renewable Energy Laboratory

Calculates:

- A power system's energy output over one year
- A power project's cash flow over years of operation

"Introduction to SAM 2020.2.29"
https://sam.nrel.gov



Front-of-Meter Battery system

Installed as part of a power generation project, or standalone storage project

Earns revenue through power sales: Power purchase agreement (PPA) or Merchant Plant

Is a project profitable given its cost and energy production?

FOM Storage Considerations

Dispatch storage to maximize value of generated power and minimize cost

Predict replacement cost based on battery degradation

Respond to generation profiles of solar PV or wind

Consider variable power pricing

Operate within policy requirements such as charge energy source and interconnection limits

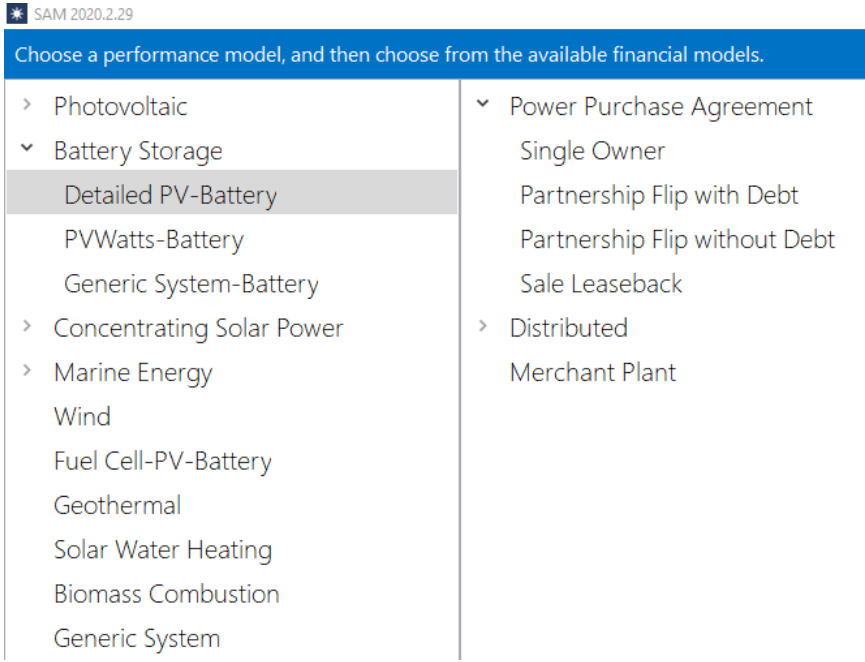
Battery Storage Model in SAM

Available with Detailed PV and Generic System model

- Generic system can use generation profile as input
- Also simple PVWatts version

Financial model determines type of storage system

- FOM: Power Purchase Agreement (PPA) or Merchant Plant financial models
- Behind-the-Meter (BTM): Residential, Commercial, Third Party Ownership models



Design steps for a PV-storage system

Choose a weather file

Design and size the PV system

Design and size the battery system

Choose battery dispatch options

Choose battery lifetime options

Define costs

Design steps for a PV-storage system

Choose a weather file

Design and size the PV system

Modeling PV Systems,
https://sam.nrel.gov/photovoltaic/pv-videos

Design and size the battery system

Choose battery dispatch options

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Battery Focus on Technology,
https://sam.nrel.gov/battery-storage/battery-videos

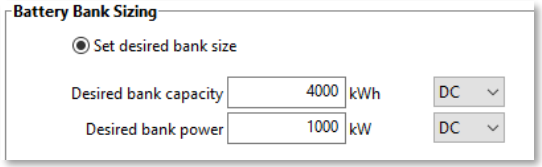
Define costs

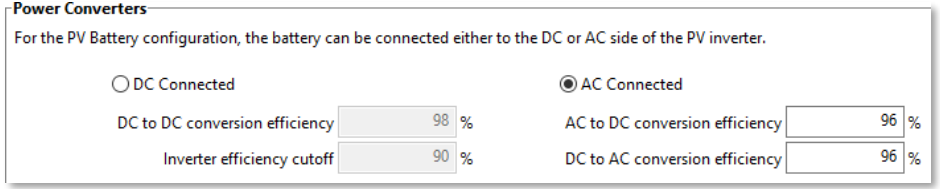
Battery Inputs

Today's examples will use default inputs except for:

- Battery desired capacity and power
- DC / AC sizing
- Dispatch options

For more on other inputs, see recorded webinars at https://sam.nrel.gov/battery-storage/battery-videos



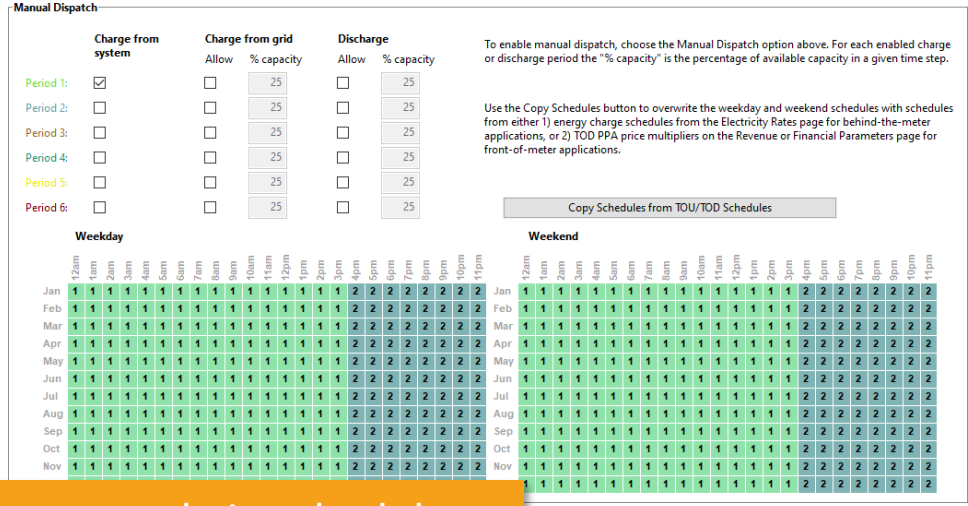


Manual Dispatch

Use a dispatch periods with month-by-hour schedule to tell SAM when to charge and discharge the battery

No automatic decision making

How battery is cycled determines replacement frequency



Select a rectangle in schedule matrix and type a number to assign times to each Period number.

Live Demonstration

Example 1: Manual Dispatch

“Automated” Dispatch

Decision in each time step (hourly or sub-hourly)

Charge from grid?

Charge from system?

Discharge?

DiOrio, N.; Denholm, P.; Hobbs, W. (2020). A Model for Evaluating the Configuration and Dispatch of PV Plus Battery Power Plants. Applied Energy Vol 262 March 2020.

Basic Rules for Automatic Dispatch

For PV DC-connected PV-battery, charge from system if array power exceeds inverter power

Charge from system if more valuable to sell power later

- But leave room for future clipped power (PV DC-connected only)

Charge from grid if purchase price is less than future power price

Discharge to grid if in high power price period

Automated Dispatch Considerations

SAM automatically dispatches battery to maximize revenue

Value of electricity sold to grid

- Determined by power price

Cost of electricity to charge battery

- Determined by power price or retail purchase rate

Cost of cycling battery

- Excessive cycling increases wear and replacement frequency

Live Demonstration

Example 2: Automated Dispatch Options

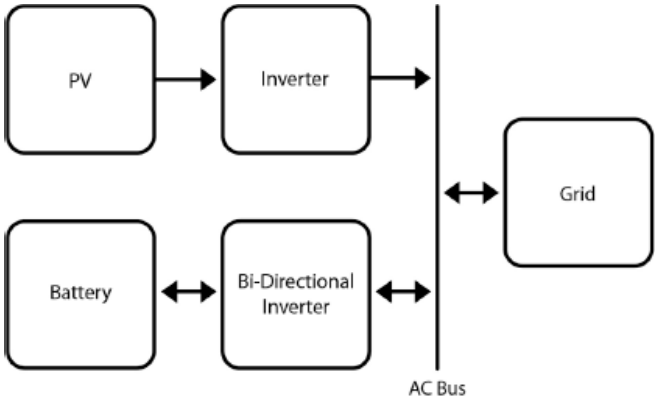
DC-connected vs AC-connected

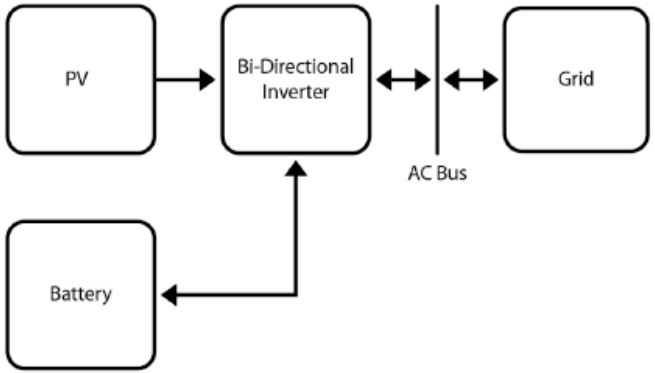
DC-connected battery can charge directly from PV array

– Increase DC/AC ratio by reducing inverter power limiting

AC-connected battery practical for retrofits

– Separate converter hardware for PV array and battery simplifies design





Live Demonstration

Example 3: DC- vs AC-connected Battery

Generic System - Battery

Set capacity factor to zero for battery-only system

Import generation profile to model battery with wind or other power system

Merchant Plant

Time series power price

Capacity requirement: Simulation fails if system does not meet capacity requirement in any time step

Automated battery dispatch responds to market power price

Live Demonstration

Generic System – Battery Tricks

Merchant Plant

Thank you!

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