System Advisor Model (SAM) Overview

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What is SAM?

The System Advisor Model (SAM)

Free computer model

Calculates:

- System's hourly (or subhourly) energy output over a single year
- Project's cost of energy over years of operation

Who makes SAM?

Developed by
- U.S. Department of Energy's National Renewable Energy Laboratory (NREL)

Uses models developed by
- NREL
- Sandia National Laboratories
- University of Wisconsin
- Other partners

Original vision in 2004
- Allow DOE to make R&D choices based on analysis of the entire system including costs
- Model different renewable energy projects in a single platform
- Facilitate technology comparison by handling performance, costs and financing consistently across technologies

Who uses SAM?

Project developers

Electric utilities

University researchers

Engineering firms

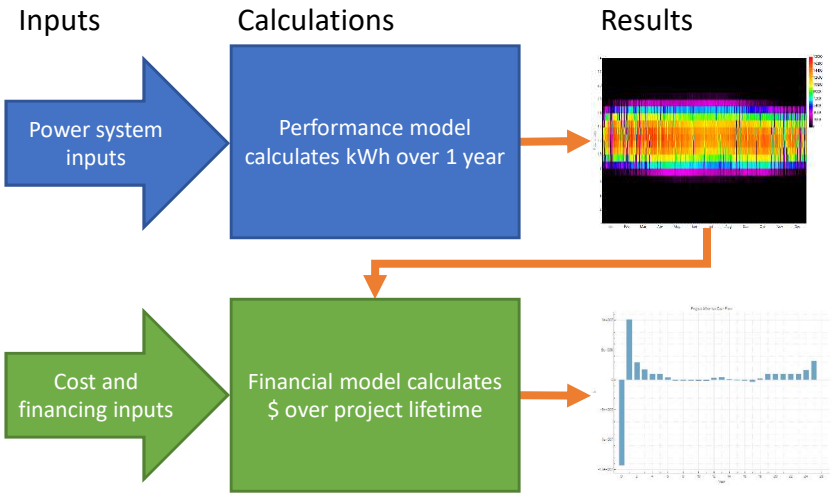
Government decision makers

Educators and students

What can you do with SAM?

- Estimate energy production for a specific system
- Calculate net present value, levelized cost of energy, payback for a project
- Perform parametric and uncertainty analyses
- Present modeling results in graphs and tables
- Evaluate project proposals
- Generate data for geospatial analysis
- Develop templates for decision-making

SAM combines performance model with financial model for techno-economic analysis



Performance models

Photovoltaic systems

Concentrating solar power

Industrial process heat

Solar water heating

Wind power

Geothermal power

Biopower

Conventional thermal power

Financial models

Residential and commercial projects

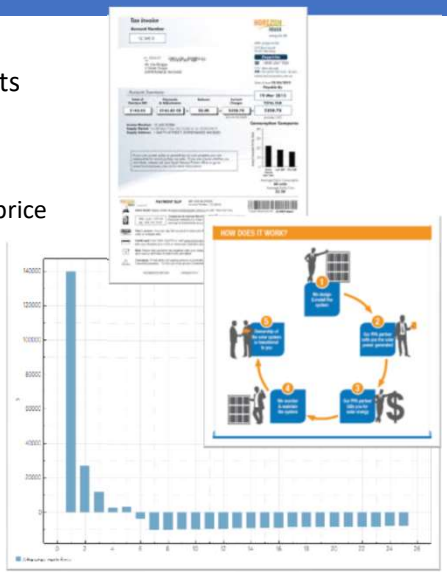
- Electricity bill savings

PPA projects

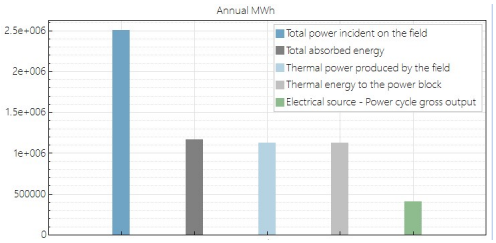
- Power purchase agreement (PPA) price
- Internal rate of return

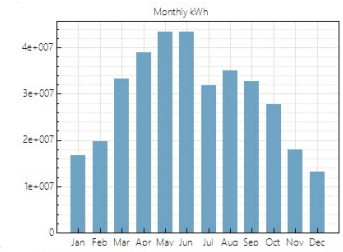
Calculate cash flow based on

- Installation and operating costs
- Tax credits
- Payment incentives
- Time-of-use electricity rates
- Project debt

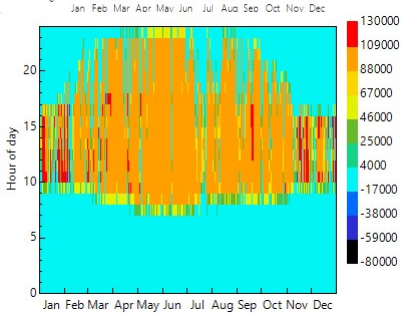


Predict system energy output





Example: 100 MW Parabolic trough system with 6 hours of storage



Optimize design parameters

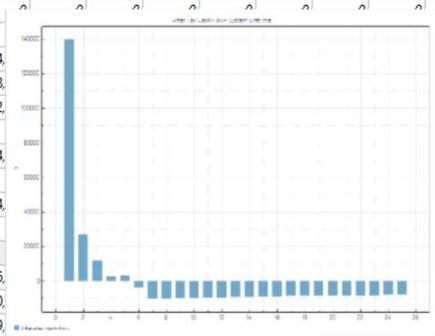
- For Boulder, CO, orient array slightly eastward to avoid summer afternoon thunderclouds over mountains
- For Los Angeles, CA, orient array slightly westward to avoid morning fog
- For Phoenix, AZ, orient array due south

Example: Explore optimal array tilt and azimuth angles for a 4 kW residential photovoltaic system in three different locations

Cash flow analysis

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

	0	1	2	3	4	5	6	7	8	9	10	11
PRODUCTION												
Energy (kWh)	0	341,153	339,448	337,750	336,062	334,381	332,709	331,046	329,391	327,744	326,105	324,4
SAVINGS												
Value of electricity savings ($)	0	31,991	32,637	33,296	33,968	34,654	35,354	36,068	36,796	37,539	38,297	39,0
OPERATING EXPENSES												
O&M fixed expense ($)	0	0	0									
O&M production-based expense ($)	0	0	0									
O&M capacity-based expense ($)	0	3,995	4,095	4,								5,1
Property tax expense ($)	0	8,499	8,499	8,								8,4
Insurance expense ($)	0	2,125	2,178	2,								2,7
Net salvage value ($)	0	0	0									
Total operating expense ($)	0	14,619	14,772	14,								16,3
Deductible expenses ($)	0	-14,619	-14,772	-14,								16,3
PROJECT DEBT												
Debt balance ($)	424,939	416,036	406,687	396,								98,4
Interest payment ($)	0	21,247	20,802	20,								15,6
Principal payment ($)	0	8,904	9,349	9,								14,5



Extending SAM

Software Development Kit (SDK)

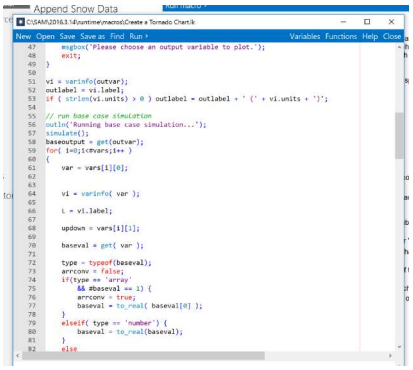
SAM simulations can be configured and run from computer programs without opening the SAM application

Allows researchers and software developers to make calls to SAM from their programs

SAM scripting in LK

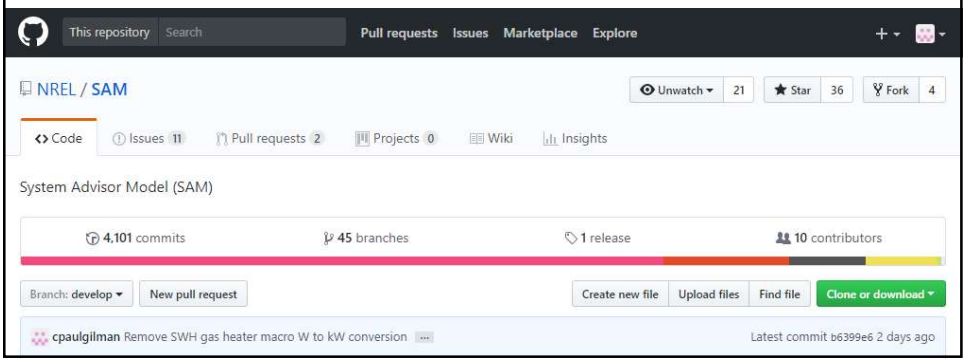
Built-in scripting language to automate complex analysis tasks

Allows you to extend the core functionality of SAM to suit your needs



SAM Open Source

- Source code is available to public on GitHub repositories: https://github.com/nrel/sam
- Useful for researchers wanting to understand algorithms and see equations
- Makes it possible for software developers to build their own versions of SAM and contribute to the NREL versions



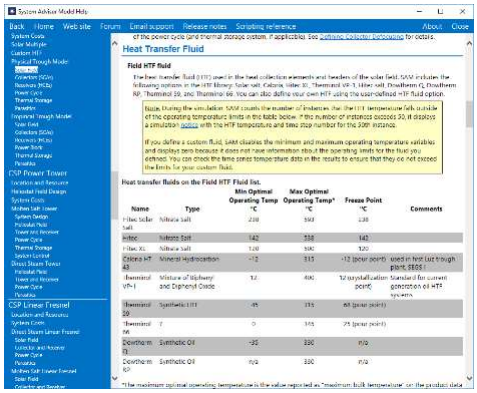
Downloading SAM

https://sam.nrel.gov/

Start software and submit email for free registration key

Where to find help using SAM

Help system
Support forum:
https://sam.nrel.gov/support
Email: sam.support@nrel.gov



Garbage in, garbage out!