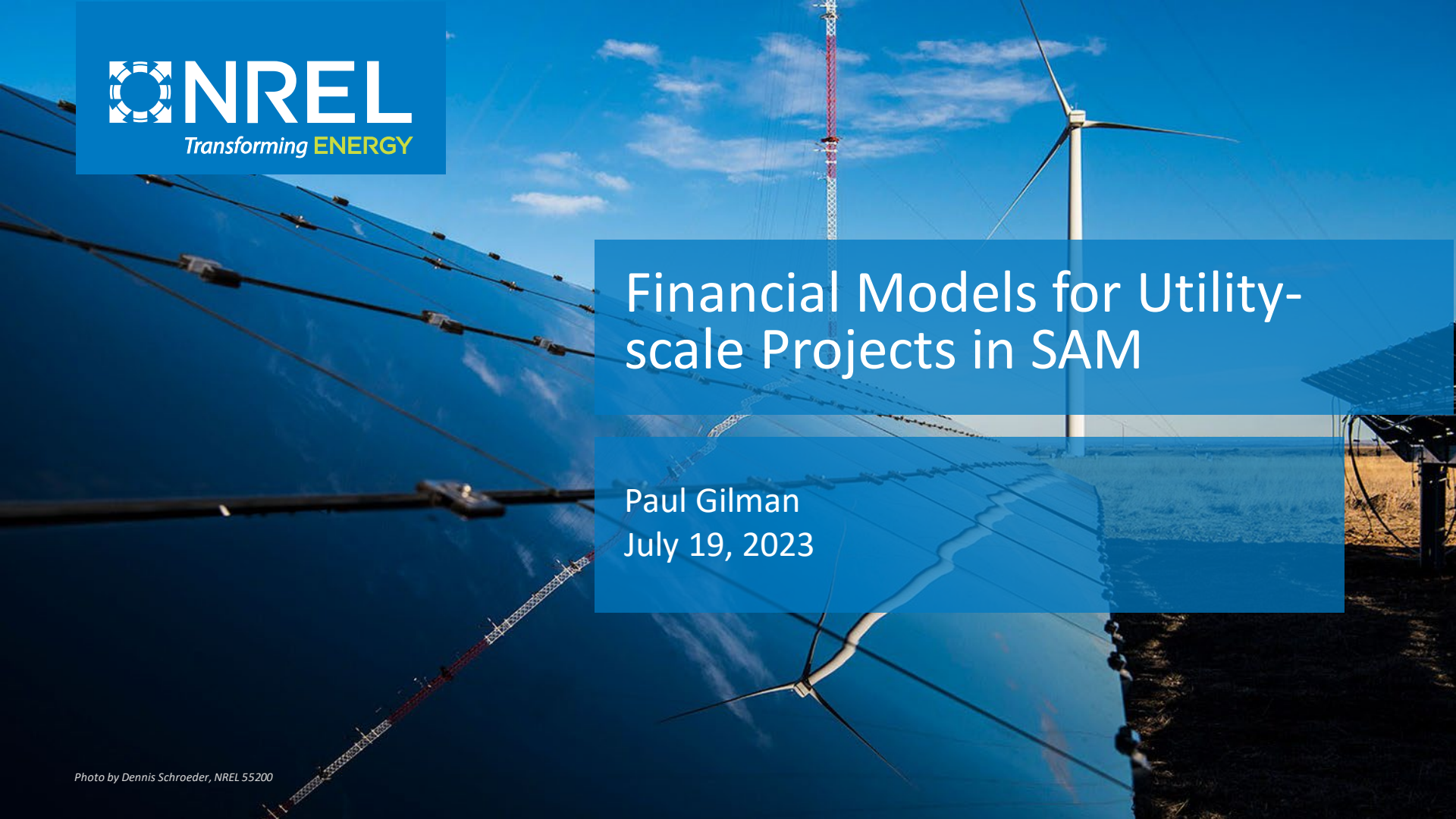


Financial Models for Utility-scale Projects in SAM

Paul Gilman
July 19, 2023

Photo by Dennis Schroeder, NREL 55200

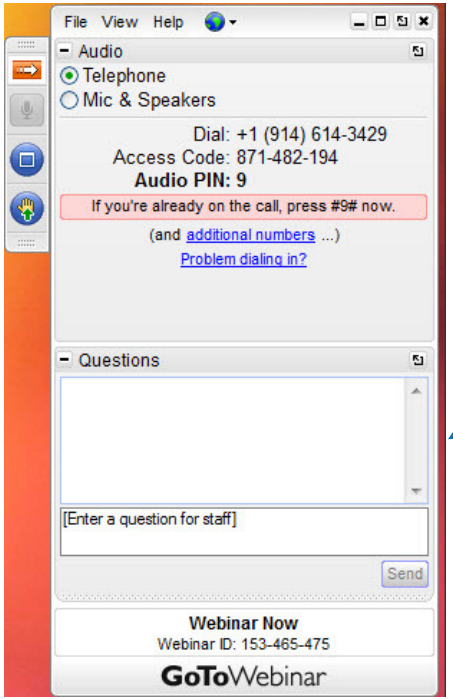
SAM Webinar Series 2023

Geothermal Electricity Technology Evaluation Model (GETEM) in SAM	January 19
Linkages between NREL's dGen, REopt and SAM Models	July 11
Financial Models for Utility-scale Projects in SAM	**July 19**
Modeling Utility-scale Photovoltaic Projects in SAM	August 23
Modeling Behind-the-meter (BTM) Batteries in SAM	September 20

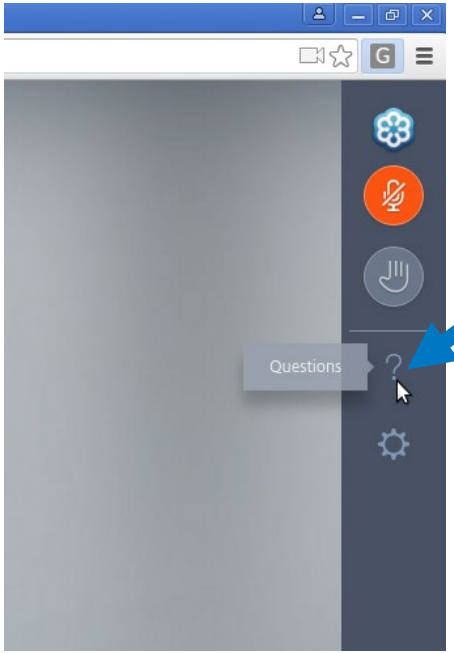
Webinars are free
- Register at https://sam.nrel.gov/events

Webinars are recorded
- https://www.youtube.com/@SAMDemoVideos
- "Videos" pages at https://sam.nrel.gov

Questions and Answers



Desktop application



Instant Join Viewer

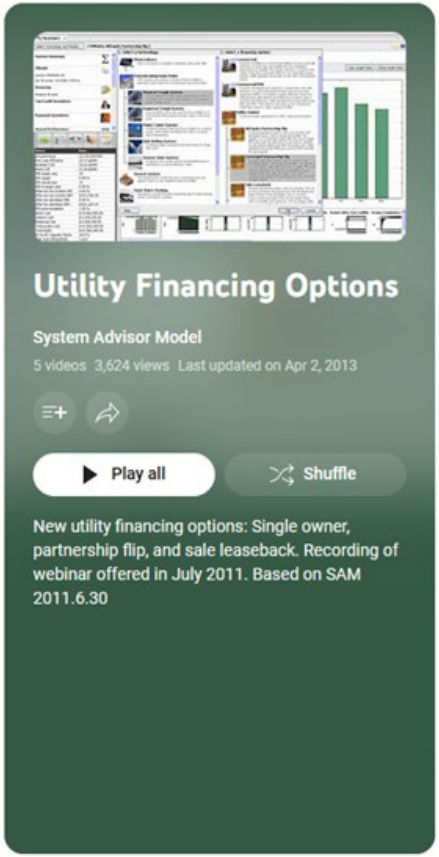
We will either type an answer to your question or answer it at the end of the presentation.

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

Agenda

1. Intro to SAM and overview of financial models
2. Ownership structures
3. Cash flow
4. Financial metrics
5. Revenue options
6. Live demonstration
7. Q&A

Update to 2011 and 2013 webinars



1 SAM Financing Part 1 of 5: Background
System Advisor Model • 2.6K views • 11 years ago
10:42

2 SAM Financing Part 2 of 5: Federal Tax Incentives and Tax Equity
System Advisor Model • 2K views • 11 years ago
6:24

3 SAM Financing Part 3 of 5: Project Financial Structures
System Advisor Model • 2.3K views • 11 years ago
9:35

4 SAM Financing Part 4 of 5: SAM Demonstration
System Advisor Model • 1.5K views • 11 years ago
17:15

5 SAM Financing Part 5 of 5: Question and Answer Session
System Advisor Model • 493 views • 11 years ago
14:59

https://www.youtube.com/playlist?list=PLB249A380C49AA176

https://www.youtube.com/watch?v=QZvPweCxzkI

Information Resources

Help System

- Press F1 key or click **Help** in SAM software
- Web version at https://sam.nrel.gov/help

SAM Forum

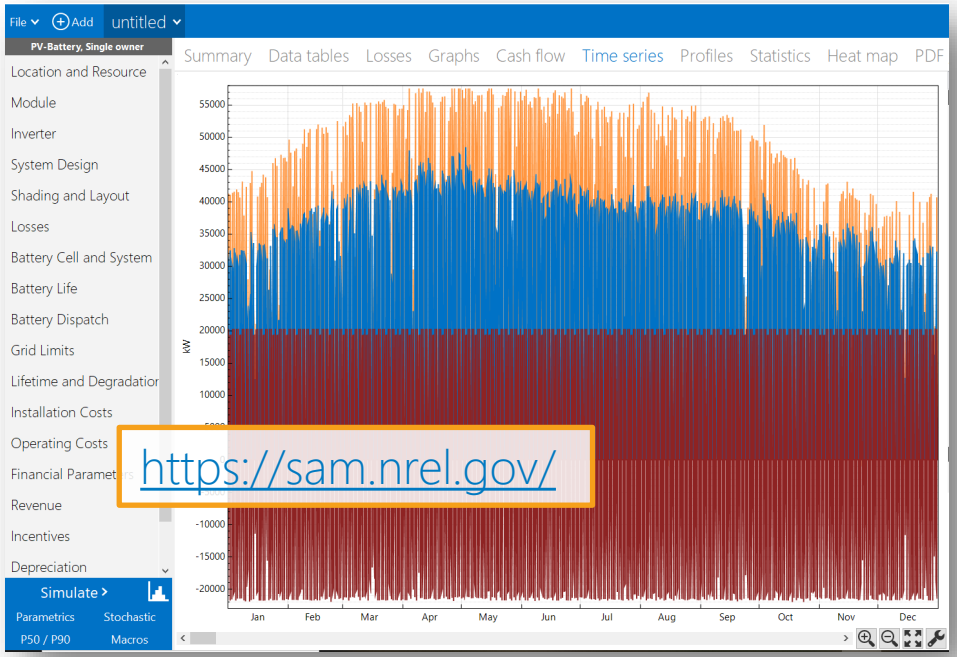
- https://sam.nrel.gov/forum
- Use search box to find information
- Register on website to post questions

Email

- sam.support@nrel.gov

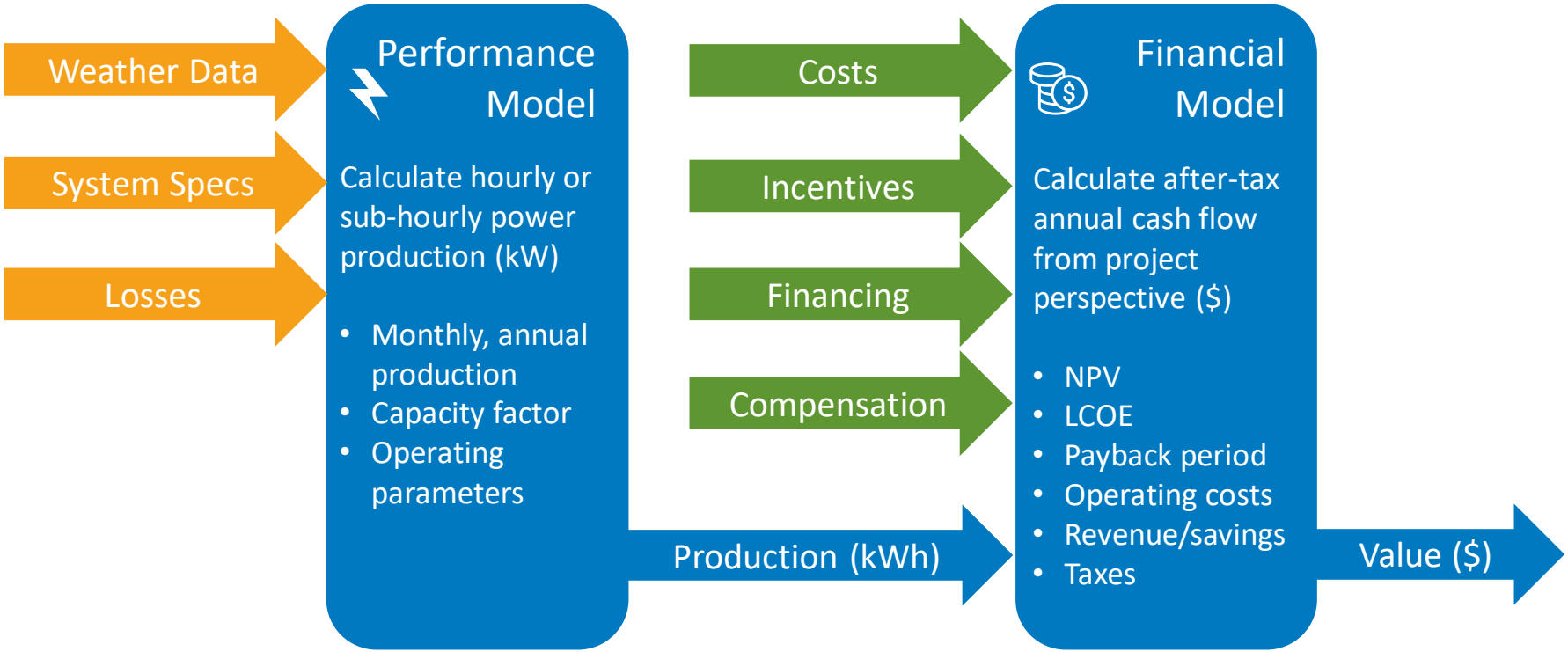
System Advisor Model (SAM)

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

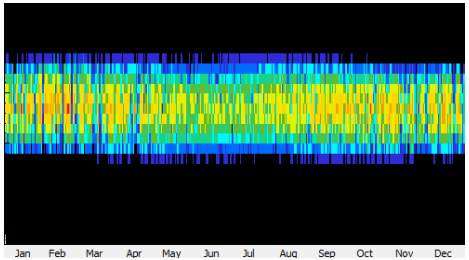


- ✓ Desktop application
- ✓ Software development kit with PySAM Python package
- ✓ Open source code repositories

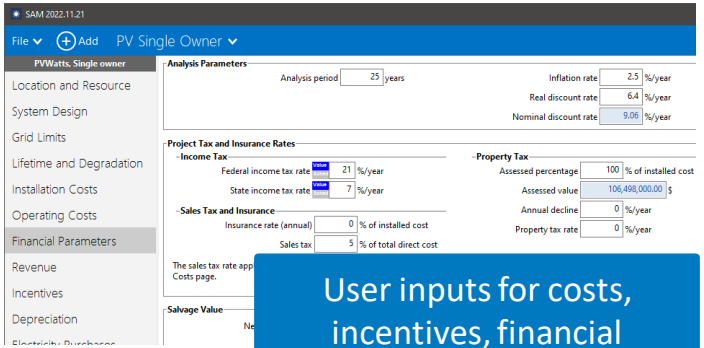
Model Structure



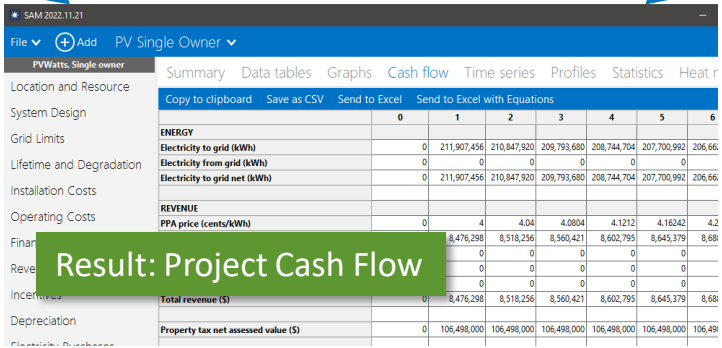
Financial model inputs include energy, costs, incentives, financial parameters, and revenue



Performance model output: kW, kWh



User inputs for costs, incentives, financial parameters, revenue options



Result: Project Cash Flow

Performance Models

- Photovoltaic
- Energy storage
  - Electric battery
  - Electric thermal storage
- Concentrating solar power
- Industrial process heat
- Marine energy
- Wind power
- Fuel cell
- Geothermal power
- Solar water heating
- Biomass combustion
- Generic system

Financial Models

- Power purchase agreements
  - Single owner
  - Partnership flips
  - Sale leaseback
- Residential
- Commercial
- Third party ownership
- Merchant plant
- Community solar
- Simple LCOE calculator

Performance Models

- Photovoltaic
- Energy storage
  - Electric battery
  - Electric thermal storage
- Concentrating solar power
- Industrial process heat
- Marine energy
- Wind power
- Fuel cell
- Geothermal power
- Solar water heating
- Biomass combustion
- Generic system

Financial Models

- Power purchase agreements
  - Single owner
  - Partnership flips
  - Sale leaseback
- Residential
- Commercial
- Third party ownership
- Merchant plant
- Community solar
- Simple LCOE calculator

FOM and BTM Models

Power Purchase Agreement (PPA), or Front of Meter (FOM)

Power generation projects

- Electricity is delivered to the grid
- Sell electricity at negotiated or market prices
- Earn revenue
- “Feasible” project: Revenue is greater than project costs

Distributed Energy, or Behind the Meter (BTM)

Customer side of meter

- Electricity meets load with excess delivered to grid
- Buy and sell electricity at retail rates
- Reduce annual electricity bill
- “Feasible” project: Bill savings are greater than project costs

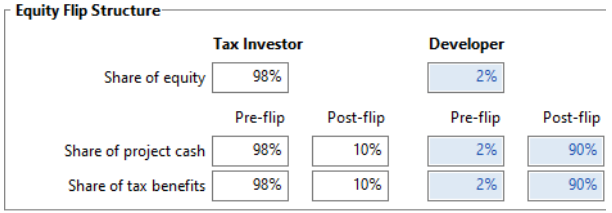
Ownership Structures

Single entity owns, builds, and operates project

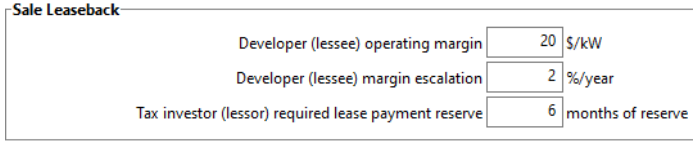
- PPA single owner
- Merchant plant
- Community Solar

Separate tax equity and investor partners

- PPA Partnership flip
  Tax investor and developer share cost and benefit of project, benefits go to developer after “flip year”



- PPA Sale leaseback
  Tax investor purchases project from developer and leases it back to the developer



Financial Model Notes

Models are based on a high-level, pro-forma cash flow

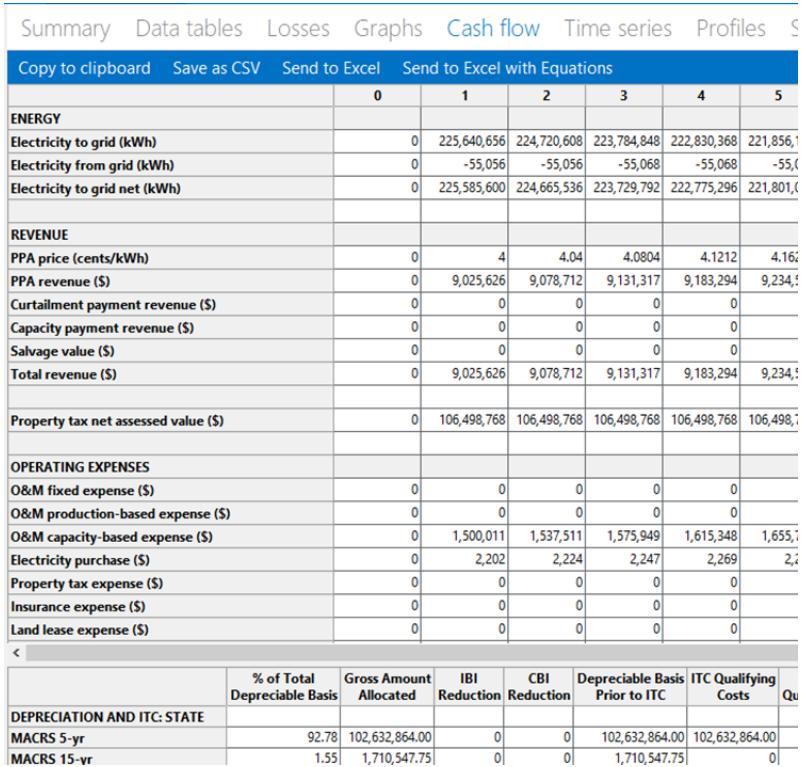
- Annual cash flows
- Simple enough to generate quick results
- Detailed enough for pre-feasibility project evaluation
- General enough to be useful for a wide range of applications

Cash flow and metrics are from the project perspective

- Account for project installation and operating costs, incentives, debt
- Do not account for external factors that may affect decision-making

Project Cash Flow

- Year zero value accounts for initial investment, incentives, and construction financing cost
- Years 1 and later account for revenue, expenses, taxes, incentives, and debt costs
- From project perspective, and from each partner's perspective as applicable
- You specify costs in Year 1 $, SAM applies inflation to calculate out-year values
- SAM does not apply inflation to revenue. Use the PPA escalation rate to inflate revenue.



Summary | Data tables | Losses | Graphs | Cash flow | Time series | Profiles

Copy to clipboard | Save as CSV | Send to Excel | Send to Excel with Equations

	0	1	2	3	4	5
ENERGY						
Electricity to grid (kWh)	0	225,640,656	224,720,608	223,784,848	222,830,368	221,856,
Electricity from grid (kWh)	0	-55,056	-55,056	-55,068	-55,068	-55,
Electricity to grid net (kWh)	0	225,585,600	224,665,536	223,729,792	222,775,296	221,801,
REVENUE						
PPA price (cents/kWh)	0	4	4.04	4.0804	4.1212	4.16
PPA revenue ($)	0	9,025,626	9,078,712	9,131,317	9,183,294	9,234,
Curtailment payment revenue ($)	0	0	0	0	0	
Capacity payment revenue ($)	0	0	0	0	0	
Salvage value ($)	0	0	0	0	0	
Total revenue ($)	0	9,025,626	9,078,712	9,131,317	9,183,294	9,234,
Property tax net assessed value ($)	0	106,498,768	106,498,768	106,498,768	106,498,768	106,498,
OPERATING EXPENSES						
O&M fixed expense ($)	0	0	0	0	0	
O&M production-based expense ($)	0	0	0	0	0	
O&M capacity-based expense ($)	0	1,500,011	1,537,511	1,575,949	1,615,348	1,655,
Electricity purchase ($)	0	2,202	2,224	2,247	2,269	2,
Property tax expense ($)	0	0	0	0	0	
Insurance expense ($)	0	0	0	0	0	
Land lease expense ($)	0	0	0	0	0	

	% of Total Depreciable Basis	Gross Amount Allocated	IBI Reduction	CBI Reduction	Depreciable Basis Prior to ITC	ITC Qualifying Costs	Qu
DEPRECIATION AND ITC: STATE							
MACRS 5-yr	92.78	102,632,864.00	0	0	102,632,864.00	102,632,864.00	
MACRS 15-yr	1.55	1,710,547.75	0	0	1,710,547.75	0	

Financial Metrics

Net present value (NPV), $

- The present value of after-tax cash flows over the analysis period
- A negative value may indicate a financially infeasible project

Internal rate of return (IRR), %

- The discount rate at which NPV = 0
- A measure of profitability

Power price, $/kWh

Size of debt, $

Metric	Value
Annual AC energy in Year 1	211,907,456 kWh
DC capacity factor in Year 1	24.2%
Energy yield in Year 1	2,119 kWh/kW
PPA price in Year 1	4.00 ¢/kWh
PPA price escalation	1.00 %/year
LPPA Levelized PPA price nominal	4.32 ¢/kWh
LPPA Levelized PPA price real	3.45 ¢/kWh
LCOE Levelized cost of energy nominal	4.27 ¢/kWh
LCOE Levelized cost of energy real	3.41 ¢/kWh
NPV Net present value	$1,025,574
IRR Internal rate of return	7.26 %
Year IRR is achieved	20
IRR at end of project	9.57 %
Net capital cost	$113,663,144
Equity	$53,756,996
Size of debt	$59,906,152
Debt percent	52.70%

Consider metrics as a set!

Metric	Value
Annual AC energy in Year 1	211,907,456 kWh
DC capacity factor in Year 1	24.2%
Energy yield in Year 1	2,119 kWh/kW
PPA price in Year 1	4.00 ¢/kWh
PPA price escalation	1.00 %/year
LPPA Levelized PPA price nominal	4.32 ¢/kWh
LPPA Levelized PPA price real	3.45 ¢/kWh
LCOE Levelized cost of energy nominal	4.27 ¢/kWh
LCOE Levelized cost of energy real	3.41 ¢/kWh
NPV Net present value	$1,025,574
IRR Internal rate of return	7.26 %
Year IRR is achieved	20
IRR at end of project	9.57 %
Net capital cost	$113,663,144
Equity	$53,756,996
Size of debt	$59,906,152
Debt percent	52.70%

- NPV > 0
- Reasonable PPA price
- Reasonable IRR
- IRR achieved by target year
- Reasonable debt size

"Reasonable" depends on the context.

Sources of Revenue

Single owner, partnership flip, sale leaseback

PPA price with optional annual escalation

- Time-of-delivery (TOD) multipliers for price that varies daily and/or seasonally, or by time step
- Capacity payments
- Curtailment payments

Merchant plant model

Time series power price and cleared capacity

- Energy market
- Ancillary service market (up to 4)
- Capacity payments

Sources of Revenue

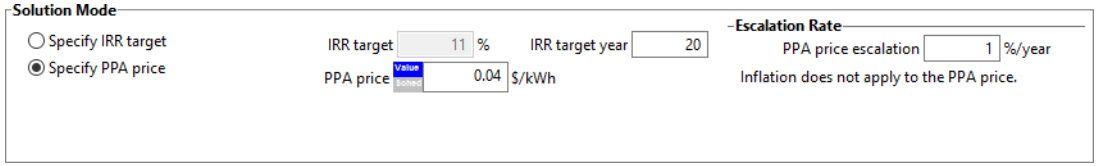
Community solar

Subscriber payments

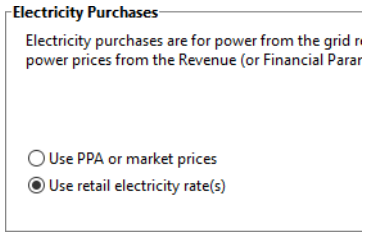
- Up-front
- Annual
- Generation

Solution Mode

Specify PPA price, SAM calculates IRR

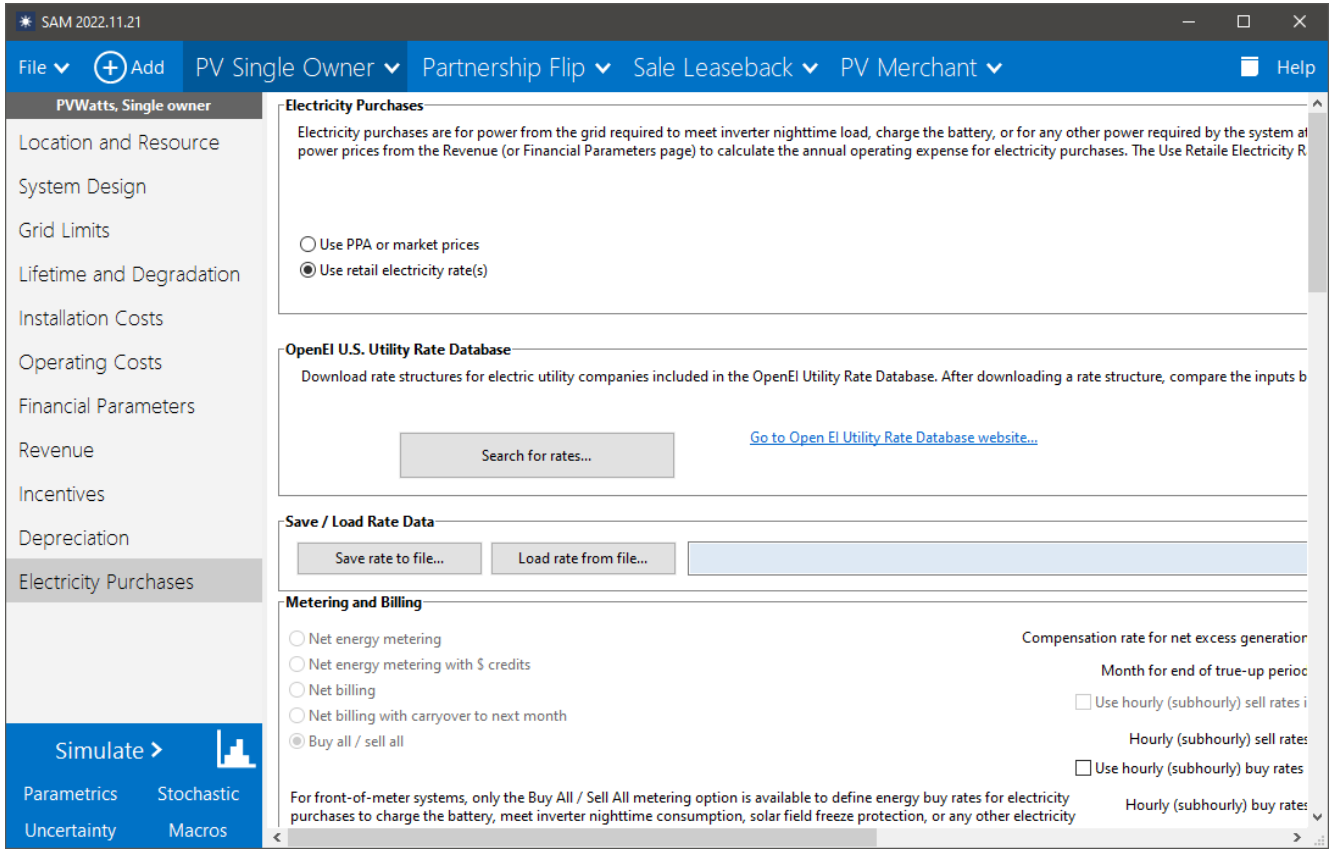


Specify target IRR and year, SAM calculates PPA price



Can’t use PPA price for electricity purchases

Demonstration



Thanks! Questions?

Janine Freeman Keith – 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, utility rates
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
Bill Hamilton – concentrating solar power models

sam.support@nrel.gov