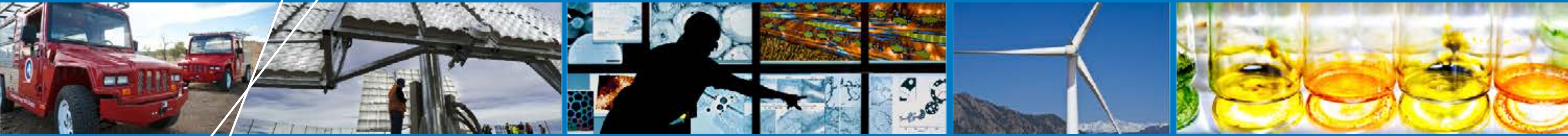
Power Purchase Agreement Financial Models in SAM 2013.1.15



SAM Webinar

Paul Gilman

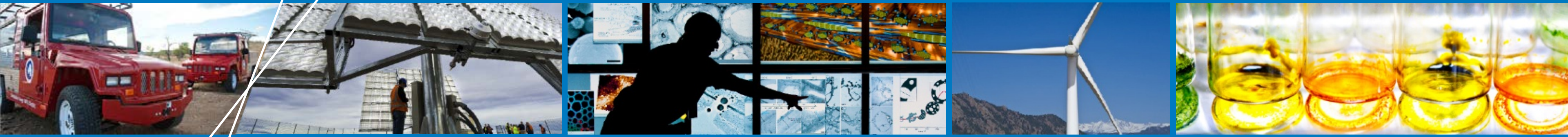
June 19, 2013

Session Outline

- Short demonstration in SAM
- Overview of SAM financial models
- SAM PPA model metrics
- Troubleshooting PPA model results

Financial model FAQ

- What is the difference between Utility IPP and Single Owner model?
- Why is the energy term in the LCOE equation discounted?
- What is the difference between nominal and real LCOE?
- If I set the discount rate to the IRR, will the NPV be zero?
- What value should I choose for the discount rate?
- Why does SAM calculate the LCOE using revenue instead of cost?



Overview of SAM's Financial Models

SAM can model two types of projects

- **Distributed – Customer side of meter**
  Buy and sell electricity at retail rates
  - Net present value (NPV)
  - Payback period
  - Levelized cost of energy (LCOE)
- **PPA – Power generation project**
  Sell electricity at a price negotiated through a power purchase agreement
  - PPA price
  - Internal rate of return (IRR)
  - NPV
  - LCOE is “levelized PPA price”

Residential lease: Coming soon to SAM?

- **SAM's distributed financial models assume that the building owner purchases the system**
- **The Commercial PPA financial model is from the perspective of the company offering the lease**
  - "What PPA price must the lessor negotiate to cover its costs?"
- **The current version of SAM *cannot* evaluate questions from the perspective of the building owner**
  - "~~Is it better to lease or buy a project in terms of NPV?~~"
  - "~~Is it better to pay all of the lease up front?~~"
  - "~~What impact do changes in inflation, PPA price escalation, discount rate, etc. have on the answers to these questions?~~"

We would like to add a model for residential lease and are pursuing funding options

Distributed project involves a building or facility load

18 kW PV system on a children's care facility in Chicago

Photo by Spire Solar Chicago NREL 632223

PPA project sells all electricity to the grid

2 MW photovoltaic facility near an airport in Prescott, Arizona

Photo by Arizona Public Service NREL 13338

SAM has two financial models for distributed projects

- **Residential**
  - Debt with tax deductible or non-tax deductible loan payments
- **Commercial**
  - Tax deductible loan payments
  - Depreciation options

For PPA projects, it has several models

- **Commercial PPA and Utility IPP**
  - A single owner builds and operates the project
  - Utility IPP option offers financial constraints to help ensure SAM can find solution
  - Debt fraction is an input
- **Advanced financial models**
  - Single Owner: Like Utility IPP, but with reserve accounts, and SAM calculates debt fraction
  - Partnership Flip: Tax investor and developer share cost and benefit of project, Benefits go to developer after “flip year”
  - Sale Leaseback: Tax investor purchases project from developer and leases it back to the developer

What are the main differences between the Utility IPP and Single Owner models?

Utility IPP

IRR: The IRR is over the entire analysis period

Project term debt: You specify the debt fraction

Constraints: You can choose options to constrain PPA price solution

- Automatically optimize debt fraction and/or PPA price escalation
- Force positive cash flow and minimum DSCR

Single Owner

IRR: You can specify a target year for the IRR

Project term debt: You specify a debt-service coverage ratio (DSCR), and SAM calculates the debt fraction

Reserve accounts: Reserve accounts for funds to cover equipment replacement, capital reserves, and debt service reserves

Compare the Financing page for the two models to see the differences.

A Note about the PPA Models

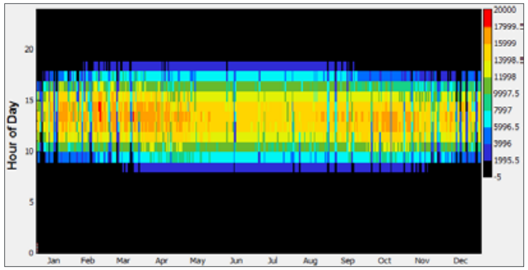
- **Models are general pro forma models**
  - Enough detail for pre-feasibility project evaluation
  - Simple enough to generate quick results
- **PPA Commercial, Utility IPP, and Single Owner all make the following assumptions**
  - A single entity builds, owns, and operates the project
  - The project has sufficient tax liability to benefit from tax credits
- **Partnership and Sale Leaseback models are simplified representations of actual partnership agreements**

Anatomy of a SAM Model Run

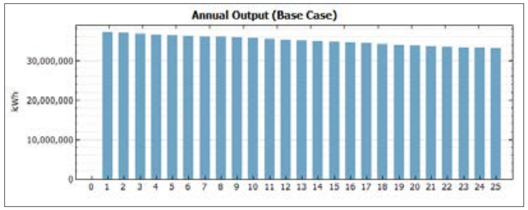
SAM 2013.1.15

Inputs | **Calculations** | **Results**

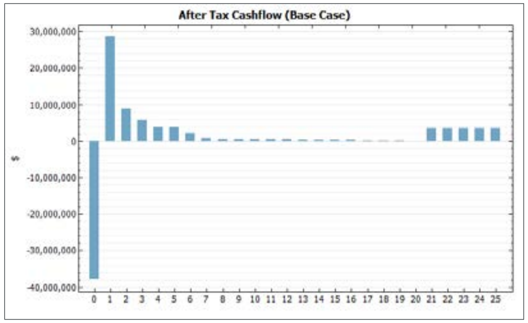
System design parameters → **Performance Model** 8760 simulation

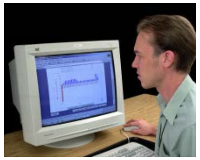


Performance adjustment factors → **Calculate production in each year**



Costs and financial parameters → **Financial Model** Project cash flow





Warren Gretz NREL 10852

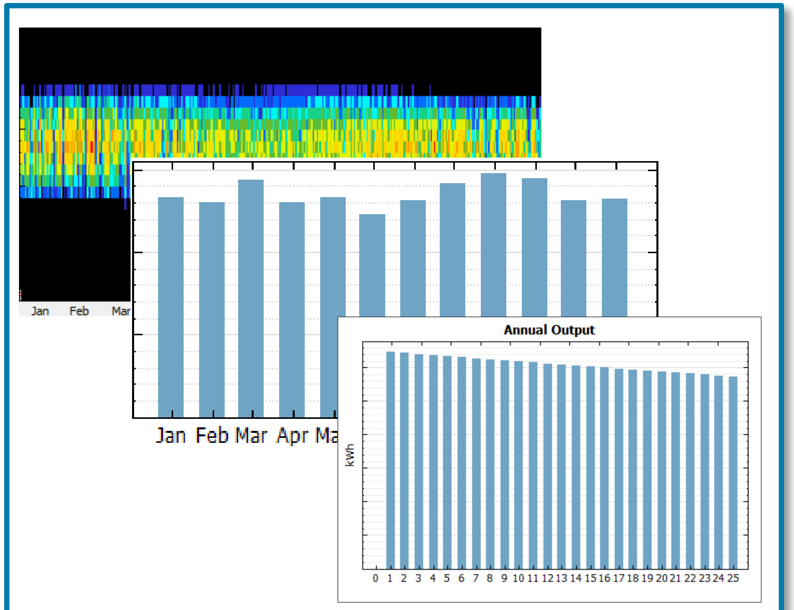
Analyze

Jim Yost NREL 12875

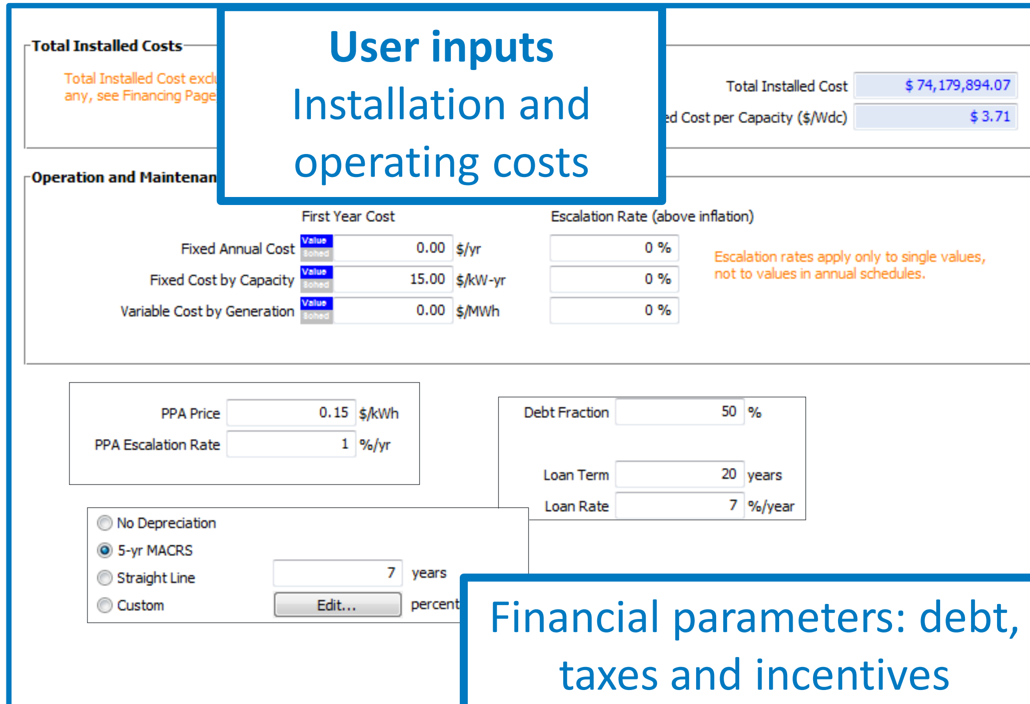
Present

Financial model inputs include energy (kWh), costs ($), and financial parameters

SAM 2013.1.15



Performance model output
kWh of Electricity



User inputs
Installation and operating costs

Financial parameters: debt, taxes and incentives

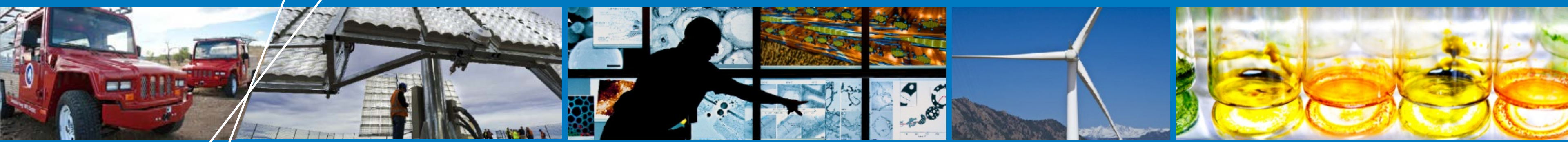
Performance Adjustments

	0	1	2	3	4	5
Energy (kWh)	0	32,417,342	32,255,256	32,093,978	31,933,510	31,773,8
Energy Price ($/kWh)	0	0.15	0.152	0.153	0.155	0.15
Energy Value ($)	0	4,862,601.5	4,886,671.5	4,910,860.5	4,935,169	4,959,598.5
Operating Expenses						
O&M Fixed expense ($)	0	0	0	0	0	0
O&M Capacity-based expense ($)	0	299,976.13	307,475.53	315,162.41	323,041.47	331,117.5
O&M Production-based expense ($)	0	0	0	0	0	
Insurance expense ($)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Property tax net assessed value ($)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Property tax expense ($)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Net Salvage Value ($)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total operating expense ($)	0	670,875.63	687,647.5	704,838.69	722,459.63	740,521.13

Metric	Base
Annual Energy	37,230,428 kWh
PPA price	16.70 ¢/kWh
LCOE Nominal	17.92 ¢/kWh
LCOE Real	14.56 ¢/kWh
Internal rate of return (%)	20.95 %
Minimum DSCR	1.55
[illegible]	$ 8,680,973.00
[illegible]	1.00 %
[illegible]	50.00 %
[illegible]	21.3 %
First year kWhac/kWdc	1,862
System performance factor (%)	0.82
Total Land Area	66.01 acres

Result: Project cash flow and metrics

NREL
NATIONAL RENEWABLE ENERGY LABORATORY



PPA Model Metrics

Each of SAM's PPA financial models reports a set of interdependent metrics and a project cash flow

PPA price and LCOE, cents/kWh
PPA price escalation rate
Internal Rate of Return, %/year
Net Present Value, $
Debt service coverage ratio (DSCR)
Debt Fraction

Avoid evaluating a single metric!

- Evaluate the metrics as a set

Utility IPP

Metric	Base
Annual Energy	37,230,428 kWh
PPA price	16.70 ¢/kWh
LCOE Nominal	17.92 ¢/kWh
LCOE Real	14.56 ¢/kWh
Internal rate of return (%)	20.95 %
Minimum DSCR	1.55
Net present value ($)	$ 8,680,973.00
Calculated ppa escalation (%)	1.00 %
Calculated debt fraction (%)	50.00 %
Capacity Factor	21.3 %
First year kWha	862
System perform	82
Total Land Area	6.01 acres

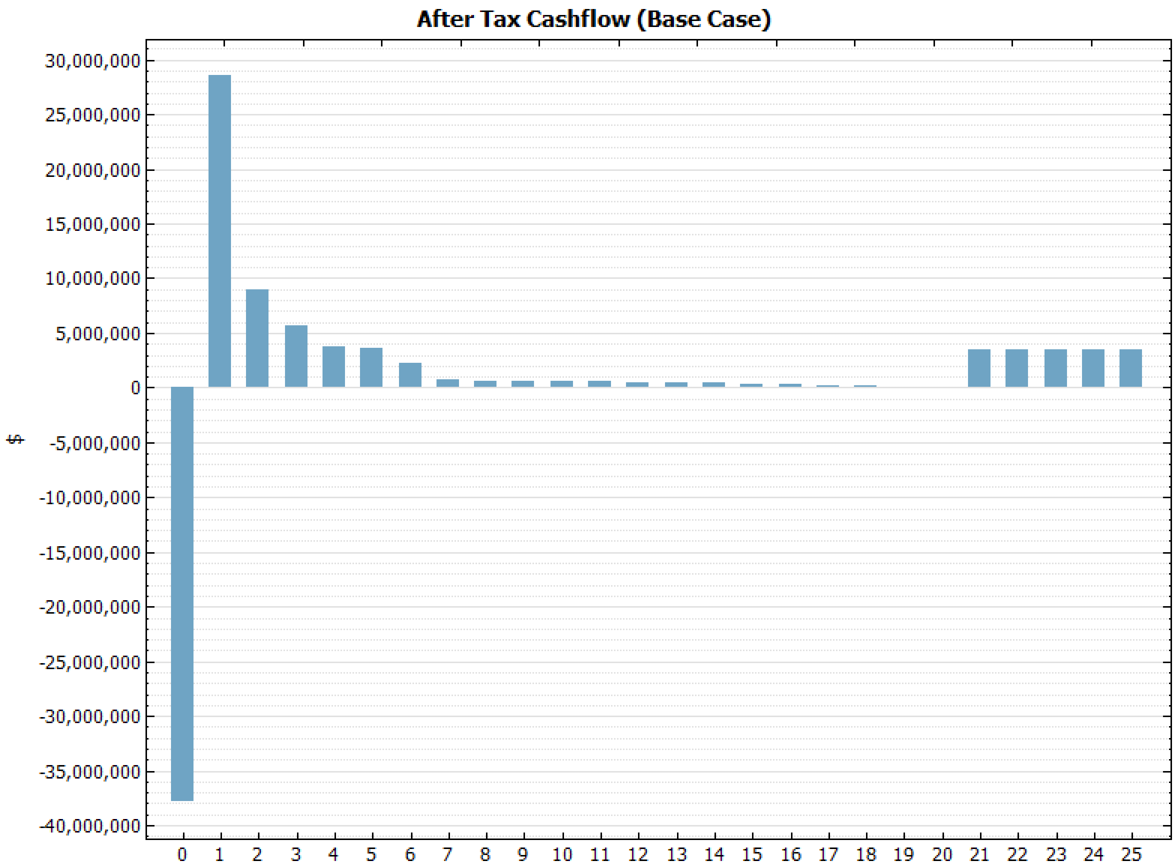
Single Owner

Metric	Base
Annual Energy	32,417,342 kWh
PPA price	19.91 ¢/kWh
LCOE Nominal	21.37 ¢/kWh
LCOE Real	17.36 ¢/kWh
IRR target year	20
IRR target	11.00 %
IRR actual year	20
IRR in target year	11.00 %
After-tax IRR	12.64 %
After-tax NPV	$ 1,703,819.88
PPA price escalation	1.00 %
Debt fraction	51.43 %
Direct Cost	$ 65,885,992.56
Indirect Cost	$ 8,293,901.51
Financing Cost	$ 5,408,657.93
Total project cost	$ 79,588,552.00
Total debt	$ 40,928,888.00
Total equity	$ 38,659,664.00
Capacity Factor	18.5 %
First year kW	
System perfo	
Total Land Ar	res

Partnership Flip

Metric	Base
Annual Energy	32,417,342 kWh
PPA price	17.23 ¢/kWh
LCOE Nominal	18.50 ¢/kWh
LCOE Real	15.02 ¢/kWh
IRR target year	20
IRR target	11.00 %
IRR actual year	20
IRR in target year	11.00 %
After-tax tax investor IRR	11.07 %
After-tax tax investor NPV	$ 308,151.84
After-tax developer IRR	-0.86 %
After-tax developer NPV	$ -17,795,588.00
PPA price escalation	1.00 %
Direct Cost	$ 65,885,992.56
Indirect Cost	$ 8,293,901.51
Financing Cost	$ 4,344,433.93
Total project cost	$ 78,524,328.00
Total equity	$ 78,524,328.00
Capacity Factor	18.5 %
First year k	
System pe	
Total Land	es

SAM calculates financial metrics from the cash flow



Metric	Base
Annual Energy	37,230,428 kWh
PPA price	16.70 ¢/kWh
LCOE Nominal	17.92 ¢/kWh
LCOE Real	14.56 ¢/kWh
Internal rate of return (%)	20.95 %
Minimum DSCR	1.55
Net present value ($)	$ 8,680,973.00
Calculated ppa escalation (%)	1.00 %
Calculated debt fraction (%)	50.00 %
Capacity Factor	21.3 %
First year kWh	,862
System perform	.82
Total Land Area	5.01 acres

Utility IPP

Include the cash flow in your evaluation of the metrics.

Cash flow

The net after-tax annual benefit (positive) or cost (negative) to the project

- 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.

$$CF_0 = B_0 - C_0$$

$$CF_n = P_n \times Q_n + B_n - C_n$$

$$C_n = C_1 \times (1 + i)^n$$

CF = after-tax cash flow in \$, B = Project benefit in \$, C = Project cost in \$
P = PPA price, n = year, Q = Energy in kWh, i = annual inflation rate

Net Present Value (NPV)

SAM 2013.1.15

The present value of the after-tax cash flow (CF_n) over the analysis period (N) discounted at the nominal discount rate (d)

- A negative value may indicate a financially infeasible project
- From project perspective, and from each partner's perspective as applicable
- SAM applies inflation to costs, but not to revenue. Use the PPA escalation rate to inflate revenue

$$\mathrm{NPV} = \sum_{n=0}^{N} \frac{\mathrm{CF}_n}{(1+\mathrm{d})^n}$$

$$\mathrm{NPV} = CF_0 + \sum_{n=1}^{N} \frac{P_n \times Q_n + B_n - C_n}{(1+\mathrm{d})^n}$$

CF = after-tax cash flow in \$, P = PPA price, Q = Energy in kWh, B = Project benefit in \$, C = Project cost in \$, n = year, N = analysis period in years, d = nominal discount rate

Internal Rate of Return (IRR)

The nominal discount rate that, when applied to the after-tax cash flow (Cn) over the analysis period (N), results in a net present value of zero

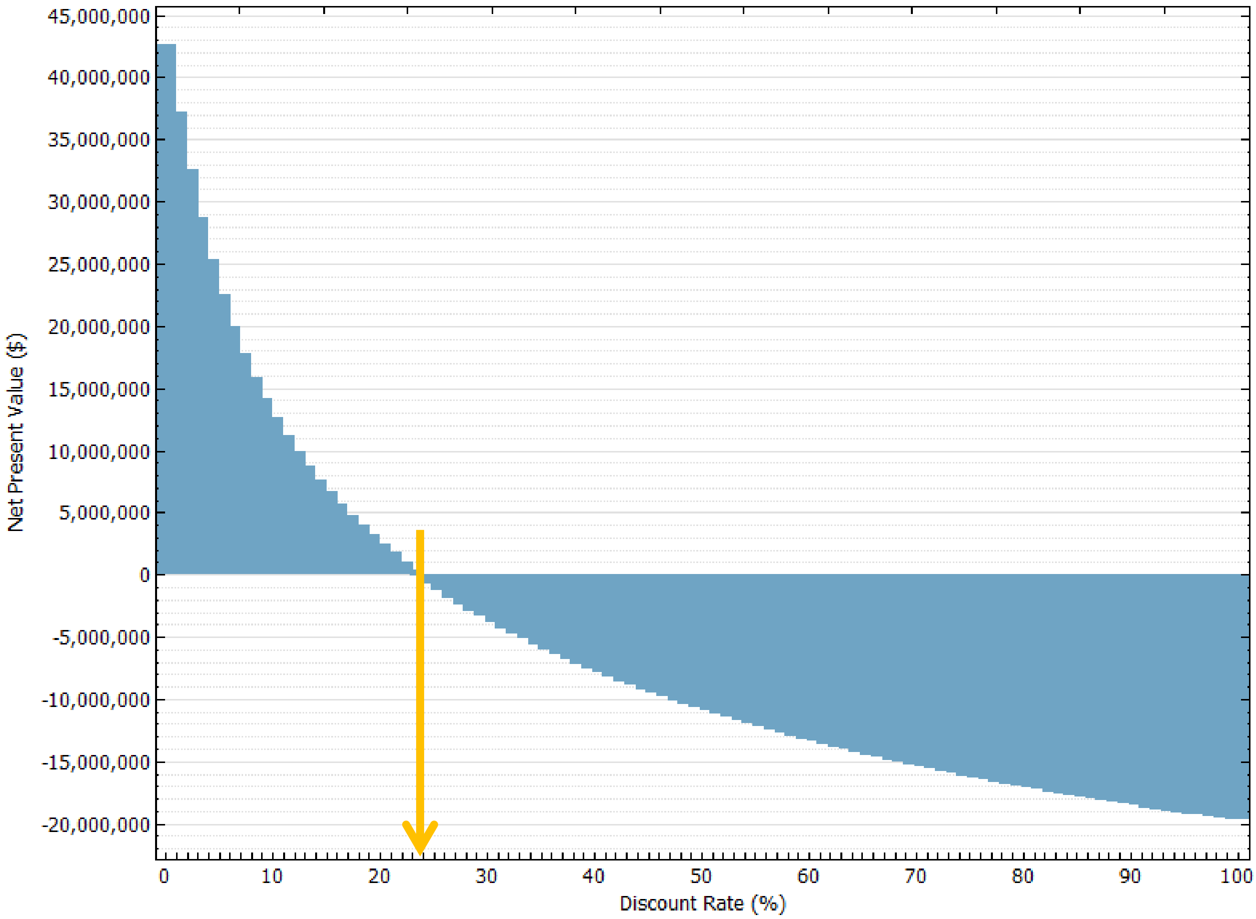
- From project perspective
- For partnership and sale lease back models, also from each partner's perspective

$$\mathrm{NPV} = \sum_{n=0}^{N} \frac{\mathrm{CF}_n}{(1+\mathrm{IRR})^n} = 0$$

$$\mathrm{NPV} = CF_0 + \sum_{n=1}^{N} \frac{P_n \times Q_n + B_n - C_n}{(1+\mathrm{IRR})^n} = 0$$

CF = after-tax cash flow in \$, P = PPA price, Q = Energy in kWh, B = Project benefit in \$, C = Project cost in \$, n = year, N = analysis period in years, d = nominal discount rate

IRR is the nominal discount rate that results in an NPV of zero



To create this graph in SAM: Set the inflation rate to zero so that the real and nominal discount rates are equal, and set up a parametric analysis on Real Discount Rate with values ranging from 0 to 100% in increments of 10%

SAM calculates the NPV and IRR from the after-tax cash flow

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Utility IPP and Commercial PPA: After tax net equity cash flow, toward bottom of cash flow table

Federal depreciation ($)	0	12,847,206	20,555,530	12,333,318	7,3
Federal Income Taxes ($)	0	-3,240,001.5	-5,723,512	-3,020,249.75	-1,38
Federal tax savings ($)	0	25,911,542	5,723,512	3,020,249.75	1,386,
After tax net equity cash flow ($)	-37,785,900	28,579,892	8,939,922	5,669,018.5	3,696,7

Single Owner: After tax, Total near middle of cash flow table

Pre-tax cash flow ($)	0	1,233,916	1,247,120	1,260,264	1,
		1,233,916	1,247,120	1,260,264	1,27
Cumulative IRR	0	-96.804	-80.359	0	
Cumulative NPV	-38,611,868	-37,499,280	-36,485,352	-35,561,488	-34,71
After-Tax					
Cash	-38,611,868	1,233,916	1,247,120	1,260,264	1,2
Total	-38,611,868	26,411,244	7,876,492	4,762,089	2,8
Cumulative IRR	0	-31.598	-9.146	0.784	
Cumulative NPV	-38,611,868	-14,797,571	-8,393,877	-4,902,923	-3

For partnership and sale-leaseback models, SAM calculates the metrics for the project and each party's perspective

SAM 2013.1.15

Metric	Base
Annual Energy	32,344,810 kWh
PPA price	29.77 ¢/kWh
LCOE Nominal	31.96 ¢/kWh
LCOE Real	25.96 ¢/kWh
IRR target year	9
IRR target	9.00 %
IRR actual year	9
IRR in target year	9.00 %
After-tax tax investor IRR	10.21 %
After-tax tax investor NPV	$ -1,111,384.50
After-tax developer IRR	13.53 %
After-tax developer NPV	$ 5,164,783.00
PPA price escalation	1.00 %
Direct Cost	$ 65,800,000.00

Project perspective

Tax investor perspective

Developer perspective

Total Project Returns					
Pre-Tax					
Total	-78,429,728	8,410,404	8,450,816	8,491,043	8
Cumulative IRR	0	-89.277	-61.378	-40.537	
Cumulative NPV	-78,429,728	-70,846,296	-63,975,668	-57,751,120	-52,
After-Tax					
Cash	-78,429,728	8,410,404	8,450,816	8,491,043	8,
Total	-78,429,728	30,858,832	12,624,795	9,607,231	7,
Cumulative IRR	0	-60.654	-35.642	-20.801	
Cumulative NPV	-78,429,728	-50,605,164	-40,341,032	-33,298,242	-28
LCOE					
Total PPA revenue ($)	0	9,630,071	9,677,740	9,725,644	9,
Net Energy (kWh)	0	32,344,810	32,183,086	32,022,170	31
NPV of PPA revenue	84,637,216				
NPV of net annual energy (nominal)	264,786,848				
LCOE Nominal	31.96				
NPV of net annual energy (real)	326,051,584				

Developer					
Capital Recovery					
Cash	0	-8,410,404	-8,450,816	-8,491,043	
Balance	31,371,890	22,961,486	14,510,67[illegible]	6,019,627	6,0
Pre-Tax					
Equity Investment	-31,371,890				
Pre-tax developer development fee ($)	2,222,700				
Operating Cash During Capital Recovery Period	0	8,410,404	8,450,816	8,491,043	
ributions/(Contributions) Post Recovery Period	0	0	0	0	
Total	0	8,410,404	8,450,816	8,491,043	
Cumulative IRR	0	0	0	0	
Cumulative NPV	-29,149,190	7,583,[illegible]31	14,454,058	20,678,604	20,6
IRR	0				
NPV	43,841,316				
After-Tax					
Equity Investment	-31,371,890				
Development Fee	2,222,70[illegible]				
Cash	-29,149,[illegible]0	8,410,404	8,450,816	8,491,043	
Investment Tax Credit	0	211,760	0	0	
Production Tax Credit	0	0	0	0	
Share of Project Tax Benefit/(Liability)	0	12,724	41,740	11,162	
Total	-29,149,190	7,755,811	8,492,556	8,502,205	
Cumulative IRR	0	-73.393	-31.104	-7.647	
Cumulative NPV	-29,149,190	-22,155,988	-15,251,426	-9,018,697	-9,0
IRR	13.53				
NPV	[illegible],164,783				

Partners Returns					
Tax Investor					
Pre-Tax					
Total	-47,057,836	0	0	0	8,531,077
Cumulative IRR	0	0	0	0	0
Cumulative NPV	-47,057,836	-47,057,836	-47,057,836	-47,057,836	-41,418,872
After-Tax					
Cash	-47,057,836	0	0	0	8,531,077
Investment Tax Credit	0	20,964,266	0	0	0
Production Tax Credit	0	0	0	0	0
Share of Project Tax Benefit/(Liability)	0	1,259,678	4,132,239	1,105,026	-718,852
Total	-47,057,836	22,223,944	4,132,239	1,105,026	7,812,225
Cumulative IRR	0	-52.773	-38.496	-34.057	-13.66
Cumulative NPV	-47,057,836	-27,019,114	-23,659,548	-22,849,484	-17,685,674
		0		0	0

SAM calculates the NPV and IRR from the total after-tax cash flow for each perspective.

Power Price (PPA Price)

- **Price paid to the project for electricity it delivers to the grid**
- **May be modified by a set of TOD factors**
- **May be an input or result:**

Specify PPA Price	**Specify IRR Target**
You specify the price, and SAM calculates the IRR	You specify a target IRR, and SAM finds the PPA price that results in that IRR

PPA Price Escalation Rate

SAM 2013.1.15

- **SAM reports the PPA price in the Metrics table as a first year value**
- **You can apply an optional escalation rate to the PPA price**
  - SAM does not apply inflation to the PPA price

Metrics table

Metric	Base
Annual Energy	32,417,342 kWh
PPA price	19.17 ¢/kWh
LCOE Nominal	20.59 ¢/kWh
LCOE Real	16.72 ¢/kWh
Internal rate of ret	
Minimum DSCR	
Net present value (	
Calculated ppa esca	
Calculated debt fra	
Capacity Factor	
First year kWhac/k	
System performanc	
Total Land Area	

This example shows the effect of a 1% PPA escalation rate

View and export data: Graphs Tables Cash Flows Time Series Loss Diagram

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

Project cash flow

	0	1	2	3	4	5	6	7
Energy (kWh)	0	…417,342	32,255,256	32,093,978	31,933,510	31,773,842	31,614,972	31,45
Energy Price ($/kWh)	0	0.192	0.194	0.196	0.198	0.2	0.202	
Energy Value ($)	0	6,215,721.5	6,246,489.5	6,277,409	6,308,482.5	6,339,709.5	6,371,091	6,40

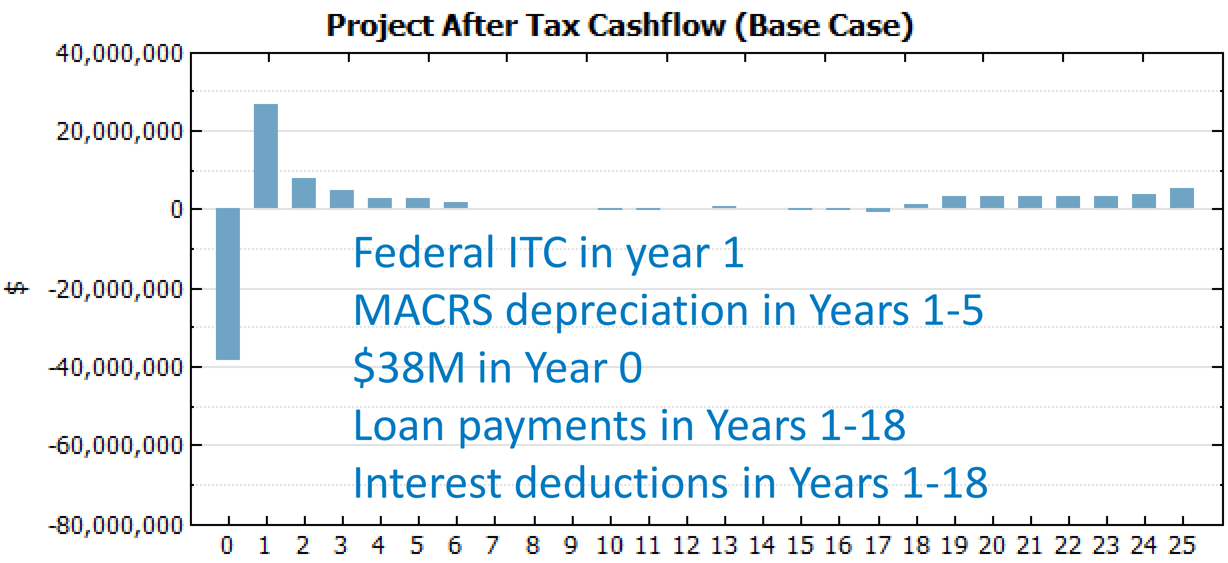
The next version of SAM will allow you to specify a different PPA price for each year.

Debt Service Coverage Ratio and Debt Fraction

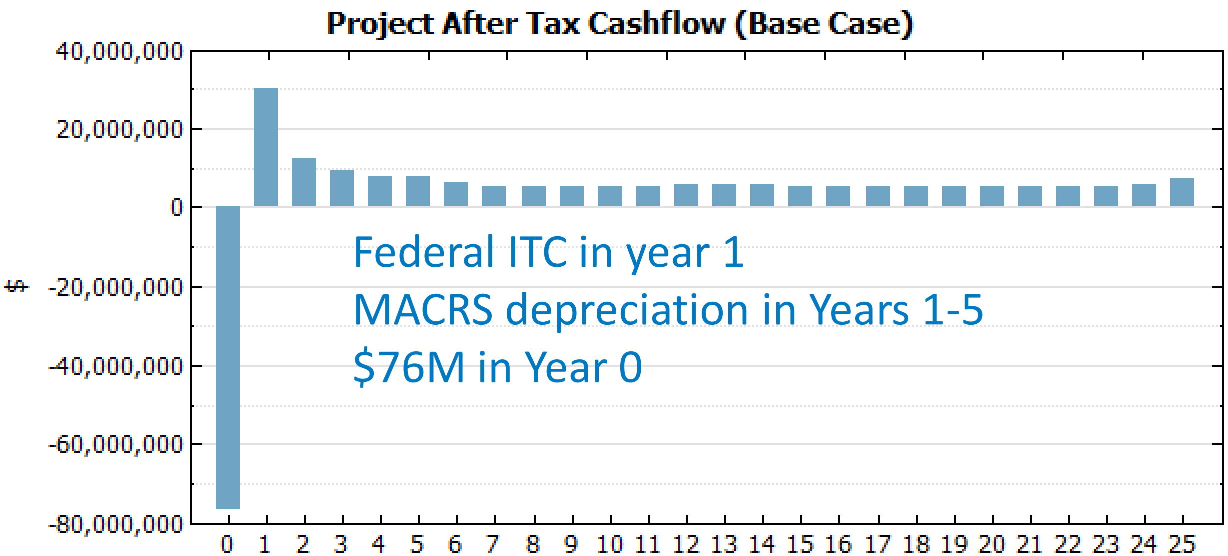
- **Debt fraction is the ratio of amount borrowed to the total installed cost**
- **Debt service coverage ratio (DSCR) is the ratio of operating income to expenses in each year**
- **For Commercial PPA and Utility IPP models, debt fraction is an input**
  - You can have SAM optimize the debt fraction for you
  - DSCR for each year is a result in the cash flow table
  - Minimum DSCR is a result in the Metrics table
- **For single owner, partnership and sale leaseback models, DSCR is an input**
  - Debt fraction is a result that depends on DSCR and debt terms
  - Models assume constant DSCR

Flat Plate PV and Single Owner financing with and without debt

SAM 2013.1.15



$76M installed cost
51% debt
17.3 cents/kWh PPA Price
12.6% IRR
$1.7M NPV



$76M installed cost
0% debt
17.3 cents/kWh PPA Price
6.89% IRR
-$13M NPV

The levelized cost of energy (LCOE) definition

SAM 2013.1.15

The value in \$/kWh, which, if multiplied by energy in kWh generated (or saved) over the project life, equals the present value of the project in \$

$$\sum_{n=1}^{N} \frac{Q_n \times \mathrm{LCOE}}{(1+d)^n} = \sum_{n=0}^{N} \frac{CF_n}{(1+d)^n}$$

Cost of installing, financing and operating the system per unit of energy over the project life in \$/kWh

Energy is electricity

Accounts for:

- Installation costs
- Operating costs
- Electric energy generated

$$\mathrm{LCOE} = \frac{\sum_{n=0}^{N} \frac{CF_n}{(1+d)^n}}{\sum_{n=1}^{N} \frac{Q_n}{(1+d)^n}}$$

Q = energy in kWh, CF = after-tax cash flow in \$
n = year, N = analysis period in years, d = annual discount rate

LCOE for PPA projects

SAM 2013.1.15

Amount the project must receive for each unit of energy ($/kWh) to cover costs *and project IRR requirements*

Accounts for:

- Installation costs
- Operating costs
- Electric energy generated
- Additional revenue required to meet target IRR

$$\mathrm{LCOE} = \frac{\sum_{n=1}^{N} \frac{P_n \times Q_n}{(1+d)^n}}{\sum_{n=1}^{N} \frac{Q_n}{(1+d)^n}}$$

Q = energy in kWh, P = PPA price in $/kWh

n = year, N = analysis period in years, d = annual discount rate

PPA price, real LCOE, and nominal LCOE for PPA Projects

SAM calculates the nominal discount rate from the real discount rate and inflation rate

$$d_{nominal} = (1 + d_{real}) \times (1 + i) - 1$$

The PPA Price may be fixed, or increase annually based on the escalation rate you specify

$$P_n = P \times (1 + e)^n$$

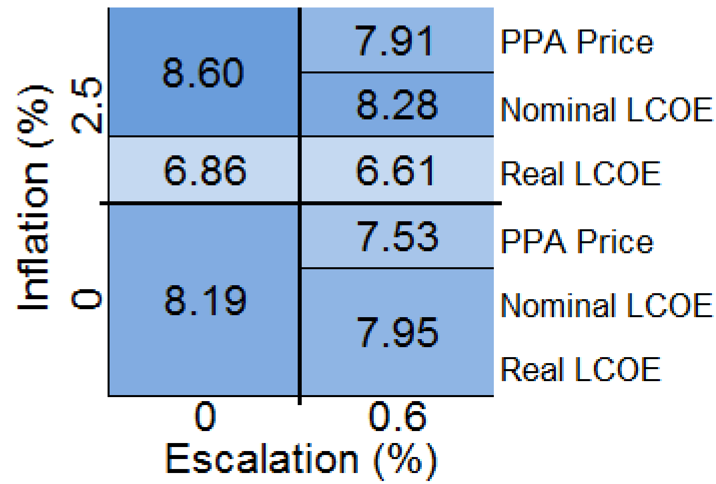
The form of the discount rate in the denominator determines the form of the LCOE

$$\text{nominal LCOE} = \frac{\sum_{n=1}^{N} \frac{P_n \times Q_n}{(1 + d_{\text{nominal}})^n}}{\sum_{n=1}^{N} \frac{Q_n}{(1 + d_{\text{nominal}})^n}}$$

$$\text{real LCOE} = \frac{\sum_{n=1}^{N} \frac{P_n \times Q_n}{(1 + d_{\text{nominal}})^n}}{\sum_{n=1}^{N} \frac{Q_n}{(1 + d_{\text{real}})^n}}$$

Real LCOE: Constant dollar, inflation-adjusted value

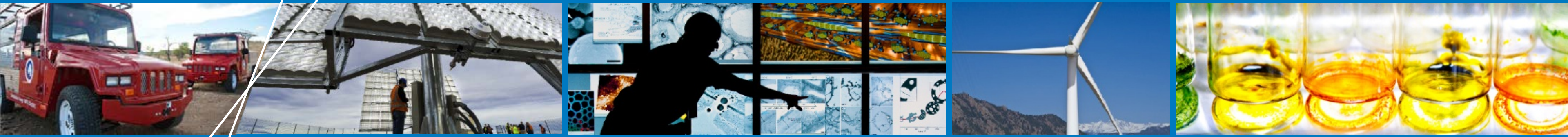
Nominal LCOE: Current dollar value



d = annual discount rate, i = inflation rate, P = PPA price in \$/kWh, e = PPA price escalation rate
Q = energy in kWh, n = year, N = analysis period in years

Summary of SAM Financial Models

- **They are pro forma cash flow models from the project perspective**
- **They use hourly output values calculated by the performance model to represent power production in Year 1**
    - Optional performance adjustment factors can adjust Year 1 production to estimate effects of annual degradation, system availability, curtailment, etc.
- **You provide input values for installation and operating costs, financial parameters, and incentives**
- **Different models generate different metrics, but all show LCOE, PPA price, IRR, and NPV**
- **You should evaluate the metrics as a set**



Troubleshooting PPA Model Results

The financial model results may not be valid for different reasons

- **Your assumptions are for a financially infeasible project**
  - Negative NPV
  - IRR much greater than the desired target
  - IRR is zero
- **SAM could not find a solution**
  - PPA Price = 400 cents/kWh (maximum limit)

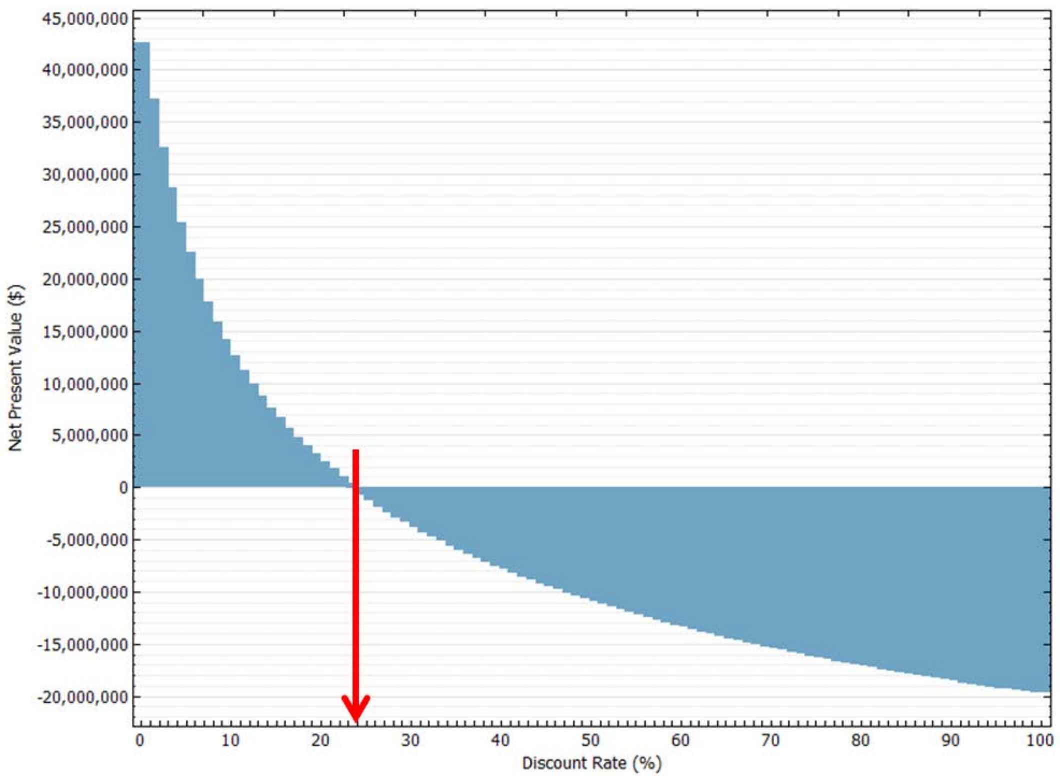
Calculating the IRR from a given PPA price is fairly straightforward

$$\text{NPV} = CF_0 + \sum_{n=1}^{N} \frac{P_n \times Q_n + B_n - C_n}{(1 + \text{IRR})^n} = 0$$

n	$C_{AfterTax,n}$
0	$ -18,663,700
1	$ 12,195,000
2	$ 8,671,650

$$\text{NPV} = -18{,}663{,}700 + \frac{12{,}195{,}000}{(1+\text{IRR})^1} + \frac{8{,}671{,}650}{(1+\text{IRR})^2} = 0$$

A simple two-year example to calculate by hand:
IRR = 38.4%



You can use a parametric analysis on discount rate in SAM to see how it determines the IRR

Calculating a PPA price to meet a desired minimum IRR is not trivial

$$\mathrm{NPV} = CF_0 + \sum_{n=1}^{N} \frac{P_n \times Q_n + B_n - C_n}{(1 + \mathrm{IRR})^n} = 0$$

After Tax Cash Flow in Year Zero = - (1 - Debt Fraction)
× (Total Installed Cost
+ Total Construction Financing Cost
- Total IBI
- Total CBI)

After Tax Cash Flow in Year n>0 = Operating Income
+ State Tax Savings
+ Federal Tax Savings
+ Total PBI
- Total Debt Payment

Operating Income = Energy Value - Operating Costs

Energy Value ($) = Energy (kWh) × Energy Price ($/kWh)

Operating Costs = Fixed O&M Annual + Fixed O&M + Variable O&M + Fuel + Insurance + Property Taxes - Salvage Value

The solution is iterative

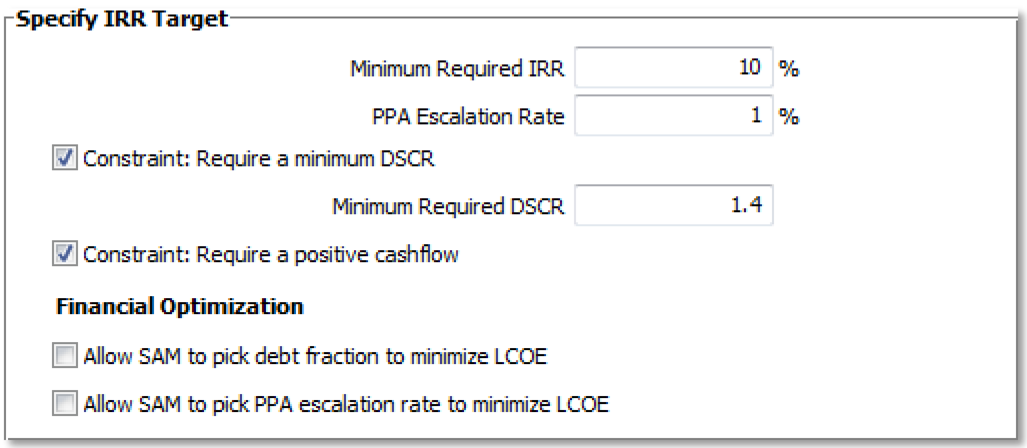
1. Calculate after-tax cash flow based on initial PPA price guess
2. Solve for IRR

$$\mathrm{NPV} = \sum_{n=0}^{N} \frac{\mathrm{CF}_n}{(1+\mathrm{IRR})^n} = 0$$

3. If resulting IRR is less than minimum target, increase PPA price guess
4. Repeat Steps 2 and 3 until IRR is within an acceptable tolerance

Utility IPP constraints help ensure that the algorithm finds a reasonable solution

- **Require a minimum DSCR**
  - o Forces PPA price to be high enough to ensure the minimum DSCR value you specify
- **Require a positive cash flow**
  - o Forces the PPA price to be high enough to ensure a positive cash flow in all years



Scenario 1: Negative NPV

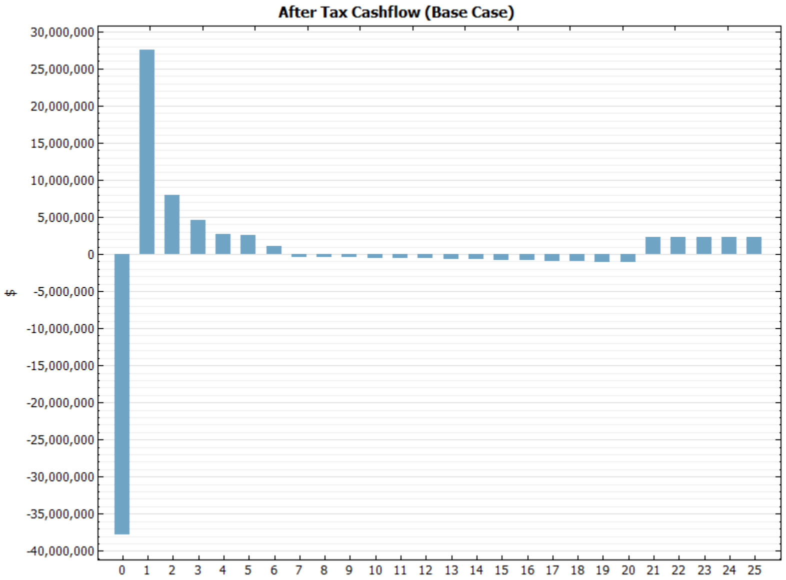
Symptoms:

- Reasonable PPA price
- Meets target IRR
- Reasonable minimum DSCR
- Negative NPV

Project income insufficient to cover initial investment.

Possible solutions:

- Increase debt (decreases initial investment, increases tax savings)
- Decrease operating expense(s) or increase production-based incentives
- Decrease discount rate
- Impose positive cash flow constraint (Utility IPP only)
- Impose minimum DSCR constraint (Utility IPP only)



Metric	Base
Annual Energy	32,417,342 kWh
PPA price	13.84 ¢/kWh
LCOE Nominal	14.86 ¢/kWh
LCOE Real	12.07 ¢/kWh
Internal rate of return (%)	10.00 %
Minimum DSCR	1.07
Net present value ($)	$ -504,328.75
Calculated ppa escalation (%)	1.00 %
Calculated debt fraction (%)	50.00 %
Capacity Factor	18.5 %
First year kWhac/kWdc	1,621
System performance factor (%)	0.83
Total Land Area	66.01 acres

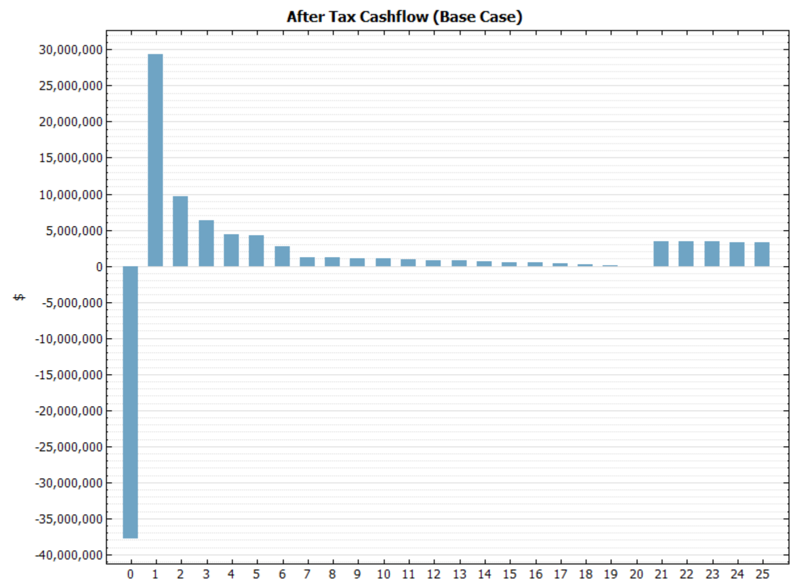
Scenario 2: IRR is too high

SAM 2013.1.15

Symptoms:
- Reasonable-to-high PPA price
- High IRR
- Reasonable minimum DSCR
- Positive NPV

Project income is more than needed to cover initial investment.

Possible solutions:
- Increase PPA escalation rate
- Increase operating expense(s) or decrease production-based incentives
- Decrease discount rate
- Impose positive cash flow constraint (Utility IPP only)
- Impose minimum DSCR constraint (Utility IPP only)



Metric	Base
Annual Energy	32,417,342 kWh
PPA price	23.16 ¢/kWh
LCOE Nominal	23.16 ¢/kWh
LCOE Real	18.81 ¢/kWh
Internal rate of return (%)	25.22 %
Minimum DSCR	1.61
Net present value ($)	$ 12,818,530.00
Calculated ppa escalation (%)	0.00 %
Calculated debt fraction (%)	50.00 %
Capacity Factor	18.5 %
First year kWhac/kWdc	1,621
System performance factor (%)	0.83
Total Land Area	66.01 acres